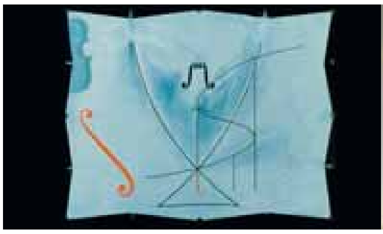
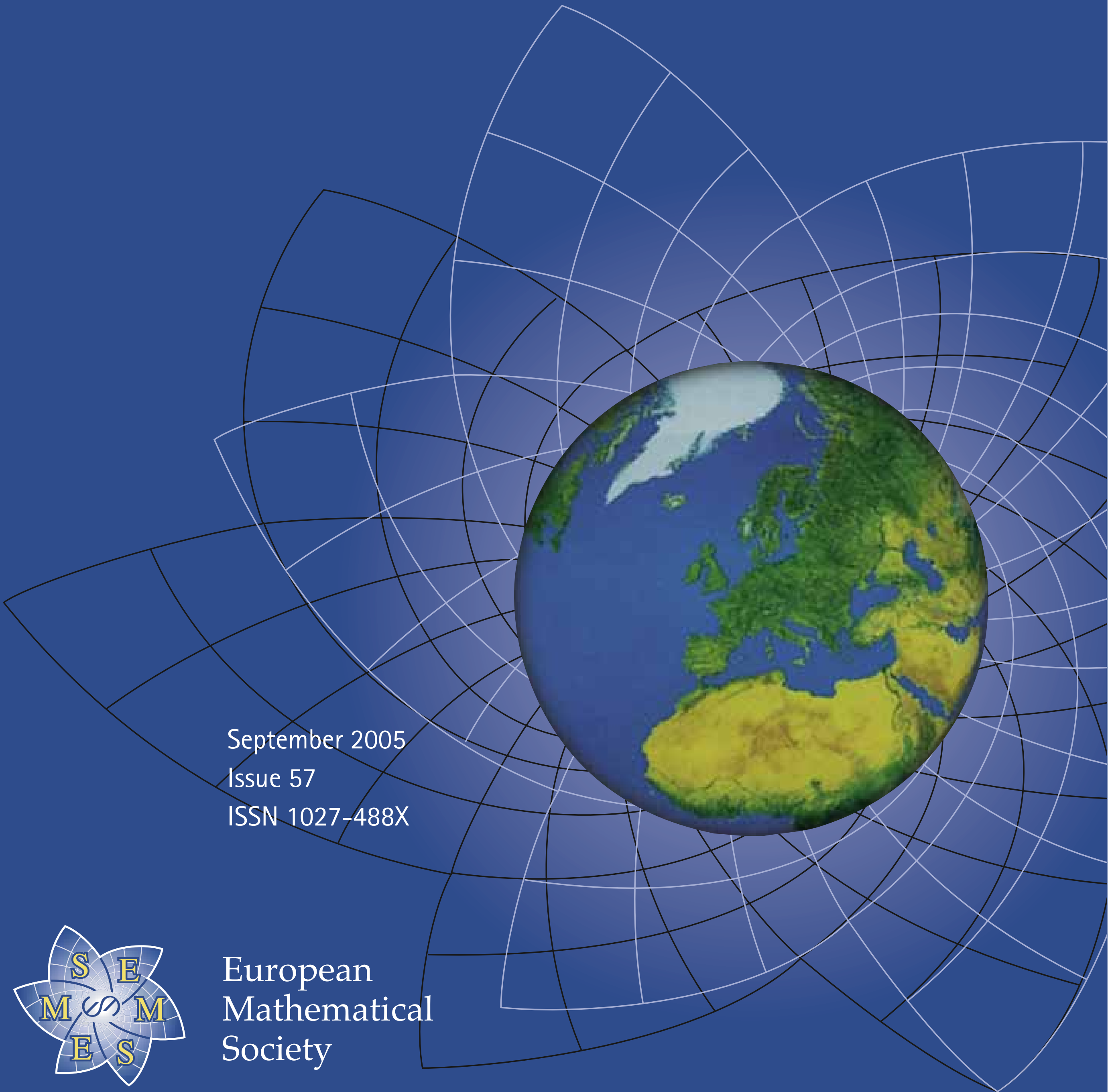
NEWSLETTER

OF THE EUROPEAN MATHEMATICAL SOCIETY





September 2005
Issue 57
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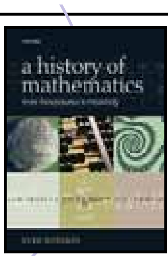
European
Mathematical
Society

| Mathematics Books from Oxford | www.oup.com |

A History of Mathematics From Mesopotamia to Modernity



Luke Hodgkin

A History of Mathematics: From Mesopotamia to Modernity covers the evolution of mathematics through time and across the major Eastern and Western civilizations. Containing more than 100 illustrations and figures, this text, aimed at advanced undergraduates and postgraduates, addresses the methods and challenges associated with studying the history of mathematics.

June 2005 | 296 pages
0-19-852937-6 | Hardback £39.50

Spectral/hp Element Methods for Computational Fluid Dynamics Second Edition

George Karniadakis and **Spencer Sherwin**

Provides a detailed explanation of the key concepts underlying the methods along with practical examples of their derivation and application, and is aimed at students, academics and practitioners in computational fluid mechanics, applied and numerical mathematics, computational mechanics, aerospace and mechanical engineering and climate/ocean modelling.

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June 2005 | 668 pages
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Inverse Eigenvalue Problems: Theory, Algorithms, and Applications

Moody Chu and Gene Golub

Authored by two world-renowned researchers, the book is aimed at graduates and researchers in appliedmathematics, engineering and computer science and makes an ideal graduate text.

NUMERICAL MATHEMATICS AND SCIENTIFIC COMPUTATION SERIES

June 2005 | 406 pages
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The Diophantine Frobenius Problem

Jorge L. Ramírez Alfonsín

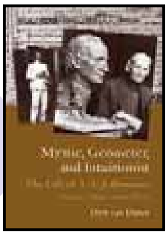
A number of methods, from several areas of mathematics, have been used in the hope of finding a formula giving the Frobenius number and algorithms to calculate it. The main intention of this book is to highlight such methods, ideas, viewpoints and applications to a broader audience.

OXFORD LECTURE SERIES IN MATHEMATICS AND ITS APPLICATIONS

December 2005 | 250 pages
0-19-856820-7 | Hardback £55.00

Mystic, Geometer, and Intuitionist: The Life of L.E.J. Brouwer

Volume 2: Hope and Disillusion



Dirk van Dalen

This book, the second in a two volume set, provides a sophisticated analysis of a crucial era of mathematical research and gives an important insight into the wider life of Brouwer one of the most fascinating characters involved.

.August 2005 | 512 pages
0-19-851620-7 | Hardback £80.00

Invitation to Fixed-Parameter Algorithms

Rolf Niedermeier

This research-level text is an application-oriented introduction to the growing and highly topical area of the development and analysis of efficient fixed-parameter algorithms for hard problems.

OXFORD LECTURE SERIES IN MATHEMATICS AND ITS APPLICATIONS

December 2005 | 312 pages
0-19-856607-7 | Hardback £55.00

Computational Text Analysis for functional genomics and bioinformatics

Soumya Raychaudhuri

This book brings together the two disparate worlds of computational text analysis and biology and presents some of the latest methods and applications to proteomics, sequence analysis, and gene expression data.

January 2006 | 256 pages
0-19-856741-3 | Paperback £35.00
0-19-856740-5 | Hardback £65.00

From Sets and Types to Topology and Analysis

Towards practicable foundations for constructive mathematics

Edited by **Laura Crosilla and Peter Schuster**

This edited collection bridges the foundations and practice of constructive mathematics and focuses on the contrast between the theoretical developments, which have been most useful for computer science.

OXFORD LOGIC GUIDES

October 2005 | 400 pages
0-19-856651-4 | Hardback £75.00

REVISED EDITION

Models for Discrete Data

Daniel Zelterman

This revised edition illustrates the statistical analysis of data using computer programs in SAS, a widely used software package in the health sciences. Many numerical examples are provided to illustrate the methods and these are discussed along with the corresponding computer output. Several new datasets are included, mostly from the health and medical sector.

March 2006 | 352 pages
0-19-856701-4 | Hardback £50.00

Statistical Evidence in Medical Trials

Mountain or molehill, what do the data really tell us?

Stephen Simon

A lucid, well-written and entertaining text that addresses common pitfalls in experimental design, ideal for students and researchers in statistics, health care professionals, and anyone needing to correctly analyse and assess statistical data .

February 2006 | 208 pages
0-19-856760-X | Hardback £65.00
0-19-856761-8 | Paperback £25.00

Editorial Team

European Mathematical Society

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EMS Executive Committee

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Prof. Sir John Kingman
(2003–06)
Isaac Newton Institute
20 Clarkson Road
Cambridge CB3 0EH, UK
e-mail: emspresident@newton.cam.ac.uk

Vice-Presidents

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(2003–06)
Department of Mathematics
Université Libre de Bruxelles
C.P. 218 – Campus Plaine
Bld du Triomphe
B-1050 Bruxelles, Belgium
e-mail: llemaire@ulb.ac.be

Prof. Pavel Exner
(2005–08)
Department of Theoretical Physics, NPI
Academy of Sciences
25068 Rez – Prague
Czech Republic
e-mail: exner@uif.cas.cz

Secretary

Prof. Helge Holden
(2003–06)
Department of Mathematical Sciences
Norwegian University of Science and Technology
Alfred Getz vei 1
NO-7491 Trondheim, Norway
e-mail: h.holden@math.ntnu.no

Treasurer

Prof. Olli Martio
(2003–06)
Department of Mathematics and Statistics
P.O. Box 68
(Gustav Hällströmintie 2B)
FI-00014 University of Helsinki
Finland
e-mail: olli.martio@helsinki.fi

Ordinary Members

Prof. Victor Buchstaber
(2005–08)
Steklov Mathematical Institute
Russian Academy of Sciences
Gubkina St. 8
Moscow 117966, Russia
e-mail: buchstab@mendeleevo.ru

Prof. Doina Cioranescu
(2003–06)
Laboratoire d'Analyse Numérique
Université Paris VI
4 Place Jussieu
F-75252 Paris Cedex 05, France
e-mail: cioran@ann.jussieu.fr

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(2005–08)
Department de Geometria i Topologia
Fac. Matematiques
Universitat de Valencia
Avda. Vte. Andres Estelles, 1
E-46100 Burjassot, Valencia
Spain
e-mail: Olga.Gil@uv.es

Prof. Carlo Sbordone
(2005–08)
Dipartmento de Matematica "R. Caccioppoli"
Università di Napoli "Federico II"
Via Cintia
80126 Napoli, Italy
e-mail: carlo.sbordone@fastwebnet.it

Prof. Klaus Schmidt
(2005–08)
Mathematics Institute
University of Vienna
Nordbergstrasse 15
A-1090 Vienna, Austria
e-mail: Klaus.schmidt@univie.ac.at

EMS Secretariat

Ms. T. Mäkeläinen
Department of Mathematics and Statistics
P.O. Box 68
(Gustav Hällströmintie 2B)
FI-00014 University of Helsinki
Finland
Tel: (+358)-9-1915-1426
Fax: (+358)-9-1915-1400
Telex: 124690
e-mail: tuulikki.makelainen@helsinki.fi
Web site: http://www.emis.de

EMS Calendar

2005

10–16 September EMS Summer School and Séminaire Européen de Statistique at Warwick (UK)
Statistics in Genetics and Molecular Biology
Web site: www2.warwick.ac.uk/fac/sci/statistics/news/semstat

13–23 September EMS Summer School at Barcelona (Catalunya, Spain)
Recent trends of Combinatorics in the mathematical context
Web site: www.crm.es/RecentTrends

16–18 September EMS-SCM Joint Mathematical Weekend at Barcelona (Catalunya, Spain)
Web site: www.iecat.net/institucio/societats/SCMatematiques/emsweekend/

18–19 September EMS Executive Committee meeting at Barcelona (Catalunya, Spain)
Contact: Helge Holden: holden@math.ntnu.no

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

2006

13–17 March EMS-SIAM-UMALCA Joint meeting in applied mathematics
Venue: the CMM (Centre for Mathematical Modelling), Santiago de Chile

16–18 June Joint EMS–SMAI–SMF Mathematical Weekend, Nantes (France)
Contact: Laurent Guillopé: Laurent.Guillope@math.univ-nantes.fr

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

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

3–7 July *Mathematics and its Applications*: First joint meeting of EMS, SIMAI, SMF, SMAI, and UMI, Torino (Italy)

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

2007

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

2008

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

Editorial

Carlo Sbordone (Napoli, Italy)

The National Mathematical Societies and their partnership with the EMS

Nowadays the National Mathematical Societies operate on many different levels but their goals are always the same:
1) To patronize Mathematical Sciences
2) To encourage interest and research in Mathematics
3) To improve Education
4) To increase Public Awareness of the importance of Mathematical Sciences

The main instruments to achieving these goals are:
- Publications via periodicals and books
- Meetings and Conferences
- Special Committees appointed to interact with educators and governments

Prizes

Equally important are activities to award gifted young mathematicians, which involve cooperation with National Committees of Mathematical Olympiads and the support of young scholars of un derrepresented countries.

Recognition of their accomplishments comes through various prizes. In Italy, for example, we have the Caccioppoli Prize, the Bartolozzi Prize, the Vinti Prize, the Fichera Prize, the Tricerri Prize and the Stampacchia Medal.

In other countries, among many awards, I would like to mention the d'Alembert and the A. Decerf Prize from the SMF, the J.L. Lions Prize, the B. Pascal Prize and the Lagrange Prize from the SMAI and the M. Audin Prize from the SMF and SMAI. The LMS awards the De Morgan Medal, the Polya Prize, the Senior Berwick Prize, the Senior Whitehead Prize, the Naylor Prize, the Berwick Prize, the Frohlich Prize, the Whitehead Prize and the D. Crighton Medal. Other examples are the Cantor medal of the German Mathematical Society, the Brouwer medal of the Royal Dutch Mathematical Society and the Banach Great Prize of the Polish Mathematical Society. The prizes are often judged jointly by different Societies or Institutions. The Catalan SCM and the IEC award the J. Teixidor Prize and the F. Sunyer I Balaguer Prize.

Publications

The assistance in publications of mathematical research is important too. My concern, personally and as a President of Unione Matematica Italiana, is that the publication fees are very often too high, especially by some commercial publishers. I am particularly pleased to observe the increase of publications from, for example, the Publishing Houses of the London Mathematical Society, the French Mathematical Society and the European Mathematical Society. These companies were created by the Mathematical Societies to represent the interests of the mathematical community and they therefore charge less.

Meetings

Following the example of the AMS, we have planned many joint meetings of the National Mathematical Societies, held under the auspices of the EMS: (UMI – SIMAI – SMAI – SMF, July 3–7, 2006 in Torino; DMV – UMI, June 2007 in Perugia; LMS – UMI June 2008 in Napoli). These meetings are excellent occasions to either begin or improve scientific cooperation between individuals or groups of researchers. It is particularly encouraging that more and more young scientists participate in these meetings, due in part to financial support from the EMS. The joint meetings are beneficial to young scholars who want to contribute and interact with more experienced researchers. A positive image of mathematics is given by the presence of young people, helping to convince politicians and governments of the important role they play in their countries. There is no better motivation for them to sponsor these activities.

In today's world, it has become clear that the developing countries have a great desire for mathematics with much mathematical talent. We are very aware that in the economically advanced countries young talented people prefer different careers, as is attested by results of international competitions. Now, in Europe, they must be attracted in much the same way as in the US, with various grants and other financial support.

Educational issues

An important area is to improve public understanding of the importance and power of mathematical education. A way to accomplish this goal is by promoting lectures and publications addressed to general audiences.
Mathematical societies should compare the teaching trends and school curricula adopted in their countries. It would be useful, for example, to publish a book with all updated maths curricula of most European countries. There are countries where the curricula are renewed and improved every year and others that do not modify their programs for decades. The possession of this information could be used by the National Societies and educators to influence governments to adopt the right decisions in the future.

I am confident that these ideas will create a new approach to mathematics for future generations.

Carlo Sbordone [carlo.sbordone@fastwebnet.it] is Professor of Mathematical Analysis at the "Federico II" University of Naples. He is President of the Unione Matematica Italiana and fellow of the Accademia Nazionale dei Lincei. Since the beginning of this year, he has been a member of the executive committee of the European Mathematical Society.

EMS council 2006

EMS council 2006 will be held on July 1–2, at Torino (Turin), preceding the first joint meeting of SIMAI-SMAI-SMF-UMI on Mathematics and its Applications (held under the auspices of the EMS).

Introducing the editorial team, part III

Ivan Netuka studied mathematics at the Faculty of Mathematics and Physics of Charles University in Prague (Czech Republic) where he has been a full professor since 1986 and Dean since 1999. He completed his Ph.D. in 1970 under the supervision of Professor Josef Král. His general background is in both classical and modern mathematical analysis; his main research field is potential theory. His publications concern mostly boundary value problems for partial differential equations on domains with non-smooth boundary, abstract potential theory and harmonic approximation. He is interested in real and complex analysis, measure and integration, convexity and functional analysis. He likes teaching and the history of mathematics. For a long time he was involved in the organization of mathematical competitions for university students. I. Netuka is a corresponding member of the Bavarian Academy of Sciences, Chevalier dans l'Ordre des Palmes Académiques and an honorary member of the Union of Czech Mathematicians and Physicists.

He was involved in the organization of the 1st European Congress of Mathematics in Paris, 1992 (as a member of the committee of Round Table I: Degree Harmonization and Student Exchange Programmes). He was also a member of the Publication Committee of the EMS. Since 1991, together with Vladimír Souček, he has been the editor of the Brief Reviews/Recent Books column of the EMS Newsletter. Ivan is married; his wife is a philologist and both of their sons are surgeons. His non-mathematical interests include languages, poetry, swimming, cooking and he enjoys walking, collecting mathematical stamps and singing.

Chris Nunn is currently halfway through a Ph.D. at Southampton University (UK) where he also completed his undergraduate degree in mathematics and physics. Now he is deep in the realms of general relativity, working under the supervision of Carsten Gundlach on the pernicious problem of boundaries to numerical relativity simulations, hoping that he can help in some way in the search for the Holy Grail of numerical gravity: the simulation of the binary black hole in spiral. Many years ago, he had the honour of winning a place on the training course for the International Mathematical Olympiad but tragically he was not chosen for the team. Despite this, he never lost his love of mathematics and still thinks many of its facets are some of the only truths you can count on in this capricious and fickle world. From this issue on, he works as copy editor of the EMS-Newsletter.

Outside of mathematics his greatest love is of theatre, despite his inconsistent acting talent. Following on from acting at the Edinburgh Fringe Festival two years ago, he is trying his hand at directing a play at the same festival this year. In addition, he has a disputable talent with the violin and loves playing many sports, especially squash, mainly because he appreciates the simplicity of hitting a ball against a wall.

Ulf Persson is professor of mathematics since 1989 at Chalmers University of Technology in Göteborg (Sweden). He got his Ph.D. at Harvard University back in 1975 under the guidance of David Mumford, writing on compact complex surfaces a topic to which he has stayed faithful ever since. Enjoying initially a somewhat peripatetic existence involving a variety of American universities, he has in later decades been geographically more stable.

He served during the years 1997–2001 first as Vice President of the Swedish Mathematical Society and later as its President, giving the occasion to engage in public debate on mathematical education savouring the opportunity to express controversial views. Currently he is the sole editor of the newsletter of the Swedish Mathematical Society, a modestly conceived publication appearing in xeroxed form thrice a year.

Among his hobbies may be noted an interest in mathematical visualization somewhat perversely articulated through a fondness of programming directly in PostScript. A popularly intended work on map projections, as well as on hyperbolic geometry, exploiting those arcane skills, have been stewing for quite some time, and may perhaps in some future see the light of the day.

Mathematics is culture, a fact seldom appreciated beyond the confines of the mathematical community, but which he entertains hopes of making more wildly so through articles in the general press.

Persson is married and has three children, all born within the space of less than three years.

Walter Purkert works at the Mathematical Institute of the Rheinische Friedrich-Wilhelms-Universität in Bonn (Germay). He is responsible for coordination of the Hausdorff-edition, a long-term project of the Nordrhein-Westfälische Akademie der Wissenschaften. Three of the planned nine volumes have already appeared; the next volume will appear in 2005. See the article of E. Scholz in issue 55 of the Newsletter for details.

Walter Purkert obtained a Ph.D. in 1972 from Leipzig University under the supervision of Hans Wussing. He has written a book on Georg Cantor (with a chapter by H.-J. Ilgauds) and is coauthor of a book on random eigenvalue problems (with J. vom Scheidt). He has acted as editor for the EMS-Newsletter with History of Mathematics as his area of responsibility.

He is married to a teacher and has two sons.

Executive Committee Meeting in Capri, 16th April 2005

David Salinger, Publicity Officer

The Unione Matematica Italiana had invited the Executive Committee, to meet on the island of Capri, an invitation impossible to refuse. Those from Northern Europe found the weather warm, those from the South demurred. Because of building works at the hotel, the meeting room was on the small side, opening onto a courtyard, so the talking had to stop whenever a particularly noisy vehicle passed by.

Klaus Schmidt was welcomed to his first meeting. After routine matters came the financial statement and budget. It was the Treasurer's pleasant task to present a surplus of 25,000 euros, after two years of losses. The Committee noted that, though the net cost of the Newsletter had decreased, individual subscriptions at their present level would not continue to cover the costs of production and distribution of the Newsletter.

The Committee accepted the application of the Voronezh Research Institute to become an institutional member.

There had been 28 applications to run EMS Summer Schools in 2006 and 2007, of which 11 were selected to be submitted to the EU Framework 6 programme. The selection had to be made not only on the grounds of quality: all the events had to fit EU rules. If any did not, then the whole submission would be rejected.

Nina Uraltseva's EMS lectures would take place this June in Coimbra and Lisboa. Names, but not locations, had been forthcoming for future years. There was some discussion of whether the Society should favour rising stars over established practitioners. In case any of you still reading this should want to host an EMS lecture series, the EMS pays an honorarium and refunds the lecturer's travel cost. The series has not attracted many applications which are independent of the Executive Committee, which suggests that the format is not quite right. The Committee will return to this question at its next meeting (in Barcelona in September).

The Committee considered what action to take to ensure continuity, given that many of its members were due to retire at the end of 2006. Rather than set up a nominations committee, the whole Executive Committee would continue to look for candidates. A replacement would also have to be found for the publicity officer, whose term of office expires at the end of 2005.

The Committee noted that the report in the Newsletter of its previous meeting had caused some misunderstanding and concern about the Applied Mathematics Committee. The Executive Committee wanted to make it clear that applied mathematics and the applications of mathematics, both traditional and new, were central concerns of the Society. The Applied Mathematics Committee would remain in operation, and new members would be appointed at the next meeting in Barcelona. Meanwhile the President was added to the membership of the Committee, and was asked to redraft the terms of reference to clarify the position.

The Developing Countries Committee was active and would meet in Vienna, funds permitting. The Education Committee wanted to meet in June. The Electronic Publishing Committee was continuing its work, with some new active members. ERCOM, the committee of directors of specific Mathematics Research Institutes, functioned well. It had suggested that EMS establish a 'Friends of Mathematics' group, involving leading industrialists. The Committee for Eastern European Mathematics had expressed a preference for supporting attendance at specialist meetings rather than congresses. The Executive Committee assented.

The EMS Publishing House was taking off in terms of publications. As was to be expected, it was still operating at a loss, but the Treasurer thought that the prospects now were good.

After lunch, we were joined by Andre Ran and Jan Wiegerinck from the Netherlands to discuss 5ecm in 2008 at Amsterdam. On budgetary matters, the main question was whether the registration fee should include the cost of the dinner and the congress proceedings. The other main concern was that the members of the scientific and prize committees should represent a reasonable spread of subjects and countries.

It had proved impossible to hold EMS Council during ICM2006 at Madrid, as originally planned, so the decision of the Italian and French mathematical societies to hold their first joint meeting on 'Mathematics and its Applications' (under the auspices of the EMS) in Turin in July 2006 was timely. The Committee decided to hold Council in Turin on the 1st and 2nd July 2006, just before the joint meeting.

A joint mathematical weekend with the French mathematical societies would take place at Nantes in June.

The Executive Committee liked the Newsletter's new layout. Martin Raussen explained that production through the Publishing House was more complex, but it had worked out well. A new editorial board had been appointed and there was plenty of material for forthcoming numbers.

The President reported that the EU had set up an identification committee to appoint a supervisory board for the proposed European Research Council and that the Society had been asked to suggest names.

The second European Science Open Forum meeting would be held in Munich, in July 2006. The Raising Public Awareness Committee would be asked to help with the EMS contribution.

The meeting ended in good time to get ready for the evening meal, but not before the President had thanked our hosts for providing such a wonderful time in Capri.

International Conference on Differential Equations
From Theory to Computational Science and Engineering

On the Occasion of Rolf Jeltsch's 60th Birthday
October 20-22, 2005 ETH Zurich, Switzerland

Keynote speakers

* Constantine Dafermos, Brown University, USA
* Peter Deuflhard, Konrad-Zuse-Zentrum für Informationstechnik Berlin, Germany
* Björn Engquist, University of Texas, Austin, USA
* Moshe Goldberg, Technion, Israel
* Martin Grötschel, Konrad-Zuse-Zentrum für Informationstechnik Berlin, Germany
* Wilfred van Gunsteren, ETH-Zurich, Switzerland
* Barbara Keyfitz, The Fields Institute, Ontario, Canada
* Rupert Klein, Potsdam Institut for Climate Impact Research, Potsdam, Germany
* Egon Krause, RWTH-Aachen, Germany
* Heinz Kreiss, University of California, Los Angeles, USA
* Olavi Nevanlinna, Helsinki University of Technology, Finland
* James Sethian, University of California, Berkeley, USA
* Ian Sloan, University of New South Wales, Australia
* Eitan Tadmor, University of Maryland, College Park, USA
* Aslak Tveito, SIMULA Research Laboratory, Norway
* Gerhard Wanner, University of Geneva, Switzerland

If you want to participate, please registrate at http://www.sam.math.ethz.ch/rolf60/registration
To contribute a talk, please contact one of the co-ordinators before July 31st.

We are looking forward to a pleasant get-together with Rolf Jeltsch's exciting academic family, colleagues and friends.
Welcome to Zurich, downtown Switzerland! http://www.zuerich.com/

Important dates
19 Oct. 6-8 pm Welcome and Registration
20 Oct. 9 am Opening
22 Oct. 3.30 pm End

Co-ordinators
Achim Schroll, Lund University, Sweden, http://www.maths.lth.se/na/staff/achim
Michael Fey, ETH-Zurich, Switzerland fey@sam.math.ethz.ch

The First Congress of Young Polish Mathematicians

September 17–19th 2004 in Warsaw.

Stanisław Janeczko (Warsaw, Poland)

The Congress was organised by the Polish Mathematical Society and the Institute of Mathematics of the Polish Aca demy of Sciences in co-operation with the Polish Children's Fund (www.fundusz.org/fundusz.php) and the Central Committee of Mathematical Olympiad (www.om.edu.pl/).

This event was the first attempt to bring together highly gifted pupils sharing an interest in mathematics, those for whom mathematics is a passion and an intellectual inspiration. For most of the young participants it was their first scientific meeting (not competitive like the Olympic Games but rather a sharing of common interests in successful team work). One of the Congress's major objectives was to pursue and develop their academic interests and talents. This is a future "investment"; perhaps some of them will become a basis for future mathematics. The realisation of this new idea to organise a congress for these young mathematicians seemed to be quite successful and the next Congress of Young Polish Mathematicians is planned for 2008.

Participants

The Congress gathered about 300 pupils, ranging from 16 to 19 years old, from all over the country. There was also an international influence, with participants from Vilnius and Rezekne (Lithuania) and Riga (Latvia). Half of the participants of the Congress were selected by the regional education authorities (*Kuratoria Oswiaty*) from the pupils chosen directly by schools and the Polish Children's Fund and the Central Committee of Mathematical Olympiad selected were rest.

Programme

Several plenary lectures were given by well-known Polish mathematicians. Besides the main lectures, 21 twenty-minute talks were given by young participants. These short presentations were chosen from many submitted abstracts. The main lectures concerned topics such as: introduction to qualitative theory of differential equations, genom mathematics, discrete mathematics, the Wiener process, function singularities and knot theory. The discussions after these lectures proved that they were given at a level understandable as well as interesting for the young mathematicians. Short talks were given in sections devoted mainly to the following topics: fractals, chess and fabular games, geometry, cryptology, number theory and the foundations of mathematics.

Prof. Stanisław Janeczko is the director of the institute of mathematics of the Polish Academy of Sciences.

◄ **Youth involved in the Universe**

▼ **Congress participants**

First Czech-Catalan Conference in Mathematics

Prague, May 27–28, 2005

Carles Casacuberta (Barcelona, Catalunya, Spain)
and Jan Kratochvíl (Prague, Czech Republic)

The stamp coupons arranged for the conference display its logo, combining Czech and Catalan features – the City Hall Tower from the Old Town Square in Prague, whose clock is replaced by a window from the crypt in Colònia Güell near Barcelona, which was designed by the world famous architect Antoni Gaudí.

Josep María Font and Petr Hájek entertaining the participants after hours.

In the last weekend of May, Prague hosted the first meeting organized jointly by the Czech and Catalan Mathematical Societies. The idea of organizing a joint event originated about a year ago, during the preparation of an agreement about reciprocal membership and collaboration between the two societies. This agreement was signed in September 2004 during the Second Mathematical Weekend in Prague, an event sponsored by the EMS. Signing the agreement in the presence of the EMS Executive Committee was understood as a gesture of unification trends in Europe but the agreement itself, based on existing intensive collaboration between our members, is certainly not an empty gesture. The first joint conference has proven this beyond any doubts.

The official conference photo taken in the Lesser Town Square behind the faculty building.

The organization of the conference followed the pattern of the joint mathematical weekends of the EMS. The scientific program ran in parallel sessions representing the branches of mathematics with strongest existing collaborations. Each session organized a plenary talk that introduced the relevant area to all participants. Though we were aware of strong links among Czech and Catalan mathematicians, we have been more than pleasantly surprised by the response from our societies. A strong scientific program of six parallel sessions: Computational Statistics and Data Analysis, Discrete Mathematics and Combinatorics, Homotopy Theory, Logic, Real and Functional Analysis and Ring and Module Theory, attracted over 100 registered participants, not only from Czechia and Catalunya.

The venue of the conference was the same as for the Mathematical Weekend in 2004: the recently restored building of the Faculty of Mathematics and Physics of Charles University in Lesser Town, close to celebrated historical monuments such as Prague Castle, Old Town Square, Charles Bridge and the Astronomical Clock. The conference opened with short speeches by Jan Kratochvíl (partly in Catalan) and Carles Casacuberta (partly in Czech). The program and abstracts of all talks can be found on the conference web page: http://cms.jcmf.cz/czech-catalan/. At the official toast during the conference banquet, we tasted the warm rays of Catalan sun – it was symbolically accompanied by Catalan cava brought by the Catalan participants, who also announced the intention to organize a second joint conference in Barcelona in September 2006. In turn, the Catalan guests were entertained in a very friendly atmosphere and with warm hospitality. We greatly appreciate and thankfully acknowledge the support of all co-organizing institutes (the Faculty of Mathematics and Physics of the Charles University in Prague, the Faculty of Science of the Masaryk University in Brno, the Faculty of Applied Sciences of the West Bohemia University in Pilsen, the Mathematical and Computer Science Institutes of the Academy of Sciences of the Czech Republic and the Institute of Theoretical Computer Science ITI) and the work of the organizing committee led by Jiří Fiala, the secretary of the Czech Mathematical Society.

Carles Casacuberta is the President of the Catalan Mathematical Society.
Jan Kratochvíl is the President of the Czech Mathematical Society.

Plenary talks

Marc Noy
(Universitat Politècnica de Catalunya, Barcelona): *Random Planar Graphs*
Pavel Pudlák
(Czech Academy of Sciences, Prague):
Can quantum theory help us prove theorems?
Bernhard Keller
(Université Paris 7): *Cluster algebras and triangulated categories*
Alberto Facchini
(University of Padova): *Direct-sum decompositions in additive categories*
Jaroslav Lukeš
(Charles University, Prague): *An interplay between real functions theory and potential theory*
Jaume Barceló
(Universitat Politécnica de Catalunya, Barcelona): *Statistical methods for the calibration and validation of simulation models*

Ferran Sunyer i Balaguer Prize awarded

fundació FERRAN SUNYER I BALAGUER
institvt d'estvdis catalans

On April 22, 2005, the Fundació Ferran Sunyer i Balaguer awarded the 2005 Ferran Sunyer i Balaguer Prize to Antonio Ambrosetti and Andrea Malchiodi of SISS in Triestre by the monograph „Perturbation Methods and Semilinear Elliptic Problems on R^n" and to José Seade the Universidad Autónoma de México by the monograph "On the topology of isolated singularities in analytical spaces".

Antonio Ambrosetti and Andrea Malchiodi

The monograph by Ambrosetti and Malchiodi is a valuable and well written text on perturbation methods in critical point theory and its applications to elliptic partial differential equations in R^n with variational structure. It develops an abstract perturbative method that combines the classical Liapunov-Schmidt procedure with a variational technique to handle the bifurcation equation. The method overcomes the lack of compactness in several elliptic problems posed on all of R^n, leading in this way to numerous applications to problems in Physics and Differential Geometry, all of them very well described in the monograph.

José Seade

The content of this monograph may be divided in two parts. The first part is mostly about complex singularities; it surveys classical results which are spread in a vast literature: Milnor's fibration theorem, exotic spheres, the relation with 3-dimensional Lie groups, Arnold's theorem that $P^2(C)$ modulo conjugation is the 4-sphere, and the relation of complex surface singularities with 3-manifolds invariants.

The second part is about real singularities with geometric properties similar to those of complex singularities: real analytic functions into R^2 with an associated Milnor fibration, and families of real analytic singularities determined by the dynamics of holomorphic vector fields and foliations in the complex domain; in the low-dimensional case these turn out to be equivalent to singularities of the form fg with f and g being complex valued holomorphic functions.

About the prize

Ferran Sunyer i Balaguer was a self-taught catalan mathematician very active in classical Mathematical Analysis. Since April 1993 the Ferran Sunyer i Balaguer Foundation awards a mathematical monograph of an expository nature. The prize amounts to 10.000 euros and the publication of the monograph through Birkhäuser Verlag.

For a list of previous winners and for the announcement concerning next years' prize, see the web page http://www.crm.es/FerranSunyerBalaguer/ffsb.htm .

International Graduate College

Universität Bielefeld
Stochastics and Real Word Models
Internationales Graduiertenkolleg

„Stochastics and Real World Models"

In the framework of an International Graduate College (International Research Training Group, supported by DFG) we offer fellowships, for a PhD program starting January 1, 2006 (in special cases also from October 2005), for up to 3 years duration.

The program is organized by the Bielefeld University **Mathematics** Department in cooperation with the Departments of **Economics** and of **Physics**, and together with the **Chinese Academy of Science** in Beijing. Doctorate degrees will be awarded by one of the three Departments of Bielefeld University. The interdisciplinary training and research program is oriented towards the study of modern methods in stochastics and their application in physics and in economics.

A structured course program will enable students to undertake research projects without undue delay. Lectures and courses by visiting scientists, as well as the exchange program with China will further contribute to a broad and internationally viable education.

Graduates (Master level) from the aforementioned three fields with a pronounced interest in mathematics and its interdisciplinary applications are encouraged to apply (as a rule candidate should not be older than 28 years).

For further information consult also
http://www.physik.uni-bielefeld.de/bibos/college/index.html

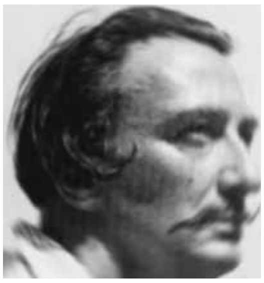
Deadline: 30.09.2005. Post-deadline applications may possibly also be considered.

Please submit your application with CV, copies of diplomas and certificates, a sketch of your research interests, and the names and e-mail addresses of two referees, to

Prof. Dr. Michael Röckner
Fakultät für Mathematik
Universität Bielefeld
Postfach 100131
D-33501 Bielefeld

Paranoia or transcendental topology? Salvador Dalí, 100 years

Rafael Pérez Gómez (Granada, Spain)



Salvador Dalí (1904–1989)

Why should we discuss a character who sent telegrams to Franco congratulating him for the death sentences dealt out to Basque separatists, someone who turned his artwork into marketing merchandise, a person whose life was rooted in childhood traumas that he never managed to overcome (for example, masturbation as a reaction to the fear of contracting venereal disease and the constant presence of locusts in his paintings), someone who is viewed by society as a selfish eccentric: the divine Dalí!?

On May 11, 1904, **Salvador Felipe Jacinto Dalí y Domènech** was born in Figueras. His figure illustrates the duality between human failure and artistic genius. He dominated marketing techniques, presenting his work under the guise of a person possessed by madness: his image, with the huge handlebar moustache that would eventually become his trademark, and the representation of a "catastrophe." His provocations were great publicity stunts: on one occasion, after the announcement of his arrival at one of his exhibitions, instead of Dalí emerging when the chauffeur opened the limousine door, hundreds of oranges rolled out onto the street. Notwithstanding such peculiarities, as a painter he bears comparison with any of the geniuses that the painting world has ever seen. And therefore I will talk about the work of "Dalí the divine", as he held himself to be, from the perspective that concerns me – as a mathematician.

A painter of the Third Culture

Beneath this original self-made character lies an artist of brilliant intelligence and extensive cultural knowledge, who always conceived his painting as a road to knowledge. To the question posed by a journalist of '*Le Figaro*', "Why are you so interested in science?" Dalí responded, "Because artists scarcely interest me. I believe that artists should have scientific notions in order to tread on other terrain, that of unity."

If we wish to gain some insight into the background of a person, one good indication comes from a glance at his or her personal library. Dalí's library contained over one hundred scientific texts, with annotations made in the margins. Furthermore, as Carme Ruiz of the '*Centro de Estudios Dalinianos*' explains in an article titled 'Salvador Dalí and Science', "Not only did we find these books, but also many scientific magazines that kept him continuously up to date, to which he subscribed up until the time of his death."

Our society now recognizes science as culture, besides its role as an engine for economic and technological development. Far behind us lie the theories of C.P. Snow, expounded in his book, '*The Two Cultures and A Second Look: An Expanded Version of The Two Cultures and the Scientific Revolution*' (1962), where he denounces the division between the scientific community and the work of those traditionally held up as intellectuals. At present, a culture is emerging known as The Third Culture – '*The Third Culture: Beyond the Scientific Revolution*' (1995), which does not make a distinction between "belles lettres" and the sciences. Moreover, in the particular case of "the queen of the sciences", i.e. Mathematics, Martin Rees, an astrophysicist continually on the front line of cosmological debate, affirms that "there exists an important separation between those who get on well with mathematics and those who do not", in reference to the requirement of mathematical knowledge for the integral development of the human being. In this sense, Dalí was well ahead of his time. In his background, the arts and the sciences are well blended, with mathematics occupying an important position, as is inferred from his works.

His friends – a source of knowledge

The other great source of knowledge on Dalí is his friends. We know of his relationship with Federico García Lorca, who served as the inspiration for '*The Last Supper*' (1955) among other works, and with Luis Buñuel, with whom he made '*Un Chien Andalou*', an excellent film with no linear narrative, full of oneiric symbolism. Both these friendships came from his days at the School of San Fernando in Madrid, where his father hoped that he would obtain some sort of academic degree (which, in the end, did not happen). It is also well-known that in the 1930s Dalí showed an interest in the creation of double images. So it was that the surrealists adopted as their creative principle the force of the subconscious, which had recently been revealed by Freud. Dalí was the only surrealist to meet Freud in person, and the Doctor from Vienna was impressed with his work. By 1922, Dalí had already read Freud's '*The Interpretation of Dreams*' and in 1926, Dalí was incorporating oneiric elements into his work, creating images that were paradoxical or contradictory and therefore very unsettling. In this way he connects with the surrealistic movement, though he would later be expelled from it, and indeed he eventually came to disown surrealism as an artistic movement.

Dalí aimed to objectify and systematize delirium in his work, calling the creative process the "paranoiac-critical method". Dreams and reality became the central themes of his creations.

But in order to really understand Dalí's creations, we must bear in mind his friendships with scientists in general and with particular figures within the field of mathematics. From Albert Einstein to René Thom, different scientists exposed Dalí to key topics of research in the 20th century, to an extent where, in the words of Carme Ruiz, "…through his work we can historically retrace the scientific events of the century, at least the ones with greatest impact." An analysis of his paintings reveals relations with the structure of DNA, with the quantum theory of Planck, which began to interest Dalí in 1940, and with antimatter. "I am studying; I want to find the means of transporting my work to antimatter. It is the application of a new equation formulated by Doctor Werner Heisenberg… This is the reason why I, who only admired Dalí, began to admire the Heisenberg who resembles me". This statement appeared in the antimatter manifesto of the catalogue for an exhibition at the Carstairs gallery of New York in 1958.

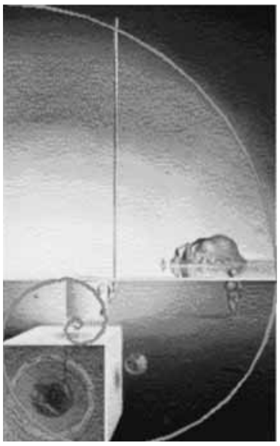
Techniques for deception: 3D into 2D

In 1929, Dalí met Picasso, who was impressed with the portrait that he showed him of his sister Ana María leaning out of the window in '*Figure at a window*' (1925). Dalí had experimented with the cubist style, where the technique for representing space entailed showing different points of view of a single scene simultaneously. This representation derives from Differential Geometry, constituting an "atlas" to represent a surface on the basis of local charts. The cubists put all their "charts" into one: the painting. Despite the fact that Dalí rapidly became adept at this type of painting, for example '*Cubist self-portrait with "la Publicitat*"' (1923), this style did not hold his interest for long, in contrast to Picasso.

Vermeer and Velázquez had a strong influence on Dalí for two reasons. Firstly, because they knew how to execute with brilliance the techniques of their time in representing three-dimensional space on the plane of the canvas; secondly, because they mastered an essential aspect of painting: the recreation of light. '*Las Meninas*' (1656) by Velázquez and '*The letter*' (1657) by Vermeer are clear examples of this, to the point where in Dalí's '*The image disappears*' (1938) it is Velázquez who is conjured from a character in this painting by Vermeer. This is not the only example on which I base my assertion. '*The girl with the pearl*' (1665), of the former, and the Infanta Margarita, the central figure in '*Las Meninas*' of the latter, again support this view because the two are melted together in '*The pearl*, according to "La Infanta Margarita"'(1981). Dalí mastered the techniques of drawing based on Descriptive Geometry, just as Vermeer and Velázquez did. In this sense, the three worked as if they were Renaissance painters, although all three were equally baroque: Vermeer and Velázquez introduced other paintings inside their works of art whereas the "Dalinian baroque" comprised using double images in order to create multiple paintings within a single one.

Throughout the 20th century, Dalí also took interest in alternative techniques arising that gave the sensation of three dimensions on a plane. Thus he came to painting two pictures of a single scene or motif, practically identical, except for the colours, so that, with the superposition of the two, a three-dimensional vision was obtained. This is the basis of stereoscopic representation that allowed Dalí to investigate further with yet another technique for the representation of space on a plane. Paintings such as '*The Christ of Gala*' (1978) or '*The School of Athens*' (1980) are examples of his work from this period.

Equilibrium and harmony



Space is represented with knowledge of Geometry and light through the skilful use of the palette of colours, yet once these achievements are made, there remains the challenge of the search for harmony and balance in art. Between 1944 and 1945, Dalí painted the picture '*Giant Flying Demi-Tasse with Incomprehensible Appendage Five Meters Long*' (1944–45). If we observe the black shadow of the upper part of the picture, we see that it is the beginning of an aural spiral that controls the entire composition of the painting, ending precisely at the base of the cup. At the time when this picture was painted, Dalí held intense conversations with the Romanian mathematician Matila Ghyka, then at the University of San Diego in the U.S., author of the book '*Esthétique des Proportions dans la Nature et dans les Arts*' (1953), which deals with the "divine proportion" of Lucas Paccioli (1509) in the animal, vegetable and mineral world and the aesthetics that originate with the Golden Section. Dalí continued to use this technique to achieve harmony in most of his paintings, the best known in this sense being '*Atomic Leda*' (1949). It presents Gala naked, as would be appropriate for a divinity — "the divine Gala," Dalí often called her — together with the swan, which happens to be a "self-portrait" of the artist. So he immortalized his love for Gala with reference to the god Zeus by converting himself into a swan in order to be together with his beloved Leda in the garden of their house. '*Leda and the Swan*' is a story from Greek mythology that, like all myths, is full of eroticism. The myth tells of the love between Zeus, turned into a swan, and the princess Leda. It is actually a story of zoophilia, but seen with delicacy and elegance, may be read as a marvellous love story. The levitation of both Leda and the swan is characteristic of the period in which Dalí is influenced by atomic theory, made manifest by the title of the picture.

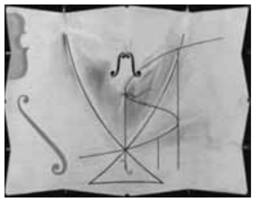
Mathematics as a means of communication

Corpus hipercubus

Carl Sagan states in '*Cosmos*' (1982) that there exists a common language for all technical civilizations, no matter how diverse, and it is science in general, or mathematics in particular. The underlying reason is that the laws of nature are identical worldwide. When we think about this fascinating premise, what comes to mind are images of equations, symbols and figures that are described in a universal language that can be used in any part of the world. The character of this metalanguage is what has really caused mathematics to be the language of science and technology and as argued here, Dalí uses this mathematical language to communicate ideas and feelings in his work. He explicitly uses well-known abstract forms such as the dodecahedron (see '*The last supper*' and '*In search of the fourth dimension*', from 1979) to represent the Universe, as is the norm in Painting (aside from the use of polyhedra with Platonic and Pythagorean reminiscences and the presentation of aesthetics based on Golden Section); the cube (see for instance '*Regarding the "treatise of a cube"*', by Juan de Herrera, 1960, or '*Galacidalacidesoxyribon-cucleicacid*', 1963) to express basic atomic structures; the sphere (see '*Molecular equestrian figure*', 1952), the logarithmic spiral (see '*Portrait of Picasso*', 1947), semiregular mosaics (see '*Picture which seen from three yards away has three lenins covered like chinese and from six appears the head of a royal bengalese tiger*', 1963), or, with a much more modern concept, the mosaics of pixelation (see '*Gala Contemplating the Mediterranean Sea Which at Twenty Meters Becomes the Portrait of Abraham Lincoln – Homage to Rothko*', second version, 1976). He also uses others, which are not as well known, that he learned through his friendship with Einstein, who sparked his interest in four-dimensional space, necessary for the development of the Theory of Relativity. Thus we have *Corpus hipercubus* (1954), which is a crucifixion on a cross that is the intersection of a hypercube (a hyperpolyhedron in four dimensional space corresponding to the three-dimensional cube) with ordinary physical space. This interest in the fourth dimension would endure in Dalí, evidenced by the fact that 25 years later he painted '*In search of the fourth dimension*', where we see the pentahedroid (a hyperpolyhedron in four dimensional space corresponding to the three-dimensional tetrahedron) in correspondence with the dodecahedron mentioned above because of its analogous projection in 2D of a pentagram. Through the website of A. Rodríguez Santos (http://www.epsilones.com), we can access a magnificent applet to visualize the flat projections of the edges of a hypercube, as well as those of its intersection with three-dimensional space.

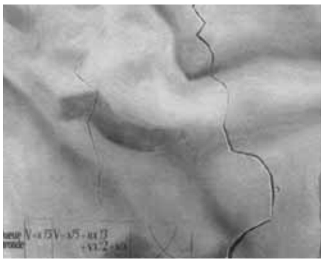
During the 80s and until the end of his life, all that Dalí created was based on the "Theory of catastrophes" of the mathematician René Thom (for which he obtained the Field Medal, the mathematical equivalent to the Nobel Prize). Thom's theory of catastrophes represented a vigorous attempt to integrate the disorder of change and rupture with order, according to a description by the creator himself: "it is a methodology or perhaps a sort of language that attempts to describe discontinuities that could be present in the evolution of the system. At http://perso.wanadoo.fr/l.d.v.dujardin/ct/elem_para.html, we can find a brief yet interesting overview of the seven elementary catastrophes and applets that allow the visualization of the curves corresponding to the edge of regression of the surfaces that intervene in each one.

In search of the fourth dimension



The swallowtail

This mathematical theory had such an impact on Dalí that he adapted his signature so that it were an additional mathematical object in his paintings. This can be seen directly in '*The swallowtail*' (1983), where the tail depicted corresponds with the "receding edge" of a surface. The surface of what? In '*Topological abduction of Europe: Homage to René Thom*' (1983) the following equations appear: $V = x^5/5$ and $V = x^5/5 + ux^3/3 + vx^2/2 + wx$ and beside them the aforementioned signature of Dalí. According to the theory of catastrophes, the first of these is the "germ" from which a given form derives (more precisely, it is the process surrounding structural stability and morphogenesis), whereas the second is a potential function of form, from which singular points can be obtained departing from the system that is obtained by setting V and its derivative with respect to x equal to zero. In real three-dimensional space, u, v and w are coordinates that are interrelated from a discriminant of the above system of equations. This relationship defines a surface whose edge of regression is the swallowtail, one of the seven elementary catastrophes. The rest are the fold, the cusp, the butterfly, the hyperbolic umbilic (or the crest of the wave), the elliptic umbilic (or the hair), and the parabolic umbilic (or toadstool). This theory requires knowledge of differential topology and dynamic systems. Thus we arrive at an understanding of the title of this painting. In '*The topological rapture of Europe*', there is an authentic homage to René Thom, as it manifests the idea of the evolution of the European continent from the theory of this outstanding, creative mathematician. It is a painting that clearly shows two cracks, one more pronounced than the other, over a warped surface with a whitish background, with equations and again the famous signature. Through his genius, Dalí unites the myth of the Rapture of Europe depicted by Tiziano and later by Rubens (whose copy the '*Rapture of Europe*' (1628–1629) hangs in the Prado) among others, again in which Zeus is an untiring conqueror. In this myth, Zeus has set his sights on a beautiful young Asian woman, Europa, daughter of Agenor, king of Tyre, from Phoenicia, in the



The topological rapture of Europe

Rapture of Europe (Tiziano)

eastern Mediterranean basin. He asks his son Hermes to help him prepare the encounter and subsequent abduction, which would become a well-known tale, because the god had decided to transform himself into a handsome bull. Hermes, who Dalí identifies with René Thom, is in charge of leading the King's herd of oxen from the high fields down to the nearby beach – which Dalí and Thom identify with the Cape of Creus, represented in the painting as a shadow that runs along the back part of the bull's horns and the beginning of its snout – where Zeus knows that Europa and the other maidens of Tyre have gone to spend a day of fun and gaiety. Zeus takes on the form of a snowy white bull with fine noble features that does not inspire fear as it wanders from the herd to approach the group of young women. The maidens are taken aback at first, but little by little they begin to trust in this tame bull that allows itself to be petted and adorned with wreaths of braided flowers between its horns. Europa is so trusting as to seat herself upon the animal's back, fully unsuspecting of what awaits her. The bull kisses the feet of the young woman while her friends decorate her and sets about his plan. The animal stands up and quickly jumps into the sea with the treasured rider on its back. The friends remain behind on the coast, astonished, raising their hands in gestures of surprise, and the group is led into the sea now opened by the Winds who help themadvance, while groups of sea divinities arise in procession. They arrive at the coasts of the European island of Crete. There, Europa will give birth to three children, Minos, Sarpedon and Radamantis, thus leaving a divine lineage on the island.

On April 29, 1985, the magazine '*Época*' published an interview titled "**Dalí, if not divine, immortal.**"

- Are you in agreement with Spain's joining the Common Market?
- It strikes me as a paradox. It is Europe that should become a member of Spain. We must hispanify Europe! as Unamuno rightly said in opposition to the germanistic thesis of Ortega y Gasset.
- On what basis?
- On a basis that is nearly geological. For many years (and it continues to occur) whenever I look at a map of Europe, my index finger reaches out instinctively and poses on a concrete point between the cities of Salles and Narbonne. On the basis of this revelation, I have always affirmed that the tectonic forces that sustained Europe when the continental dispersion took place, acted in this specific zone. Many thought it was a joke until Thom, one of the great contemporary mathematicians, proved me correct by situating the exact place in Perpignan.
- Those three cities are French.
- But they border on Spain and on the Pyrenees, which were, from Spain, what held Europe back so that it did not end up in Australia. In a conference I gave in the French Academy, I told the French so clearly: if it had not been for Spain, you would now be living with kangaroos".

He looks at me firmly, and in absolute control of his right hand, exclaims:

- It was the Iberian bull that restrained Europe.
- How do we interpret, then, the myth of *The rapture of Europe*?
- The only one, the only one to understand that myth is Salvador Dalí. The bull, which is Spain, did not abduct Europe; it restrained it with all its spirit, all its bravery, and it keeps it in place. Europe owes its whole being to Spain.

On one occasion, when asked how to describe his paranoiac-critical method, Dalí responded: "In the method there is no fantasy, only transcendental topology". Well then, yes: if not divine, immortal, and above all, a genius.

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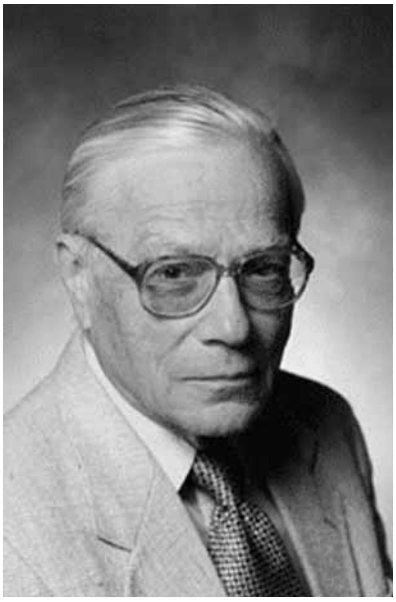
Rafael Pérez Gómez has a Ph.D. in Mathematics from the University of Granada (Spain). His main line of investigation focuses on Chromatic Symmetry. The most recent doctoral thesis under his direction was titled 'Constructions in Hyperbolic Geometry and Tessellations by means of Polygonal NEC Groups. Automatization algorithms.' He has also worked in the area of 'Theory of Social Choice', where he co-directed the thesis 'Proportional representation. Parliamentary representation.' Likewise, he has participated in diverse research projects and he is the principal researcher in the project 'Building Software.'

Currently a professor in the Department of Applied Mathematics at the University of Granada, he also teaches within the Schools of Architecture and Civil Engineering. He directs a line of educational publications at the Proyecto Sur de Ediciones, most notably in 'Constructing Mathematic Concepts', which is being institutionally implemented in different parts of Spain (Madrid, Canary Islands and Navarra), as well as Interm@ates, which won the Second Prize for Innovation in 2003 and is available at the server of the regional government of Cataluña (www.edu365.com). In addition to creating and directing the journals Epsilon, Suma and Uno, he regularly collaborates with the Museum of the Sciences in Granada and occasionally with the Museum of Barcelona. He has given over one hundred courses and conferences in Spain and abroad.

Armand Borel (1923–2003)

André Haeflinger (Geneva, Switzerland)



Armand Borel (1923–2003)

Armand Borel died in Princeton on August 11, 2003 at the age of 80, following a brief illness and while still in full activity. His body of mathematical work is considerable and shows remarkable coherence. Borel's work, apart from a dozen books, lecture notes and post 1999 articles, was published by Springer Verlag in four large volumes and encompasses more than 150 articles (cited below under [Oe]). Beyond 50 of them are written in collaboration with more than 30 different coauthors (notably ten joint works with J.-P Serre and five with J. Tits). They focus on Lie groups and their actions, as well as on algebraic and arithmetic groups, and broach core questions regarding many different areas: algebraic topology, differential geometry, analytic and algebraic geometry, number theory, etc. These articles were fundamental to the development of mathematics in the second half of the 20th century.

Armand Borel was born in La Chaux-de-Fonds, Switzerland on May 21, 1923. Following his secondary school studies in Geneva and in private institutions, he entered the Ecole Polytechnique Federale (EPF) of Zurich's mathematics and physics division in 1942. All the while fulfilling his compulsory term of Swiss military service (one of his admittedly least favorite episodes), Borel obtained his diploma in mathematics (his masters work done under the supervision of E. Stiefel) in the spring of 1947. He was then appointed teaching assistant at EPF for two years. During this period he published two works: one on the characterization of connected subgroups of maximum rank of compact Lie groups (in collaboration with J. de Siebenthal) and the other on compact Lie groups acting transitively on spheres or tori. They are testimony to his already solid knowledge of compact Lie groups and root systems, as well as of algebraic topology. He had been introduced to these subjects in the courses he took with E. Stiefel and H. Hopf (both exceptional teachers). His first works show that he had perfectly assimilated the Stiefel paper [St] and Heinz Hopf's two fundamental works [H1] and [H2].

Borel wished to prepare a thesis on Lie groups, however Stiefel had by then resolutely turned towards applied mathematics. Luckily, and thanks to a grant for an exchange between EPF and CNRS, he spent the following academic year (1949–1950) in Paris. Armand Borel immediately integrated into the epoch's steaming cauldron of Parisian mathematical life. He actively participated in Cartan's seminar at the Ecole Normale on the topology of fiber spaces giving two talks which provided a complete tableau of what was known at the time on homotopy groups of compact Lie groups. At the College de France, J. Leray expounded his revolutionary concepts in algebraic topology, the theory of sheaves and spectral sequences. Among the few attending were A. Borel and J-P Serre. The latter, discouraged, ended up giving up, but Borel tenaciously hung on to the end (he even completed the theory and simplified it in [Oe, I, 10]). The following is how Serre, in an interview with Marian Schmidt [Sc], recalls the role played by Borel in his early life as a researcher while in quest of a thesis subject: *I finally, two years after my departure from the Ecole Normale, 'took off'. This 'take off' I owe in great part to the Swiss mathematician, Armand Borel. Having come from Zurich, where he had been the student of H. Hopf, he arrived in Paris during the fall of 1949 and stayed for two years*[1]*. We met at the Cartan seminar and immediately connected. Slightly older than I, he already had several publications on his roster, and he taught me a great deal about research technique. Furthermore, and what was paramount, he succeeded in understanding Leray's mysterious theory of spectral sequences and explained it to me. On a certain Sunday of 1950 (the day the Korean war began), we found an application for this theory, which, while not difficult, was of a new genre: we proved that there existed no fibration of a Euclidean space of which the fibers were compact and did not consist of points. We prepared a note on this for the Comptes rendus of the Academy of Science. Presented the following day by Elie Cartan, it appeared two weeks later. Having gained confidence from this success, I undertook the exploration of the Leray theory to see what other applications could be culled from it.* And a bit further, in answer to the question: "What were the principle influences you were subject to?": *Those of Henri Cartan and Armand Borel were decisive. And then Andre Weil's.* This first joint work with Serre, recalled above, served as a catalyst for both of them: They realized the benefit to be reaped from the study of the spectral sequence of a fibration to establish relationships between the cohomology of the fiber and the base when the total space is contractible.

Borel also gave a report at the Bourbaki seminar on the work of Iwasawa and Gleason in relation to Hilbert's 5th problem. Shortly thereafter, he presented other works at the Bourbaki Seminar and soon became an active member of Bourbaki. He retired at the mandatory age of 50. (Serre, despite being a few years younger, left at the same time.) During his Paris sojourn, Borel was to assimilate the new ideas developed by A. Weil, H. Cartan, C. Chevalley, and J-L Koszul (explained by H. Cartan at the Bruxelles Topology colloquium [CA]) on the transgression in the real cohomology of principal fiber bundles and the Chern-Weil homomorphism. The aim of his thesis (director, J. Leray) would be to reinterpret these results within their geometric framework and to extend them to integral and modulo p cohomology using Leray's spectral sequence of a fibration.

From 1950 to 1952 he substituted for the algebra professor at Geneva University while making frequent trips to Paris and Zurich, He gave lectures at the latter during the 1951 summer semester on *La cohomologie des espaces localement compacts, d'après J. Leray*. The copy notes from this course (published later in the Springer Lecture Notes in Mathematics, vol. 2) were widely circulated. Vitally important, they constituted the first systematic and detailed account of Leray's theories. It is during this period that he wrote his thesis, defending it in Paris in the spring of 1952. The jury was composed of J. Leray, president, H. Cartan and A. Lichnerowitz. This monumental work entitled *Sur la cohomologie des fibrés principaux et des espaces homogènes de groupes de Lie compacts* was published in the Annals of Math [Oe. I, 23]. His second thesis on the automorphic functions of complex variables (a subject that he was to hold dear throughout his career) became the object of an expository article in the Bulletin de la Sociéte Mathématique de France [Oe. I 22].

It is also in this year that he married Gaby Pittet, who remained his devoted companion to the end. In the autumn of 1952, the young couple embarked for the United States. Armand had been invited to Princeton as a visiting member of the Institute for Advanced Study. This two years stint in Princeton would prove crucial to the broadening of his mathematical interests, in fact as crucial as his Paris sojourn in 1949–1950 had been. In his paper entitled *The School of Mathematics of the Institute for Advanced Study* [Oe. IV, 138], he describes with enthusiasm the exhilarating mathematics ambiance of the time (see pages 212–215). He reconnected with F. Hirzebruch, whom he had met in Zurich in 1949, and who was also a visitor at IAS. Together they began their great work *Characteristic Classes and Homogeneous Spaces*. He evokes the genesis of the Riemann-Roch theorem and his contacts with D. Montgomery, H. Samelson, J. Moore, and many others.

Following his participation in a summer school on Lie groups and Lie algebras organized by the AMS where he explained the results of his thesis and where Chevalley gave a course on algebraic groups, he returned to the Institute for the fall of'53 and a second year. There, Borel pursued once again his collaboration with Hirzebruch. Influenced by the new developments in analytical and algebraic geometry due to H. Cartan, J-P Serre, C. Chevalley, F. Hirzebruch, K. Kodaira, D. Spencer et A. Weil, he began to interest himself in the complex analytic and algebraic aspect of Lie groups. And so the Borel-Weil theorem was born from a conversation with Weil in Chicago at the end of 1953. Borel came to think of linear algebraic groups globally rather than in terms of Lie algebra. He was to develop this point more deeply during the following academic year 1954-1955, spent in Chicago as guest professor, where he greatly benefited from his contacts with Andre Weil. From this emerged Borel's seminal and monumental work *Groupes algébriques linéaires*, [Oe. I. 39], marking a decisive turning point in the subject.

By then he had already published more than twenty works, which already represented a major body of mathematical work. Appointed professor at the Federal Polytechnic School in Zurich (Heinz Hopf had always wished him to come back to Switzerland), he began to teach in this institution in the fall of 1955. His duties included teaching a course in descriptive geometry in French and he also gave an advanced course on Lie group theory. The following year he received a prestigious offer: a permanent professorship at the Institute for Advanced Study (IAS). After some hesitation (see [Oe, IV, p. 215]), he accepted, leaving Zurich for Princeton in the spring of 1957. From then on, it was here that his career would unfold and that he would fully realize himself. While continuing to expand his fields of research in multiple directions, he devoted tremendous energy to enlivening the mathematical activity at the Institute and to tirelessly defending with Andre Weil, who joined him a year later, the level of excellence of the institution (cf. [Oe. IV, 138]. With the participation of numerous collaborators, he organized seminars on current subjects that would become immensely popular. The home of Gaby and Armand Borel was likewise to become a warm and privileged haven of welcome for many, many visitors.

Armand Borel received a number of distinctions: an honorary doctorate from the University of Geneva in 1972, the Brouwer medal in 1978, the Steele Prize from the American Mathematical Society in 1991 and the Balzan prize in 1992. He was nominated as a member of several institutions; in particular, the American Academy of Arts and Sciences in 1976, the National Academy of Science, USA, in 1987 and as foreign associate of the French Academy of Science in 1981, etc.

A few of Armand Borel's Mathematical Results

The body of Armand Borel's mathematical work is considerable. It touches on so many different areas that a detailed analysis would demand the concurrence of several experts. I refer back to Serre's article for a general view of his work and to Gopal Prasad for Borel's contributions to arithmetic groups. I will confine myself here to mention only and very briefly a few examples of Armand's work, giving an, alas, extremely limited view of the richness of his work.

One of the aims of Borel's thesis [Oe, I, 23] was to compute the integral and mod p cohomology (p a prime) of connected compact Lie groups G, as well as the cohomology of B_G, the classifying space for principal bundles with structural group G (the elements of this cohomology are by definition the universal characteristic classes for these bundles). One of the typical results is that, if the integral (resp. mod p) cohomology of G is an exterior algebra with generators $x_i, i = 1, \dots, r$, of odd degrees $2m_i - 1$, then the integral (resp. mod p) cohomology of B_G is a polynomial algebra in generators y_i of even degree $2m_i$. This hypothesis is satisfied if the integral cohomology of G is without torsion (resp. without p-torsion). More precisely, if $\pi : E_G \to B_G$ is a universal principal fiber bundle with structure group G, one can

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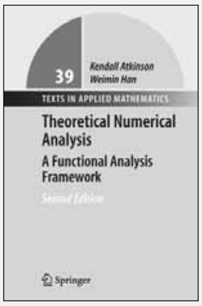

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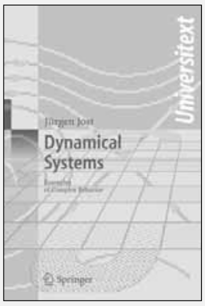

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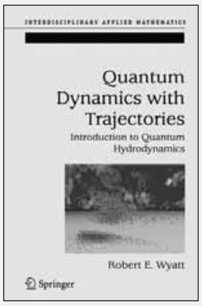

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choose the generators x_i and y_i such that x_i is obtained by restricting to the fiber a cochain x_i' of E_G whose coboundary is $\pi^*(y_i)$. It is said that the elements x_i are transgressive and that y_i is the image of x_i by transgression. This result is obtained using Leray's spectral sequence. Another important result is the following. If T is a maximal torus in G, one has a map $B_T \to B_G$ induced by the inclusion of T in G. Under the preceding hypothesis, the map induced in cohomology is injective and maps isomorphically the cohomology of B_G onto I_G, the subspace of the cohomology of B_T (which is a polynomial algebra in elements of degree 2) left invariant by the action of the Weyl group of G. For instance, for $G = U(n)$, the integral cohomology of B_T is a polynomial algebra in n generators $t_1,\dots,t_n$ of degree 2 and the integral cohomology of $B_{U(n)}$ is the polynomial algebra in the Chern classes which appear as the elementary symmetric functions in t_i. A little bit later Borel has obtained a similar result for the mod 2 cohomology of $O(n)$ (cf. [Oe, I, 25]). In that case T is replaced by the subgroup $Q(n)$ of diagonal matrices. The mod 2 cohomology of $B_{Q(n)}$ is a polynomial algebra in n generators x_i of degree one and the Stiefel-Whitney classes are interpreted as the elementary symmetric polynomials in $x_1,\dots,x_n$.

Previously, in the second chapter of his thesis, he extracts from the fundamental paper [H1] of Hopf the algebraic condition that Hopf had single out for the cohomology algebra of a space with a law of composition. Borel calls such an algebra a Hopf algebra. He establishes the structure of Hopf algebras on a perfect field; he shows in particular that it is a tensor product of Hopf algebras with a single generator. The survey *Topology of Lie groups and characteristic classes* [Oe, I, 33] published in 1955 in the Bulletin of the AMS, following a report of Samelson on the same subject published in this journal three years prior, shows how the topological methods developed in Borel's thesis have superseded the previous techniques, unifying and pushing forward the theory.

Let us mention a striking application of a joint work with Serre [Oe, I, 16], namely that the only spheres which carry an almost complex structure are of dimension 2 and 6.

Resulting from a collaboration with F. Hirzebruch which began in the fall 1952 (cf. [Oe, IV, pp. 212–214]), the series of three articles *Characteristic classes and homogeneous space* [Oe, I, 43 and II, 45 and 47] had a considerable influence at the time, even before its publication (1958–1961). In particular on the genesis of Bott periodicity theorems, see the long report by Bott in Math. Reviews and his remarks in the announcement of his results (see Bott, *The stable homotopy of the classical groups*, Proc. Nat. Acad of Sci. 43 (1957) p. 934). The initial aim of this work was to determine the characteristic classes of a homogeneous space G/U, where U is a closed subgroup of a compact Lie group G from some roots of G. The authors obtain a wealth of concrete results, in particular a divisibility theorem for the Chern class of a vector bundle on a sphere of odd dimension; this gave information on certain homotopy groups of Lie groups contradicting an erroneous result of Toda but in agreement with the potential periodicity.

Borel wrote a series of papers ([Oe I, 24 with Serre, 28, 29, 35 with Chevalley, 37, II, 51, 52]) aiming to compute the p-torsion of the integral cohomology of compact connected Lie groups G and to relate it to the commutative subgroups of G. For instance he shows that $H^*(G,\mathbb{Z})$ has no p-torsion if and only if any abelian subgroup that is a product of cyclic group of order p is contained in a maximal torus. Also if the cohomology of G has p-torsion, then p divides the order of the Weyl group of G (assumed to be simply connected). The recent paper [B4] falls in line with these works.

Borel organized for the academic year 1958–59 at the IAS in Princeton a seminar on transformations groups (*Seminar on transformations groups*, Ann. Math. Studies 46, 1960). In that seminar he introduced and exploited systematically the notion of equivariant cohomology: If X is a space on which a topological group G acts continuously, the equivariant cohomology of the G-space X is the cohomology of the space X_G, quotient of $E_G \times X$ by the diagonal action of G (this is now called the Borel construction).

I would also mention the conjecture that Borel had stated in 1953 in an informal conversation, namely that a compact manifold without boundary whose universal cover is contractible is determined up to homeomorphism by its fundamental group. This conjecture, now called Borel conjecture and probably motivated by the result of Mostow on quotients of connected solvable Lie groups by cocompact discrete subgroups, is the object of intense research[2].

What is now called the Borel-Weil theorem was found at the end of 1953, but was not published at this time (see [Oe I, 30 and its comment p. 704, as well as IV, p. 214]). It is the following result. The quotient G/T of a simple compact Lie group G by a maximal torus T has an invariant natural complex structure. Therefore G acts on the spaces of holomorphic sections of homogeneous complex vector bundles of rank one on G/T. Such a bundle is determined by a character χ of T. The theorem shows in particular that the representation obtained in this way is irreducible with dominant weight χ.

The fundamental work *Groupes algébriques linéaires* of Borel finished in 1953 [Oe, I, 39] is a decisive turning point in his research as well as in the evolution of this field. Borel considers linear algebraic groups defined over an algebraically closed field K of any characteristic. Therefore he has to avoid considering Lie algebras, as the exponential map cannot be defined in characteristic p. As he said himself: *I was influenced by some works of Hopf, Samelson and Stiefel, done in the forties, where they obtained some basic properties of those groups by topological or geometrical methods, without recourse to infinitesimal theory* (see [B2, p. 124 and p. 158] for the genesis of this work). A basic result is the existence and uniqueness up to conjugation of maximal connected closed solvable subgroups; it is an immediate consequence of a fixed point theorem proved geometrically in a few lines (see [B2, p. 124]). Such a maximal connected closed subgroup was called a *Borel subgroup* by Chevalley. Borel also extends the theory of maximal tori (product of copies of K^*), of regular and singular elements. Chevalley, who saw the manuscript of this paper, understood immediately what one could get from it, and obtained in the following year the classification of simple algebraic groups over an arbitrary algebraically closed field. The extension of the theory of algebraic groups over an arbitrary field will be the subject of an impressive series of five papers written in collaboration with J. Tits, leading to the famous Borel-Tits theory.

A useful result is the density theorem of Borel [Oe II, 50]. Let G be a linear connected Lie group defined over $\mathbb{R}$, without compact components. Let $\Gamma \subset G$ be a closed topological subgroup such that G/Γ has a finite G-invariant measure. Then Γ is Zariski dense in G.

A major step is surely his work *Arithmetic subgroups of algebraic groups* with Harish-Chandra [Oe, II, 54], followed by a series of papers on arithmetic groups, for which I refer to the report of Gopal Prasad.

I would nevertheless like to mention the beautiful theorem about the existence of cocompact lattices [Oe, II, 62]: A semisimple algebraic connected Lie group G always has a discrete torsionfree subgroup Γ such that G/Γ is compact.

Another striking result is the following (cf. [Oe, IV, 129]). Let G be a connected linear Lie group and K be a maximal compact subgroup. If the rank of G is equal to the rank of K, the L^2-cohomology of the symmetric space $X = G/K$ is zero in dimension other than $(\dim X)/2$.

Finally, one of the most remarkable result of Borel and a testimony to his belief in the unity of mathematics is the determination of the stable real cohomology of arithmetic groups, its applications to K-theory and its relations with the value of the ζ -function of a number field at integral points (cf. [Oe, III, 93, 100, 101, 108, 116, 118 and the survey in IV, 157]). He shows in particular that $\lim_{n\to\infty} Sl_n(\mathbb{Z},\mathbb{R})$ is an exterior algebra in an infinity of generators x_i of degree $4i-1$. As a consequence, the groups of K-theory $K_n(\mathbb{Z})\otimes\mathbb{Q}$ are of dimension 1 for $n \equiv 1 \pmod 4$ and are zero otherwise ($n > 1$).

A man of communication and culture

The fourth volume of his complete works, 700 pages strong, encompasses Armand Borel's published articles up until 1999, at which point he was already over 60. Apart from numerous research papers, it contains fifteen or so articles destined for a more general public, which make for a most engrossing read. In some (cf. [Oe. III, 119, IV, 149, 150, 153]), he reveals his individual conception of mathematics as well as his experiences at the heart of the mathematical community, particularly at the Institute for Advanced Study in Princeton (Oe IV, 138]) and Bourbaki [Oe IV, 165]. In others, of a historical nature, he analyzes rigorously, with rare competence and objectivity, the scientific work of his predecessors (E. Cartan, H. Weyl) and of his elders whom he kept so closely abreast of (J. Leray, A. Weil, C. Chevalley, E. Kolchin, D. Montgomery), as well as Harish-Chandra. He explores motivation, the genesis of ideas and reciprocal influences. The whole is beaded with precious recollections, as he was both an actor and a privileged witness of some of the greatest moments in the evolution of the mathematics of his time. His analysis of Poincaré's contribution to restrained relativity (see [Oe IV, 173] and his commentary on pages 709–710), as well as his analysis [B3] of the controversy between H. Weyl and E. Cartan on projective connections is a masterpiece of impartiality and it is fascinating to follow both sides of the issue.

As underscored in the citations of the Steele Prize and the Balzan prize, Armand Borel also played an essential role as organizer and chair of an array of mathematical activities (seminars and summer schools in the United States, China and India, etc.) and as an enthusiastic propagator of innovative ideas. These produced numerous books that have become major references.

I will limit myself to citing only one example. When he returned as professor to EPF in Zurich from 1983 to 1986, Borel organized a seminar that brought together students and professors from all Swiss universities as well as outside guests. The meetings took place one day a week at the Mathematical Institute of Bern located just around the corner from the train station. Their aim was to study together new emerging subjects (such as Intersection homology or D-modules) and to engender active participation of both specialists and nonspecialists. They had the winter semester to prepare. This resulted in animated and fruitful discussions during lunch breaks and train commutes. The tradition of the Bern seminar (which now goes by his name) was kept up after Borel's departure. It greatly contributed to the development of contacts between Swiss mathematicians and was the catalyst for a number of extremely valuable publications.

Of great strength of character, even more demanding of himself than of others, of infallible honesty and of a prodigious work force, Armand Borel was a man of great culture. He was as passionate about his leisure activities as he was of his work. An avid sportsman, he swam with great discipline, nearly every day, and he loved mountain hiking. Both he and Gaby were serious and enthusiastic travelers. Armand would painstakingly research and prepare himself for visits to archeological sites, architectural treasures or undiscovered landscapes (India, Mexico, China, etc.). He was also a great connoisseur of painting and music; starting with jazz (he adored frequenting Jazz clubs, Harlem in the 50's and throughout his life in New-York, Paris, Chicago, Philadelphia, listening to the Blues deep in Mississippi with Joshua Leslie and more), then with contemporary music (especially Bartok) and finally with classical Indian music of which he became a veritable expert. He created and organized, with love and pride, a concert series at the Institute for Advanced Study, initiating programs that were top drawer and off the beaten path.

Armand Borel remained deeply attached to Switzerland and in particular to Geneva, the town of his childhood and adolescence. He spent much of his summers each year at La Conversion, the family home of Gaby, overlooking Lac Léman, taking advantage of this time to visit old friends (G. Rham, for example), swimming in the lake and rambling in the mountains. A faithful friend, he never forgot to contact us and it was with great joy that our families got together every summer.

We share, with his wife Gaby and two daughters Dominique and Anne, the feeling of having lost an exceptional human being.

Notes

1. In fact Borel stayed only one year in Paris.
2. The conjecture indeed appears as a question in a letter (dated April 2nd, 1953) from Borel to Serre commenting on Mostow's result.

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André Haefliger [andre.haefliger@math.unige.ch] has recently retired from a Professorship in Mathematics at the University of Geneva, Switzerland.

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A solution of the Ten Martini problem

The Ten Martini problem asks for the Cantor structure of the so-called Almost Mathieu or Harper operator which is the following operator

$$\left(H_{b,\omega,\phi}x\right)_n = qx_{n+1} + x_{n-1} + b\cos\left(2\pi\omega n + \phi\right)x_n.$$

on $l^2(\mathbb{Z})$ where b is a coupling parameter, ω is a frequency and ϕ a phase.

Apart from its naturality (it is probably the "simplest" example of a quasi-periodic Schrödinger operator) this operator appears in the study of the Hamiltonian of an electron in a rectangular lattice subject to a perpendicular magnetic field. The frequency ω stands for the intensity of the magnetic field while $b/2$ takes into account the nearest neighbour couplings. This model was introduced by Peierls and Harper in 1955 and Azbel, in 1962, conjectured that the spectrum of the operator for irrational frequencies (which does not depend on ϕ for such irrational values) should be a Cantor set if $b \neq 0$. This conjecture was strengthened by the numerical experiments of Hofstadter (1976) and Aubry (1977) who, in addition, conjectured that the measure of the spectrum should be zero in the "square case" $|b| = 2$. Such numerical computations are usually referred as "Hofstadter butterflies": the spectrum is plotted against the frequency and a fixed value of the coupling constant (see Figure 1).

In the beginning of the eighties there was a lot of work in the mathematical theory of almost periodic Schrödinger operators and, in fact, the name of the "Ten Martini problem" was coined by Simon after an offer by Kac in a meeting of the American Mathematical Society in 1981. The problem, which appeared in a famous list of problems in almost periodic Schrödinger operators (1982) remained open until recently.

Previous partial results include Bellissard & Simon (1982) who prove Cantor structure for generic pairs of (b,ω); Sinai (1987) proved that if ω satisfies a Diophantine condition then the spectrum is a Cantor set provided $|b|$ is small enough (how small depending on the precise Diophantine condition). These Diophantine frequencies, a total measure subset of the real numbers, are characterized by being "far from rational numbers". Regarding non-Diophantine irrational numbers, the so-called Liouville numbers, Choi, Elliot & Yui (1991) proved the Ten Martini Problem for a class of these Liouville numbers.

The "square case" is special because the spectrum is a Cantor set of zero measure, as a series of works by Helffer & Sjöstrand (1989), Last (1994) and Avila & Krikorian (2004) show. This case is also know as the "self-dual" case because it is invariant by Fourier transform, known as "Aubry duality" in this context. More generally, the Fourier transform can be used to show that the spectrum of the Almost Mathieu oper-

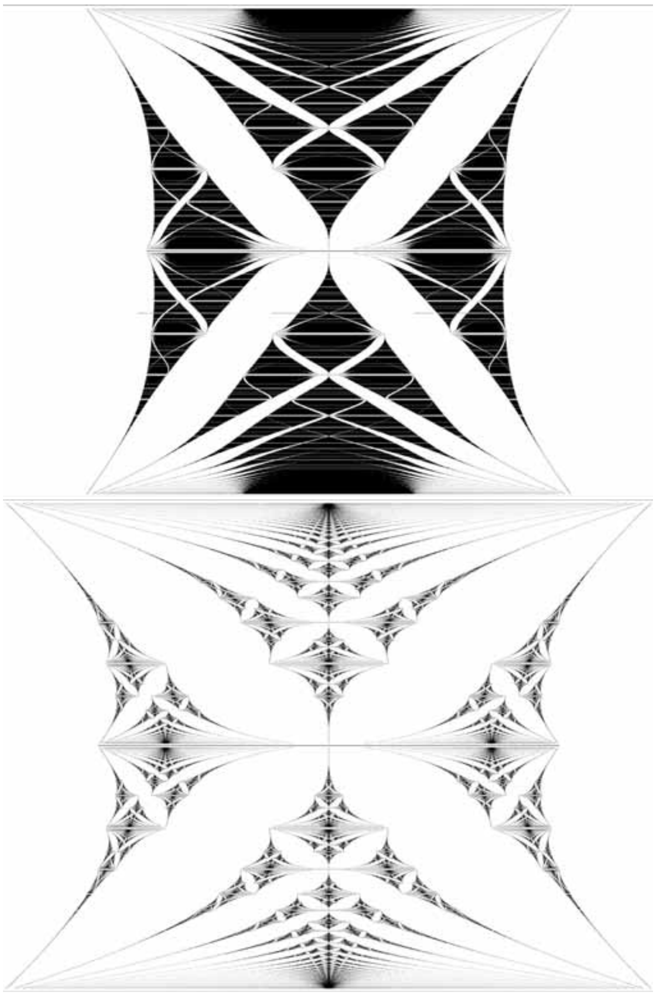

Figure 1. Hofstadter butterflies for values of $b = 1$ (top) and 2 (bottom) from top to bottom and left to right respectively. These pictures are computed taking rational frequencies ω in the vertical direction and computing the spectral bands of the periodic problem. The "classical" Hofstadter butterfly corresponds to the case $b = 2$ where the measure of the spectrum is zero for irrational frequencies.

ator for some $b \neq 0$ is just a dilatation of the spectrum for its "dual" value $2/b$.

Joaquim Puig, in the paper "Cantor spectrum for the Almost Mathieu operator" and as a part of his PhD thesis proved that if $|b| \neq 2$ and ω is Diophantine, then the spectrum of the Almost Mathieu operator is a Cantor set. The idea of the proof is the combination of tools coming from spectral theory and dynamical systems. On the spectral side a non-perturbative localization result due to Jitomirskaya (1999) is key for the proof. On the dynamical side, the concept of reducibility of quasi-periodic cocycles is also very important. While these two techniques can be generalized to other quasi-periodic Schrödinger operators, an adaption of Ince's (1922) argument for the classical Mathieu equation to the present almost periodic case is very specific of this model. The combination of these spectral and dynamical techniques for the study of quasi-periodic Schrödinger operators is powerful and opens a promising field of research. Recently, for instance, Avila & Jitomirskaya (preprint 2005) have obtained a proof of the Ten Martini problem which includes the non-Diophantine frequencies which were not covered by Choi, Elliot & Yui so that the Ten Martini problem is now settled for all irrational frequencies.

Joaquim Puig i Sadurní, presently at the Polytechnic University of Catalonia, received his PhD in Mathematics by the University of Barcelona with the thesis "Reducibility of Quasi-Periodic Skew-Products and the Spectrum of Schrödinger Operators", under the supervision of Carles Simó i Torres, on June 22nd 2004. Among the results in the thesis there is the proof of the conjecture known as the Ten Martini Problem for Diophantine frequencies.

Letter to the Editor: An Observation on Real Division Algebras

Holger P. Petersson, Hagen (Germany)

In [1] a short and elementary proof is given for the well-known fact that there are no associative real divison algebras of dimension 3. Without claiming originality, we present here an even shorter but still elementary proof for the following general observation that holds for both associative and non-associative division algebras:

Observation. *There are no real division algebras of odd dimension* > 1.

Proof. Suppose on the contrary that A is such an algebra and write $L_u : A \to A,\ v \mapsto L_u(v) = uv$, for the left multiplication by $u \in A$, which, thanks to our hypothesis, is a bijective linear transformation unless $u = 0$. Hence, given linearly independent vectors $x, y \in A$ and $t \in \mathbf{R},\ p(t) = \det L_{x+ty}$ is a real polynomial of odd degree without real roots, a contradiction. $\square$

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[1] Z. Marciniak, *Why is there no decent multiplication in 3D?*, EMS-Newsletter **56**(2005), pp. 18 – 19.

Holger P. Petersson [holger.petersson@fernuni-hagen.de] is Professor emeritus at Fachbereich Mathematik, Fernuniversität in Hagen, Germany.

The 2005 Abel Prize

Nils Voje Johansen and Yngvar Reichelt
(Oslo, Norway)

On 17th March this year, the Norwegian Academy of Science and Letters awarded the Abel Prize for 2005 to Peter D. Lax from the Courant Institute of Mathematical Sciences, New York University

"for his groundbreaking contributions to the theory and application of partial differential equations and to the computation of their solutions."

Two months later on 24th May the award was ceremoniously presented at the University Aula in Oslo. For the occasion, Oslo was arrayed in mathematical finery with its main street, Karl Johans gate, festooned with Abel banners in honour of the year's Laureate. Many events took place and Peter D. Lax was the guest of honour at them all.

The Holmboe Prize

When the Abel Prize was established in 2002, a precondition was that a portion of the endowed funds was to be used to encourage recruitment to mathematical subjects. This requirement was met by the fund's support of the Abel Contest for upper secondary school pupils and the KappAbel contest for lower secondary school pupils among other activities. This year a separate prize for proficient teachers of mathematics was established. The prize bears the name of Bernt Michael Holmboe, the mathematics teacher who discovered Niels Henrik Abel's talent and encouraged him in his further study in the subject. The winner of the 2005 Holmboe Prize was Svein H. Torkildsen. On 23rd May, the Minister of Education and Research, Kristin Clemet, awarded him the prize during a ceremony at Niels Henrik Abel's alma mater, Oslo Cathedral School. The presence of Peter D. Lax added lustre to the festivities and the 2005 Abel Laureate honoured the winners of the two mathematics contests with brief words of congratulations.

Peter Lax with the winners of the Abel competition: Hilde Galleberg Johnsen, Nina Holden, Peter D. Lax and Jürgen Vold Rennemo

Wreath-laying ceremony

In the afternoon, in what has become a tradition, a wreath was laid at Gustav Vigeland's Abel Monument in the Palace grounds. The event opened with a performance of the expressly composed Abel Fanfare, arranged for the occasion for three wind instruments. The Chairman of the Abel Board, Ragnar Winter, gave a speech before Peter Lax laid the wreath. Last year's Abel Prize winners Sir Michael Atiyah and Isadore Singer were also present.

Award ceremony in the University Aula

On Tuesday 24th May, all was in readiness for the Abel Prize award ceremony. At 2 pm, a nearly full Aula received HRH the Crown Prince Regent Haakon Magnus and Queen Sonja. In the absence due to illness of King Harald V, it was the Crown Prince who assumed the duty of awarding the 2005 Abel Prize to Peter D. Lax. The ceremony was accompanied by music performed by the trio *Opera i Tiden*. They began by performing *Morning Mood* by Edvard Grieg. Then the President of the Norwegian Academy of Science and Letters, Professor Jan Fridthjof Bernt, came to the rostrum and briefed the audience on the various activities supported by the Abel Fund. He particularly emphasised the role the fund wished to play in recruitment to the subject. After the speech it was again time for music, this time *In the Hall of the Mountain King* taken from Grieg's musical score for Henrik Ibsen's drama *Peer Gynt*. When the music concluded, Professor Erling Størmer, the Chairman of the Abel Committee, came to the rostrum and talked about the motivation for the Committee to award the Prize to Peter D. Lax. Among other things, Størmer said,

"Numerous problems appearing in nature, especially in areas related to waves, such as aerodynamics, meteorology and oil production, are described by nonlinear partial differential equations. Such equations are often very complicated and difficult to study and quite commonly, solutions cannot be given by explicit formulas. In addition, the solutions can develop singularities: think of the shock wave that arises when an aeroplane breaks the sound barrier.

In the 1950s to 1960s, Lax laid the foundations for subsequent theory of such equations, in their theoretical development as well as in their practical applications. Particularly important for applications are Lax's methods for finding numerical solutions to differential equations, as well as conditions under which valid approximations of solutions are given."

Then Peter D. Lax stepped forward to the podium and received the Abel Prize from the Crown Prince Regent to the applause of an enthusiastic audience. Lax then expressed his gratitude for the Prize, saying:

"Mathematics is spoken and written in a language of its own, closed to the general public. Occasions like this are a window of opportunity to give the public a glimpse of the power, importance and sweep of mathematics."

He continued by pointing out the beneficial interaction existing between applied and pure mathematics and quoted von Neumann, who had said that now and then abstract mathematics needed to be revitalized by an injection of new empirical data.

Lax also thanked all the many good teachers, colleagues and students he had had the pleasure of working with throughout the years, stressing the Hungarian mathematics community that had helped him along in his youth.

Towards the end of his speech, he also touched upon the crucial role that computers now play in mathematics. When he was at Los Alamos he had quickly come to see the positive interaction between computers and mathematics:

"I saw there the overwhelming importance of computation for science and the role that mathematics plays in it. Von Neumann was the main champion in every way of computational science."

Following the speech, *Opera i Tiden* took to the stage, performing *Movement in Battle* before the audience filed out into the sunshine.

Peter Lax receives the Abel Prize from HRH Crown Prince Haakon

Banquet

In the evening the Norwegian Government held a banquet at Akershus Castle. The hostess of the banquet was the Minister of Education and Research, Kristin Clemet, and HRH Queen Sonja was in attendance.

The dinner, which was served in the Romerike Hall, consisted of smoked fjord trout, herb-marinated rack of lamb and strawberry-vanilla mousse.

The Minister, Kristin Clemet, gave a speech in honour of the Abel Laureate, Peter Lax, to which James G. Arthur, president of the American Mathematical Society, responded. Among other things, he said the following about Abel and the Abel Prize:

"The lack of a Nobel Prize in mathematics was long regarded as an anomaly that diminished public perception of the importance of mathematics in society. The vision and generosity that led to the creation of the Abel Prize has now put mathematics on an equal footing with the other sciences.

It is also an honour and a pleasure on this glorious occasion to congratulate Professor Peter Lax. It goes without saying that the Abel Prize is the highest honour a mathematician can achieve. The decision is made by a jury of mathematical peers, who work with a large pool of nominees taken from the greatest mathematicians in the world. The circumstances of the award make the Abel Prize as close as one could imagine to a Nobel Prize in mathematics. However, with laureates of the distinction of Peter Lax and Jean-Pierre Serre, Sir Michael Atiyah and Isadore Singer before him, perceptions might change. Perhaps physicists will some day refer to that prize presented in Stockholm as 'an analogue for physics of the Abel Prize!' …

I am sure that the story of Abel is familiar to everyone here. People who are not mathematicians might be surprised to find that Abel is known to countless students as an adjective – abelian. I should say that when a scientist discovers something especially noteworthy, his name gets attached to it. However, the supreme measure of recognition comes when this adjective is no longer capitalized. In this sense, Abel is in the same company as Archimedes, Newton and Gauss."

At the Banquet, from left: Helen Gross, Dr. James Lax, Peter Lax, Cynthia Wang and Daniel Sedlis

Exhibit

This year the Department of Mathematics at the University of Oslo prepared an exhibit for the occasion of the awarding of the Abel Prize. The exhibit was set up in the University Library, where the Abel Symposium was held in honour of Lax. Mathematics connected with this year's Abel Laureate was, of course, a key element of the exhibit. In a popular-scientific manner, the public was shown areas where Lax has made key contributions; laws of conservation, shocks and solitons were major elements of this part of the exhibit. The exhibit also presented historical material connected with the Abel Monument, created by the Norwegian sculptor Gustav Vigeland for the Abel Centenary in 1902. It was from this monument that the designers took their inspiration for the logo of the Abel Prize. The third element of the exhibit was surveying, commemorating the centenary of the dissolution of Norway's union with Sweden. The exhibit started with the old survey of the border, done in the 1750s and 1760s, and followed the history of surveying in Scandinavia until the end of that century when the Norwegian surveyor Caspar Wessel used the complex plane in his calculations for the survey.

Garden party

In the evening after the Abel Lectures, a more informal gathering was held on the premises of the Norwegian

From the exhibition. In the middle a small copy of Vigeland's Abel monument

Academy of Science and Letters. In honour of the Laureate's work on solitons, a small 'canal' was built, equipped with a boat, so that the guests could study solitons into the wee hours.

In 1834, John Scott Russell was observing a boat being drawn along 'rapidly' by a pair of horses. When the boat suddenly stopped, Scott Russell noticed that the bow wave continued forward "at great velocity, assuming the form of a large solitary elevation, a well-defined heap of water which continued its course along the channel apparently without change of form or diminution of speed". Intrigued, the young scientist followed the wave on horseback as it rolled on at about eight or nine miles an hour but after a chase of one or two miles he lost it.

Scott Russell was convinced that he had observed an important phenomenon and he built an experimental tank in his garden to continue his studies of what he dubbed the 'Wave of Translation'. Unfortunately the implications that so excited him (he described the day he made his original observations as the happiest of his life) were ill-understood and largely ignored by his contemporaries.

The 'Wave of Translation' itself was regarded as a curiosity until the 1960s when scientists began to use modern digital computers to study non-linear wave propagation. Then an explosion of activity occurred when it was discovered that many phenomena in physics, electronics and biology could be described by the mathematical and physical theory of the 'soliton', as Scott Russell's wave is now known. This work has continued and currently includes modelling high temperature superconductors and energy transport in DNA while developing new mathematical techniques and concepts to underpin further developments.

Peter Lax himself was in charge of opening the 'canal'.

As part of the formal programme, the President of the Norwegian Academy of Science and Letters presented a commemorative plaque to the members of the Working Group for the Abel Prize, the group that developed the idea of the Abel Prize and proposed its creation to the Norwegian Government in May 2001.

Peter Lax initiating and drinking the soliton

Nils Voje Johansen [nilsvo@math.uio.no] and Yngvar Reichelt [reichelt@math.uio.no] are associated to the Department of Mathematics at the University of Oslo. Both were members of a group of mathematicians that formulated the suggestion to the Norwegian government to install the Abel Prize in commemoration of Niels Henrik Abel's bicentenary, which was finally adopted by the Norwegian parliament.

Interview with Peter D. Lax

Interviewers: Martin Raussen and Christian Skau

The interview took place in Oslo on the 23rd of May, 2005, prior to the Abel Prize celebrations.

On behalf of the Norwegian and Danish Mathematical Societies we would like to congratulate you on winning the Abel Prize for 2005. You came to the U.S. in 1941 as a 15 year old kid from Hungary. Only three years later, in 1944, you were drafted into the U.S army. Instead of being shipped overseas to the war front, you were sent to Los Alamos in 1945 to participate in the Manhattan project, building the first atomic bomb. It must have been awesome as a young man to come to Los Alamos taking part in such a momentous endeavour, and to meet so many legendary famous scientists: Fermi, Bethe, Szilard, Wigner, Teller, Feynman, to name some of the physicists, and von Neumann and Ulam, to name some of the mathematicians. How did this experience shape your view of mathematics and influence your choice of research field within mathematics?

In fact, I returned to Los Alamos after I got my Ph.D. in 1949 for a year's stay and then spent many summers as a consultant. The first time I spent in Los Alamos, and especially the later exposure, shaped my mathematical thinking. First of all it was the experience of being part of a scientific team, not just of mathematicians, people with different outlooks, and the aim being not a theorem, but a product. One can not learn that from books, one must be a participant, and for that reason I urge my students to spend at least a summer as a visitor at Los Alamos. Los Alamos has a very active visitor's program. Secondly, it was there – that was in the 50's – that I became imbued with the utter importance of computing for science and mathematics. Los Alamos, under the influence of von Neumann, was for a while in the 50's and the early 60's the undisputed leader in computational science.

Research Contributions

May we come back to computers later? First some questions about some of your main research contributions to mathematics: You have made outstanding contributions to the theory of non-linear partial differential equations. For the theory and numerical solutions of hyperbolic systems of conservation laws your contribution has been decisive, not to mention your contribution to the understanding of the propagation of discontinuities, so called shocks. Could you describe in a few words how you were able to overcome the formidable obstacles and difficulties this area of mathematics presented?

From the left: Peter Lax, Martin Raussen, Christian Skau (Photo: Knut Falch/Scanpix)

Well, when I started to work on it I was very much influenced by two papers. One was Eberhard Hopf's on the viscous limit of Burgers' equation, and the other was the von Neumann – Richtmyer paper on artificial viscosity. And looking at these examples I was able to see what the general theory might look like.

The astonishing discovery by Kruskal and Zabusky in the 1960's of the role of solitons for solutions of the Korteweg–de Vries (KdV) equation, and the no less astonishing subsequent explanation given by several people that the KdV equation is completely integrable, represented a revolutionary development within the theory of non-linear partial differential equations. You entered this field with an ingenious original point of view, introducing the so-called Lax-pair, which gave an understanding of how the inverse scattering transform applies to equations like the KdV, and also to other non-linear equations which are central in mathematical physics, like the sine-Gordon and the non-linear Schrödinger equation. Could you give us some thoughts on how important you think this theory is for mathematical physics and for applications, and how do you view the future of this field?

Perhaps I start by pointing out that the astonishing phenomenon of the interaction of solitons was discovered by numerical calculations, as was predicted by von Neumann some years before, namely that calculations will reveal extremely interesting phenomena. Since I was a good friend of Kruskal I learned early about his discoveries, and that started me thinking. It was quite clear that there are infinitely many conserved quantities, and so I asked myself: How can you generate all at once an infinity of conserved quantities. I thought if you had a transformation that preserved the spectrum of an operator then that would be such a transformation, and that turned out to be a very fruitful idea applicable quite widely.

Now you ask how important is it? I think it is pretty important. After all, from the point of view of technology for the transmission of signals, signalling by solitons is very important and a promising future technology in trans-oceanic transmission. This was developed by Linn Mollenauer, a brilliant engineer at Bell Labs. It has not yet been put into practice, but it will some day. The interesting thing about it is that classical signal theory is entirely linear, and the main point of soliton signal transmission is that the equations are non-linear. That's one aspect of the practical importance of it.

As for the theoretic importance: the KdV equation is completely integrable, and then an astonishing number of other completely integrable systems were discovered. Completely integrable systems can really be solved in the-sense that the general population uses the word solved. When a mathematician says he has solved the problem he means he knows the solution exists, that it's unique, but very often not much more.

Now the question is: Are completely integrable systems exceptions to the behavior of solutions of non-integrable systems, or is it that other systems have similar behaviour, only we are unable to analyse it? And here our guide might well be the Kolmogorov-Arnold-Moser theorem which says that a system near a completely integrable system behaves as if it were completely integrable. Now, what near means is one thing when you prove theorems, another when you do experiments. It's another aspect of numerical experimentation revealing things. So I do think that studying completely integrable systems will give a clue to the behaviour of more general systems as well.

Who could have guessed in 1965 that completely integrable systems would become so important?

The next question is about your seminal paper "Asymptotic solutions of oscillating initial value problems" from 1957. This paper is by many people considered to be the genesis of Fourier Integral Operators. What was the new viewpoint in the paper that proved to be so fruitful?
It is a micro-local description of what is going on. It combines looking at the problem in the large and in the small. It combines both aspects and that gives it its strengths. The numerical implementation of the micro-local point of view is by wavelets and similar approaches, which are very powerful numerically.

May we touch upon your collaboration with Ralph Phillips – on and off over a span of more that 30 years – on scattering theory, applying it in a number of settings. Could you comment on this collaboration, and what do you consider to be the most important results you obtained?
That was one of the great pleasures of my life! Ralph Phillips is one of the great analysts of our time and we formed a very close friendship. We had a new way of viewing the scattering process with incoming and outgoing subspaces. We were, so to say, carving a semi-group out of the unitary group, whose infinitesimal generator contained almost all the information about the scattering process. So we applied that to classical scattering of sound waves and electromagnetic waves by potensials and obstacles. Following a very interesting discovery of Faddeev and Pavlov, we studied the spectral theory of automorphic functions. We elaborated it further, and we had a brand new approach to Eisenstein series for instance, getting at spectral representation via translation representation. And we were even able to contemplate - following Faddeev and Pavlov – the Riemann hypothesis peeking around the corner.

That must have been exciting!
Yes! Whether this approach will lead to the proof of the Riemann hypothesis, stating it, as one can, purely in terms of decaying signals by cutting out all standing waves, is unlikely. The Riemann hypothesis is a very elusive thing. You may remember in *Peer Gynt* there is a mystical character, the Boyg, which bars Peer Gynt's way wherever he goes. The Riemann hypothesis resembles the Boyg!

Which particular areas or questions are you most interested in today?
I have some ideas about the zero dispersion limit.

Pure and applied mathematics

May we raise a perhaps contentious issue with you: pure mathematics versus applied mathematics. Occasionally one can hear within the mathematical community statements that the theory of non-linear partial differential equations, though profound and often very important for applications, is fraught with ugly theorems and awkward arguments. In pure mathematics, on the other hand, beauty and aesthetics rule. The English mathematician G.H. Hardy is an extreme example of such an attitude, but it can be encountered also today. How do you respond to this? Does it make you angry?
I don't get angry very easily. I got angry once at a dean we had, terrible son of a bitch, destructive liar, and I got very angry at the mob that occupied the Courant Institute and tried to burn down our computer. Scientific disagreements do not arouse my anger. But I think this oppinion is definitely wrong. I think Paul Halmos once claimed that applied mathematics was, if not bad mathematics, at least ugly mathematics, but I think I can point to those citations of the Abel Committee dwelling on the elegance of my works!

Now about Hardy: When Hardy wrote "Apology of a Mathematician" he was at the end of his life, he was old, I think he had suffered a debilitating heart-attack, he was very depressed. So that should be taken into account. About the book itself: There was a very harsh criticism by the chemist Frederick Soddy, who was one of the co-discoverers of the isotopes – he shared the Nobel Prize with Rutherford. He looked at the pride that Hardy took in the uselessness of his mathematics and wrote: "From such cloistral clowning the world sickens". It was very harsh because Hardy was a very nice person.

My friend Joe Keller, a most distinguished applied mathematician, was once asked to define applied mathematics and he came up with this: "Pure mathematics is a branch of applied mathematics". Which is true if you think a bit about it. Mathematics originally, say after Newton, was designed to solve very concrete problems that arose in physics. Later on these subjects developed on their own and became branches of pure mathematics, but they all came from applied background. As von Neumann pointed out, after a while these pure branches that develop on their own need invigoration by new empiri-

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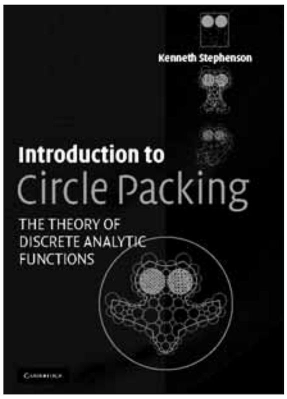

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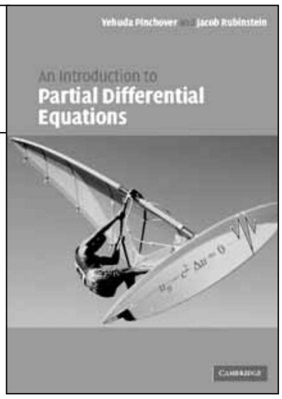

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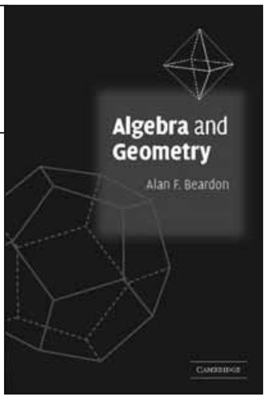

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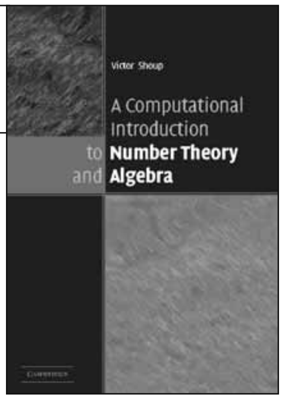

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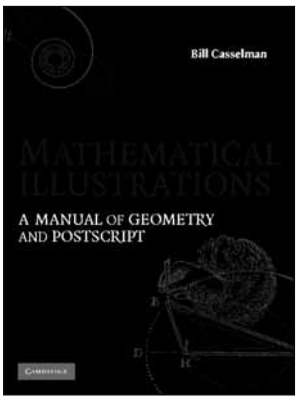

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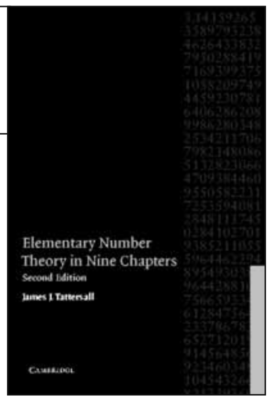

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cal material, like some scientific questions, experimental facts and, in particular, some numerical evidence.

In the history of mathematics, Abel and Galois may have been the first great mathematicians that one may describe as "pure mathematicians", not being interested in any "applied" mathematics as such. However, Abel did solve an integral equation, later called "Abel's integral equation", and Abel gave an explicit solution, which incidentally may have been the first time in the history of mathematics that an integral equation had been formulated and solved. Interestingly, by a simple reformulation one can show that the Abel integral equation and its solution are equivalent to the Radon Transform, the mathematical foundation on which modern medical tomography is based. Examples of such totally unexpected practical applications of pure mathematical results and theorems abound in the history of mathematics – group theory that evolved from Galois' work is another striking example. What are your thoughts on this phenomenon? Is it true that deep and important theories and theorems in mathematics will eventually find practical applications, for example in the physical sciences?

Well, as you pointed out this has very often happened: Take for example Eugene Wigner's use of group theory in quantum mechanics. And this has happened too often to be just a coincidence. Although, one might perhaps say that other theories and theorems which did not find applications were forgotten. It might be interesting for a historian of mathematics to look into that phenomenon. But I do believe that mathematics has a mysterious unity which really connects seemingly distinct parts, which is one of the glories of mathematics.

You have said that Los Alamos was the birthplace of computational dynamics, and I guess it is safe to say that the U.S. war effort in the 1940's advanced and accelerated this development. In what way has the emergence of the high-speed computer altered the way mathematics is done? Which role will high-speed computers play within mathematics in the future?

It has played several roles. One is what we saw in Kruskal's and Zabusky's discovery of solitons, which would not have been discovered without computational evidence. Likewise the Fermi-Pasta-Ulam phenomenon of recurrence was also a very striking thing which may or may not have been discovered without the computer. That is one aspect.

But another is this: in the old days, to get numerical results you had to make enormously drastic simplifications if your computations were done by hand, or by simple computing machines. And the talent of what drastic simplifications to make was a special talent that did not appeal to most mathematicians. Today you are in an entirely different situation. You don't have to put the problem on a Procrustean bed and mutilate it before you attack it numerically. And I think that has attracted a much larger group of people to numerical problems of applications – you could really use the full theory. It invigorated the subject of linear algebra, which as a research subject

Peter Lax was received by Crown Prince Haakon and Queen Sonja of Norway (Photo: Knut Falch/Scanpix)

died in the 1920's. Suddenly the actual algorithms for carrying out these operations became important. It was full of surprises, like fast matrix multiplication. In the new edition of my linear algebra book I will add a chapter on the numerical calculation of the eigenvalues of symmetric matrices.

You know it's a truism that due to increased speed of computers, a problem that took a month 40 years ago can be done in minutes, if not seconds today. Most of the speed-up is attributed, at least by the general public, to increased speed of computers. But if you look at it, actually only half of the speed-up is due to this increased speed. The other half is due to clever algorithms, and it takes mathematicians to invent clever algorithms. So it is very important to get mathematicians involved, and they are involved now.

Could you give us personal examples of how questions and methods from applied points of view have triggered "pure" mathematical research and results? And conversely, are there examples where your theory of nonlinear partial differential equations, especially your explanation of how discontinuities propagate, have had commercial interests? In particular, concerning oil exploration, so important for Norway!

Yes, oil exploration uses signals generated by detonations that are propagated through the earth and through the oil reservoir and are recorded at distant stations. It's a so-called inverse problem. If you know the distribution of the densities of materials and the associated waves' speeds, then you can calculate how signals propagate. The inverse problem is that if you know how signals propagate, then you want to deduce from it the distribution of the materials. Since the signals are discontinuities, you need the theory of propagation of discontinuities. Otherwise it's somewhat similar to the medical imaging problem, also an inverse problem. Here the signals do not go through the earth but through the human body, but there is a similarity in the problems. But there is no doubt that you have to understand the direct problem very well before you can tackle the inverse problem.

Hungarian mathematics

Now to some questions related to your personal history. The first one is about your interest in, and great

aptitude for, solving problems of a type that you call "Mathematics Light" yourself. To mention just a few, already as a 17 year old boy you gave an elegant solution to a problem that was posed by Erdös and is related to a certain inequality for polynomials, which was earlier proved by Bernstein. Much later in your career you studied the so-called Polya function which maps the unit interval continuously onto a right-angled triangle, and you discovered its amazing differentiability properties. Was problem solving specifically encouraged in your early mathematical education in your native Hungary, and what effect has this had on your career later on?

Yes, problem solving was regarded as a royal road to stimulate talented youngsters, and I was very pleased to learn that here in Norway they have a successful high-school contest, where the winners were honoured this morning. But after a while one shouldn't stick to problem solving, one should broaden out. I return ever once in a while to it, though.

Back to the differentiability of the Polya function: I knew Polya quite well having taken a summer course with him in '46. The differentiability question came about this way: I was teaching a course on real variables and I presented Polya's example of an area-filling curve, and I gave as homework to the students to prove that it's nowhere differentiable. Nobody did the homework, so then I sat down and I found out that the situation was more complicated.

There was a tradition in Hungary to look for the simplest proof. You may be familiar with Erdös' concept of The Book. That's The Book kept by the Lord of all theorems and the best proofs. The highest praise that Erdös had for a proof was that it was out of The Book. One can overdo that, but shortly after I had got my Ph.D., I learned about the Hahn-Banach theorem, and I thought that it could be used to prove the existence of Green's function. It's a very simple argument – I believe it's the simplest – so it's out of The Book. And I think I have a proof of Brouwer's Fixed Point Theorem, using calculus and just change of variables. It is probably the simplest proof and is again out of The Book. I think all this is part of the Hungarian tradition. But one must not overdo it.

There is an impressive list of great Hungarian physicists and mathematicians of Jewish background that had to flee to the US after the rise of fascism, Nazism and anti-Semitism in Europe. How do you explain this extraordinary culture of excellence in Hungary that produced people like de Hevesy, Szilard, Wigner, Teller, von Neumann, von Karman, Erdös, Szegö, Polya, yourself, to name some of the most prominent ones?

There is a very interesting book written by John Lukacs with the title "Budapest 1900: A Historical Portrait of a City and its Culture", and it chronicles the rise of the middle class, rise of commerce, rise of industry, rise of science, rise of literature. It was fuelled by many things: a long period of peace, the influx of mostly Jewish population from the East eager to rise, an intellectual tradition. You know in mathematics, Bolyai was a culture hero to Hungarians, and that's why mathematics was particularly looked upon as a glorious profession.

But who nurtured this fantastic flourishing of talent, which is so remarkable?

Perhaps much credit should be given to Julius König, whose name is probably not known to you. He was a student of Kronecker, I believe, but he also learned Cantor's set theory and made some basic contribution to it. I think he was influential in nurturing mathematics. His son was a very distinguished mathematician, Denes König, really the father of modern graph theory. And then there arose extraordinary people. Leopold Fejér, for instance, had enormous influence. There were too many to fill positions in a small country like Hungary, so that's why they had to go abroad. Part of it was also anti-Semitism.

There is a charming story about the appointment of Leopold Fejér, who was the first Jew proposed for a professorship at Budapest University. There was opposition to it. At that time there was a very distinguished theologian, Ignatius Fejér, in the Faculty of Theology. Fejér's original name was Weiss. So one of the opponents, who knew full well that Fejér's original name had been Weiss, said pointedly: "This professor Leopold Fejér that you are proposing, is he related to our distinguished colleague Father Ignatius Fejér?" And Eötvös, the great physicist who was pushing the appointment, replied without batting an eyelash: "Illegitimate son". That put an end to it.

And he got the job?

He got the job.

Scribbles that changed the course of human affairs

The mathematician Stanisław Ulam was involved with the Manhattan Project and is considered to be one of the fathers of the hydrogen bomb. He wrote in his autobiography "Adventures of a Mathematician": "It is still an unending source of surprise for me to see how a few scribbles on a blackboard, or on a sheet of paper, could change the course of human affairs". Do you share this feeling? And what are your feelings to what happened to Hiroshima and Nagasaki, to the victims of the explosions of the atomic bombs that brought an end to World War II?

Well, let me answer the last question first. I was in the army, and all of us in the army expected to be sent to the Pacific to participate in the invasion of Japan. You remember the tremendous slaughter that the invasion of Normandy brought about. That would have been nothing compared to the invasion of the Japanese mainland. You remember the tremendous slaughter on Okinawa and Iwo Jima. The Japanese would have resisted to the last man. The atomic bomb put an end to all this and made an invasion unnecessary. I don't believe reversionary historians who say: "Oh, Japan was already beaten, they would have surrendered anyway". I don't see any evidence for that.

There is another point which I raised once with someone who had been involved with the atomic bomb project. Would the world have had the horror of nuclear war if it had not seen what one bomb could do? The world was inoculated against using nuclear weapon by its use. I am not saying that alone justifies it, and it certainly was not the justification for its use. But I think that is a historical fact.

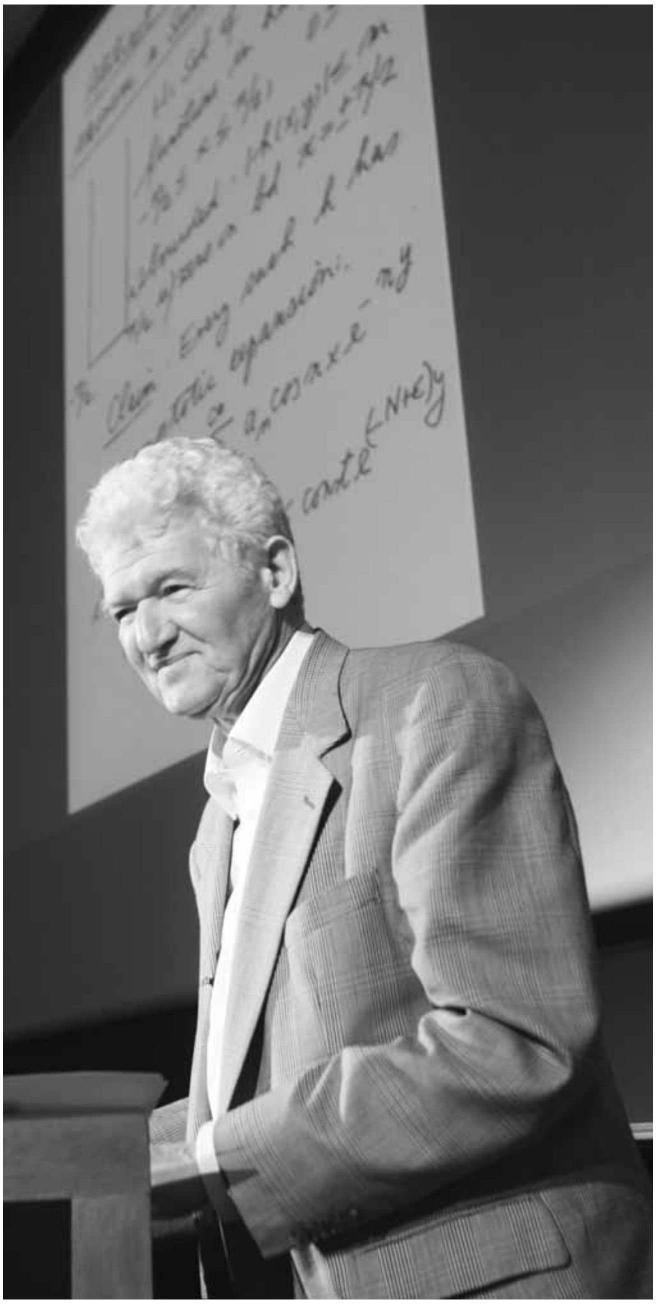
Now about scribbles changing history: Sure, the special theory of relativity, or quantum mechanics, it would be unimaginable today without scribbles. Incidentally, Ulam was a very interesting mathematician. He was an idea man. Most mathematicians like to push their ideas through. He preferred throwing out ideas. His good friend Rota even suggested that he did not have the technical ability or patience to work them out. But if so, then it's an instance of Ulam turning a disability to tremendous advantage. I learned a lot from him.

It is amazing for us to learn that an 18 year old immigrant was allowed to participate in a top-secret and decisive weapon development during WWII.
The war created an emergency. Many of the leaders of the Manhattan Project were foreigners, so being a foreigner was no bar.

Collaboration. Work Style

Your main workplace has been the Courant Institute of Mathematical Sciences in New York, which is part of New York University. You served as its director for an eight year period in the 70's. Can you describe what made this institute, which was created by the German refugee Richard Courant in the 1930's, a very special place from the early days on, with a particular spirit and atmosphere? And is the Courant Institute today still a special place that differs from others?
To answer your first question, certainly the personality of Courant was decisive. Courant saw mathematics very broadly, he was suspicious of specialisation. He wanted it drawn as broadly as possible, and that's how it came about that applied topics and pure mathematics were pursued side by side, often by the same people. This made the Courant Institute unique at the time of its founding, as well as in the 40's, 50's and 60's. Since then there are other centres where applied mathematics is respected and pursued. I am happy to say that this original spirit is still present at the Courant Institute. We still have large areas of applied interest, meteorology and climatology under Andy Majda, solid state and material science under Robert Kohn and others, and fluid dynamics. But we also have differential geometry as well as some pure aspects of partial differential equations, even some algebra.

I am very pleased how the Courant Institute is presently run. It's now the third generation that's running it, and the spirit that Courant instilled in it – kind of a family feeling – still prevails. I am happy to note that many Norwegian mathematicians received their training at the Courant Institute, and later rose to become leaders in their field.



Peter Lax lecturing at Oslo University (Photo: Terje Bendiksby/Scanpix)

You told us already about your collaboration with Ralph Phillips. Generally speaking, looking through your publication list and the theorems and methods you and your collaborators have given name to, it is apparent that you have had a vast collaboration with a lot of mathematicians. Is this sharing of ideas a particularly successful, and maybe also joyful, way of advancing for you?
Sure, sure. Mathematics is a social phenomenon after all. Collaboration is a psychological and interesting phenomenon. A friend of mine, Vera John-Steiner, has written a book ("Creative Collaboration") about it. Two halves

of a solution are supplied by two different people, and something quite wonderful comes out of it.

Many mathematicians have a very particular work style when they work hard on certain problems. How would you characterise your own particular way of thinking, working, and writing? Is it rather playful or rather industrious? Or both?

Phillips thought I was lazy. He was a product of the Depression which imposed a certain strict discipline on people. He thought I did not work hard enough, but I think I did!

Sometimes mathematical insights seem to rely on a sudden unexpected inspiration. Do you have examples of this sort from your own career? And what is the background for such sudden inspiration in your opinion?

The question reminds me of a story about a German mathematician, Schottky, when he reached the age of 70 or 80. There was a celebration of the event, and in an interview like we are having, he was asked: "To what do you attribute your creativity and productivity". The question threw him into great confusion. Finally he said: "But gentlemen, if one thinks of mathematics for 50 years, one must think of something!"

It was different with Hilbert. This is a story I heard from Courant. It was a similar occasion. At his 70th birthday he was asked what he attributed his great creativity and originality to. He had the answer immediately: "I attribute it to my very bad memory". He really had to reconstruct everything, and then it became something else, something better. So maybe that is all I should say. I am between these two extremes. Incidentally, I have a very good memory.

Teaching

You have also been engaged in the teaching of calculus. For instance, you have written a calculus textbook with your wife Anneli as one of the co-authors. In this connection you have expressed strong opinions about how calculus should be exposed to beginning students. Could you elaborate on this?

Our calculus book was enormously unsuccessful, in spite of containing many excellent ideas. Part of the reason was that certain materials were not presented in a fashion that students could absorb it. A calculus book has to be fine-tuned, and I didn't have the patience for it. Anneli would have had it, but I bullied her too much, I am afraid. Sometimes I dream of redoing it because the ideas that were in there, and that I have had since, are still valid.

Of course, there has been a calculus reform movement and some good books have come out of it but I don't think they are the answer. First of all, the books are too thick, often more than 1000 pages. It's unfair to give such a book into the hands of an unsuspecting student who can barely carry it. And the reaction to it would be: "Oh, my God, I have to learn all that is in it?" Well, all that is not in it! Secondly, if you compare it to the old standards, Thomas, say, it's not so different – the order of the topics and concepts, perhaps.

In my calculus book, for instance, instead of continuity at a point, I advocated uniform continuity. This you can explain much easier than defining continuity at a point and then say the function is continuous at every point. You lose the students; there are too many quantifiers in that. But the mathematical communities are enormously conservative: "continuity has been defined pointwise, and so it should be!"

Other things that I would emphasize: To be sure there are applications in these new books. But the applications should all stand out. In my book there were chapters devoted to the applications, that's how it should be, they should be featured prominently. I have many other ideas as well. I still dream of redoing my calculus book, and I am looking for a good collaborator. I recently met someone who expressed admiration for the original book, so perhaps it could be realized, if I have the energy. I have other things to do as well, like the second edition of my linear algebra book, and revising some old lecture notes on hyperbolic equations. But even if I could find a collaborator on a calculus book, would it be accepted? Not clear. In 1873, Dedekind posed the important question: "What are, and what should be, the real numbers"? Unfortunately, he gave the wrong answer as far as calculus students are concerned. The right answer is: infinidecimals. I don't know how such a joke will go down?

Heading large institutions

You were several times the head of large organisations: director of the Courant Institute in 1972–1980, president of the American Mathematical Society in 1977–1980, leader of what was called the Lax Panel on the National Science Board in 1980–1986. Can you tell us about some of the most important decisions that had to be taken in these periods?

The president of the Mathematical Society is a figurehead. His influence lies in appointing members of committees. Having a wide friendship and reasonable judgement are helpful. I was very much helped by the secretary of the Mathematical Society, Everett Pitcher.

As for being the director of the Courant Institute, I started my directorship at the worst possible time for New York University. They had just closed down their School of Engineering, and that meant that mathematicians from the engineering school were transferred to the Courant Institute. This was the time when the Computer Science Department was founded at Courant by Jack Schwartz. There was a group of engineers that wanted to start activity in informatics, which is the engineers' word for the same thing. As a director I fought very hard to stop that. I think it would have been very bad for the university to have two computing departments – it certainly would have been very bad for our Computer Science Department. Other things: Well, I was instrumental in hiring Charlie Peskin at the recommendation of Alexander Chorin, I was very pleased with that. Likewise, hiring Sylvain Cappell at the recommendation of Bob Kohn. Both were enormous successes.

What were my failures? Well, maybe when the Computer Science Department was founded I should have insisted on having a very high standard of hiring. We needed people to teach courses, but in hindsight I think we should have exercised more restraint in our hiring. We might have become the number one computer science department. Right now the quality has improved very much - we have a wonderful chairwoman, Margaret Wright.

Being on the National Science Board was my most pleasant administrative experience. It's a policy-making body for the National Science Foundation (NSF), so I found out what making policy means. Most of the time it just means nodding 'yes', and a few times saying 'no'. But then there are sometimes windows of opportunity, and the Lax Panel was a response to such a thing. You see, I noticed through my own experience and those of my friends who are interested in large scale computing, in particular, Paul Garabedian, who complained that university computational scientists had no access to the supercomputers. At a certain point the government, which alone had enough money to purchase these supercomputers, stopped placing them at universities. Instead they went to national labs and industrial labs. Unless you happened to have a friend there with whom you collaborated, you had no access. That was very bad from the point of view of the advance of computational science, because the most talented people were at the universities. At that time accessing and computing at remote sites became possible thanks to ARPANET, which then became a model for the Internet. So the panel that I established made strong recommendation that the NSF establish computing centres, and that was followed up. My quote on our achievement was a paraphrase of Emerson: "Nothing can resist the force of an idea that is ten years overdue".

A lot of mathematical research in the US has been funded by contracts from DOD, DOE, the atomic energy commission, the NSA. Is this dependence of mutual benefit? Are there pitfalls?
I am afraid that our leaders are no longer aware of the subtle but close connection between scientific vigour and technological sophistication.

Personal Interests

Would you tell us a bit about your interests and hobbies that are not directly related to mathematics?
I love poetry. Hungarian poetry is particularly beautiful, but English poetry is perhaps even more beautiful. I love to play tennis. Now my knees are a bit wobbly and I can't run anymore, but perhaps these can be replaced – I'm not there yet. My son and three grandsons are tennis enthusiasts so I can play doubles with them. I like to read. I have a knack for writing. Alas, these days I write obituaries – it's better to write them than being written about.

Prize winners Atiyah, Lax and Singer (Photo: Ørn E. Borgen/Scanpix)

You have also written Japanese haikus?
You're right. I got this idea from a nice article by Marshall Stone – I forget exactly where it was – where he wrote that the mathematical language is enormously concentrated, it is like haikus. And I thought I would take it one step further and actually express a mathematical idea by a haiku.

Speed depends on size
Balanced by dispersion
Oh, solitary splendour.

Professor Lax, thank you very much for this interview on behalf of the Norwegian, the Danish, and the European Mathematical Societies!
I thank you.

The interviewers were Martin Raussen [raussen@math.aau.dk], Aalborg University, Denmark, and Christian Skau [csk@math.ntnu.no], Norwegian University of Science and Technology, Trondheim, Norway.

Breakfast with John Horton Conway

The interview was conducted by Jorge Nuno Silva (Lisbon, Portugal) at Curia (Portugal) on the 12th of September, 2004.

Professor Conway, can we start this interview with the genesis of "On Numbers and Games" (ONAG) and the Theory of Surreal Numbers?

Of course. I was in Cambridge at the time, and used to play Go with a colleague, who was the English champion. I'm not good at Go, but became very curious about the game. Simultaneously, I'd been thinking about sums of partizan games for a long time. I already knew that such games formed a group. I've investigated the structure of that group. I've found a sequence of games of type A, B = 2A, C = 3A, etc., it was natural to associate them with the natural numbers; another sequence satisfied 2B = A, 2C = B, etc., it was natural to associate it with the dyadic rationals. I've realised in this way that the group of the games had interesting subgroups, isomorphic to other well-known ones. Later on I've convinced myself that I had obtained more than this, games were indeed numbers, they were not bound to contain subgroups isomorphic to the integers and the fractions alone, there were more general ones, like the irrationals and the infinite ordinals.

It took me more than one year to obtain the definition in the final form. In 1970 I successfully presented my construction at the California Institute of Technology, suddenly we realised the stuff was important; a generalization of Dedekind's construction of the real numbers, and produced many other numbers. In the following year I went to Calgary's University in order to work with Richard Guy on this matter, and ended up writing down a paper, "All games bright and beautiful", where I presented this theory.

Somewhat later, in a break during a conference, I mentioned this work of mine to Donald Knuth. Shortly after, on the pretext of having discussed with his wife, the latter spent one week in an hotel, in Norway, writing *Surreal Numbers*, which is the first book mentioning my construction. Actually, the term "surreal numbers" was coined by Knuth. Other authors have been writing some books and papers about the subject.

How was it possible to write ONAG in one week?

Well, I was involved, with Elwyn Berlekamp and Richard Guy, in the project of writing a book about impartial games, I mean, games of Nim type. Nevertheless, I was uncovering so many things about the other class of games that I preferred to take it out of my attention, by writing a book. I locked myself in the office and only stopped for eating and sleeping. In one week the book was finished. It remained the final chapter, which I have completed two years later, and some tables, but essentially the book was finished after one week.

This book almost gave rise to a quarrel between friends...

John Horton Conway and Jorge Nuno Silva

It's true. I sent a letter to my colleagues Berlekamp and Guy, which started "Dear colleagues, last week I wrote a book, which you will get by mail in a couple of days…". Even before they got the book, I had a letter from Berlekamp, threatening me with a lawsuit. He thought I was stealing stuff from our joint project to publish under my name alone.

That lawsuit didn't go ahead, did it?

I was so distressed with Berlekamp's reaction, that I answered him by explaining what my real intention was, and offering to withdraw my name from the joint work we were doing. In the end he set down and we have been three good friends until today. The collaboration continued and culminated with the publication of *Winning Ways* (WW). Our typical method of work consisted in having me going to the blackboard and explain the theory, while Guy was taking notes. Later, Richard Guy would expose on the blackboard the result of his work on the notes he had taken. That was the point where the battle would begin, I would say "Richard, that was not what I have written!" and Richard Guy would answer "Of course it isn't. This is better!" The sessions were always very vibrant. The strong point of Berlekamp consisted in the analysis of some particular games; the most interesting of them is Dots and Squares, which I know it makes part of your National Championship of Mathematical Games.[1]

[1] Pavilhão do Conhecimento, Lisbon, 26th of November of 2004. http://ludicum.org

But Berlekamp's style is different from yours, how come that does not show up in "WW"?

The text suffered many stylistic changes, mainly done by Richard Guy. You may note, in certain chapters, mainly in the annexes, that the language of Berlekamp shows up more.

How did the possibility of working with Richard Guy came up, as he is much older than the two other co-authors?

My friendship started with his son, Michael Guy, who had been my colleague in Cambridge and is an excellent mathematician. It was through him that I got to know Richard, who was very interested in games, and that's it. Michael was my best friend for many years, but today it is his father which I know better… In the beginning I had a strange feeling, I was in my twenties and he was almost fifty! But everything worked out well; we have had great fun together. Once, we had rented a house in New Jersey, where we were both working at Bell. Richard came in the house with me and said: the largest room is for me, as I'm the oldest. There were two books in that house: a novel and a children's book with card tricks. Richard kept the novel with him and gave me the children's book (it was there that I learned the trick I have done some days ago, at Gulbenkian,[2] though I have modified it a bit). The weeks we spent together in New Jersey were very amusing, and we worked a lot on mathematical games.

I know you were born in Liverpool. How were you as a student?

I was a good student at high school, which allowed me to enter in Cambridge. Here I did my first degree and the PhD.

How influent was Cambridge in your career?

The system there, with lectures and tutorials worked out very well with my fellows and me. Some teachers were really good and the ones who dedicated themselves to the tutorial classes did that with high competence, the students could learn a lot.

You did your PhD under Harold Davenport, an expert in Number Theory, but your thesis was in Logic. How did that happen?

Well, I have always been very fond of Number Theory. Davenport's lectures were excellent; I even liked his Northern accent! It was natural to choose him for supervisor. Davenport gave me a problem to think about (Waring's problem). We met every Thursday, so that I could show him my progress. There was none along the first year, and I started feeling guilty. At the end of the academic year I spent some weeks thinking on the problem and solved it. When the classes resumed I showed him my work. He took it for one week. In the following meeting he told me: Conway, what we have here is a poor PhD thesis… Davenport never congratulated anybody, so this was the best we could expect to hear from him. In this way the message he wanted to get through was the following: if you don't do anything more, this work will give you the PhD, but you should work more. Actually, the average time for a PhD is three years, and this happened right after the first year.

After this our Thursdays meetings were always open to discussions on nearly any subject in mathematics, philosophy, etc.

Why not presenting the very same work after the three years?

A Chinese mathematician solved the same problem and published his work meanwhile. Therefore, after this, my work was no longer worth a PhD. Another reason is that I also got interested on some problems of Logic and Set Theory which, fortunately, gave me enough material to finish my degree. Davenport also had interest in these subjects, so I could keep the same supervisor.

Your interest in Logic didn't last long...

In the conferences I used to go I could see many important problems in the theory being solved, but all proofs extended over hundreds of pages… it was difficult to work. At the same time, some colleagues introduced me to some hot questions in Group Theory, and my dormant old interest for this theory woke up again. In the following fifteen years I dedicated myself professionally to this field. After this period I published, together with some colleagues, the *Atlas of Finite Groups*, in 1984. I simultaneously moved to Princeton.

This is when the packing of spheres enters the scene, right?

Right, with Sloane, I devoted myself to the sphere-packing problem and Kepler's conjecture. So, I became a geometer! All my work after this point has to do with geometry.

What is the mathematical discovery you are more proud of?

Well, the answer must be the surreal numbers. This is, nevertheless, a surprising answer, even for me, due to the short mathematical content involved. In this theory, after introducing the definitions, everything is constructed in few pages. The simplicity of the process is amazing.

The amount of work I invested in the Atlas was enormous, along many years. The reconstruction of the Monster was also a nontrivial task.

If I had to prove someone I am a competent mathematician, I'd show my production in Group Theory.

The book *Packing of Spheres*, which I have written with Sloane, got very positive criticisms. One of them in particular, from Gian-Carlo Rota, was so enthusiastic, that I copied it and hanged it on the wall. It helped me during times of depression.

The *Book of Numbers* was also very well accepted, being translated in nine languages, I believe.

[2] John Conway visited Portugal last September to present a series of lectures, at Fundação Gulbenkian in Lisbon, in a Summer School of the "New Talents in Mathematics" programme.

And what do you think was the most important result of last century?

Well, we have Gödel's theorems, for example, which are extremely important. We have also the recently announced proof of Poincaré's conjecture, if it proves correct. But maybe the work of Wyles, in the proof of Fermat's last theorem, is the most remarkable result. It is hard to say, because, as we all know, the relevance of a result depends more on its future than on its past…

John Horton Conway is John von Neumann Distinguished Professor at Princeton University (USA). Jorge Nuno Silva is Professor at the Mathematics Department of the University of Lisbon (Portugal). A Portuguese version of the interview was previously published in Boletim SPM 51 (2004), pp. 49-53. We thank the editors for the permission to reproduce it in the Newsletter.

John Horton Conway

The Laboratory of Mathematical Machines of Modena

Michela Maschietto (Modena, Italy)

Mathematical objects cannot be easily grasped by our senses. This creates well known problems in the popularization and in the teaching of mathematics. Yet students (and mathematicians as well) usually make use of external representations of mathematical objects (e. g. words, schemes, symbols, gestures, instruments). In common sense the representation of a mathematics lessons is a blackboard full of formulas. Yet from the very ancient times tangible instruments (like the ruler and the compass) are part of mathematical experience and of the iconography of mathematics.

The Laboratory of Mathematical Machines (the MMLab), at the Department of Mathematics in Modena, contains a collection of geometrical instruments ('mathematical machines'). They have been reconstructed with a didactical aim, according to the design described in historical texts from classical Greece (linked to the theory of conic sections) to the 20th century. The MMLab works for both didactical research and popularisation of mathematics. The research activity has been funded by several agencies, local (the University, Regional Institute for School), National (Ministry of Instruction), international (the European Commission).

The MMLab staff includes academic researchers, university students, teachers and the members of association 'Macchine Matematiche' (http://associazioni.monet.modena.it/macmatem/).

Aim of this paper is to present the MMLab, an unusual case of Math laboratory.

According to the recent documents of the Teaching Commission of the Italian Mathematical Society (www.dm.unibo.it/umi/italiano/didattica/2003/secondaria.pdf),

A mathematics laboratory is (...) rather a methodology, based on various and structured activities, aimed to the construction of meanings of mathematical objects. (...) We can imagine the laboratory environment as a renaissance workshop, in which the apprentices learned by doing, seeing, imitating, communicating with each other, in a word: practicing. In the laboratory activities, the construction of meanings is strictly bound, on one hand, to the use of tools, and on the other, to the interactions between people working together (without distinguishing between teacher and students).

What is a mathematical machine?

A mathematical machine (related to the geometry field) is an artefact designed and built for the following purpose, that does not depend on the practical use (if any): it aims at forcing a point, a line segment or a plane fig-

Fig. 1: The MMLab

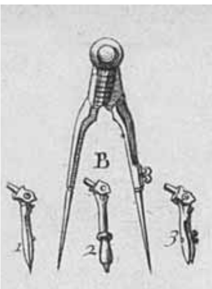


Fig. 2: Compass

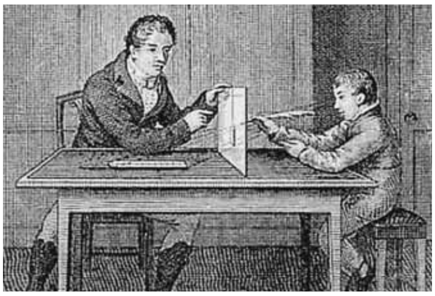


Fig. 3: Perspectograph

ure (supported by a material support that makes them visible and touchable) to move or to be transformed according to a mathematical law that has been determined by the designer.

The most well-known mathematical machine is the pair of compasses (to draw circles) that is part of the iconography of mathematicians (Fig. 2). It is the ancestor of many curve drawing devices and pantographs.

Another class of mathematical machines is given by perspectographs (e.g. Fig. 3) that are related to the ancient three-dimensional theory of conics, on the one hand, and to the roots of projective geometry on the other hand.

The story of the MMLab

The Laboratory was initiated in the early 80s by a small group of secondary school teachers, who were inspired by the didactical work of Castelnuovo and Lombardo Radice in Rome. They began to build instruments with poor materials in the basement of a secondary school (the 'Liceo Scientifico Tassoni') and they used them in everyday classroom activity. Very soon they established deep links with the team of didacticians at the Department of Mathematics. When they retired from school, they constituted the non-profit Association 'Macchine Matematiche' that has already cooperated with the University and with other Museums, by producing exhibits and preparing exhibitions. In 1996 the Laboratory was moved from the school to the Science Museum of the University, then to the Department of Mathematics in 2002. During that time, dozens of instruments (about 200) have been reconstructed.

In 1992 the expositive activity began with a public exhibition (*Macchine matematiche e altri oggetti*) in the Town Hall of Modena. After that, many exhibitions were realised in Italy and abroad. Just to quote one, we were invited at 5th Salon of the 'Comité International des Jeux Mathématiques' (2004) in Paris. The two major collections of instruments are *Theatrum Machinarum* (Modena, 1998; Cesenatico, 2000; Cesena, 2002) and *Perspectiva Artificialis* (Florence, 2002; Modena, 2003). Two smaller travelling exhibitions for schools have been prepared: *Geometria a tu per tu* and *Apparenza e realtà*. They are based on a written agreement between the Department of Mathematics and the Regional Institute for School (of Emilia Romagna). The travelling exhibitions have been on show at the Science Festival in Genoa (2004 and 2005). The latter has also met the challenge of the many thousands visitors of a shopping centre and of the interested students who took part in the National Olympic Competitions of Mathematics (2005).

Besides producing working physical models, the MMLAB entered the field of multimedia. After the production of motion pictures concerning pencils of conics, in the 90s, the MMLab began to produce 'virtual' copies of instruments, by means of various software from the didactic (e.g. Cabri) or the professional fields (e.g. Cinema4d or java). The aim is both to show the functioning of a physical instrument and to produce 'infinitely many' different instruments by changing parameters. The MMLAB produced *Labmat* (www.museo.unimo.it/labmat/), *Theatrum Machinarum* and *Perspectiva Artificialis* (www.mmlab.unimore.it).

From 1999 to 2003 the MMLab has been involved in the Thematic Network Maths Alive, financed within the 5th framework program of the European Commission and coordinated by Albrecht Beuthelspacher (Mathematikum, Germany). In 2004, the project "Hands on Maths" was finalist for the Altran award for Innovation. In the same year a DEMO of *Perspectiva Artificialis* was shortlisted at the Pirelli INTERNETational award.

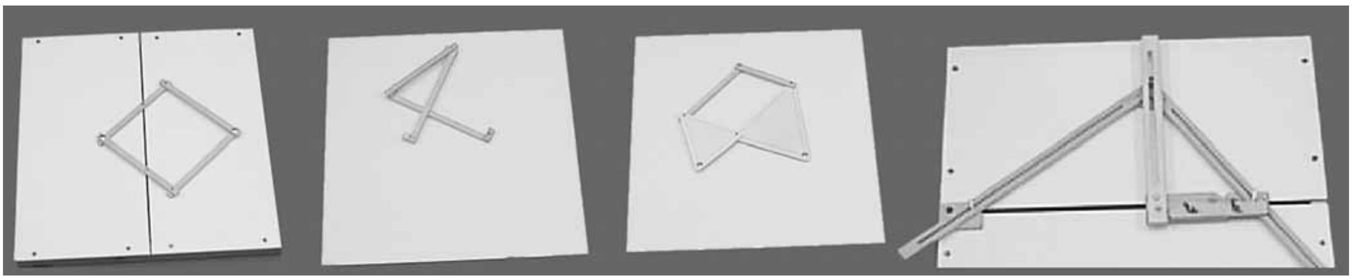


Fig. 4: Images from the kit classroom activity

In parallel, didactical research on the function of instruments had been carried out for many years. A product is represented by the two teaching units on curve drawing devices and transformation pantographs for secondary school (www5.indire.it:8080/set/set_modelli/modellizzazione.htm). In order to foster the personal contact of students with instruments, the MMLAB has designed special kits (Fig. 4) for schools. Classroom activities within the MMLab are organized on teachers' request by the MMLab staff. Teaching experiments for primary school have been also carried out.

At the end of 2003, the MMLAB hosted the meeting of the International Program Committee of the Study n. 16 *Challenging Mathematics in and beyond the Classroom* (EMS Newsletter, N. 55).

Fig. 5: Dürer's glass

Didactical implications

The practice of tangible instruments in mathematics (and in geometry too) was present in the work of mathematicians until the early decades of 20th century, when the Bourbakist program shifted the focus to formal and symbolic aspects.

The enactive mode of knowledge (according to J. Bruner) remained in mathematics education, usually limited to young pupils, as if the importance of handling objects and exploring space were decreasing with age. In some cases the confidence of the power of the concrete experience itself was surely excessive, as if it were transparent for the mathematical meanings or procedures embodied in it. Anthropological research however has pointed out that the transparency of any technology always exists with respect to some purpose, it is intricately tied to the cultural practice and it cannot be viewed as a feature of the artefact in itself.

The use of working copies of historical instruments has the potential to address some important issues (for details, Bartolini Bussi, 2000):

Cultural: To make the users aware that mathematics is a developing part of human culture, connected with art, technology and everyday life,

Affective: To foster a positive attitude towards mathematics, emphasizing the discovery and the enjoying aspects of mathematical activity.

Cognitive: To foster the involvement of the body as a whole in mental processes, according to both the most recent studies of neuroscience and cognitive linguistics.

Didactic: To provide a suitable learning context where to activate important processes such as the construction of meanings and the construction of proofs.

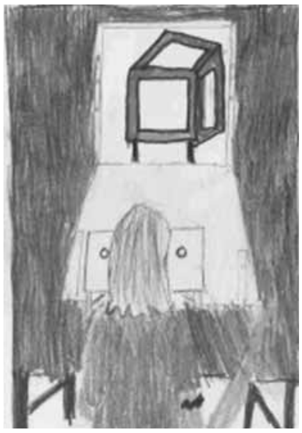


Fig. 6: Drawing of the Dürer's glass

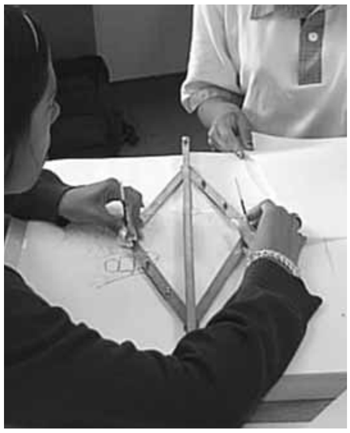


Fig. 7: The brass machine

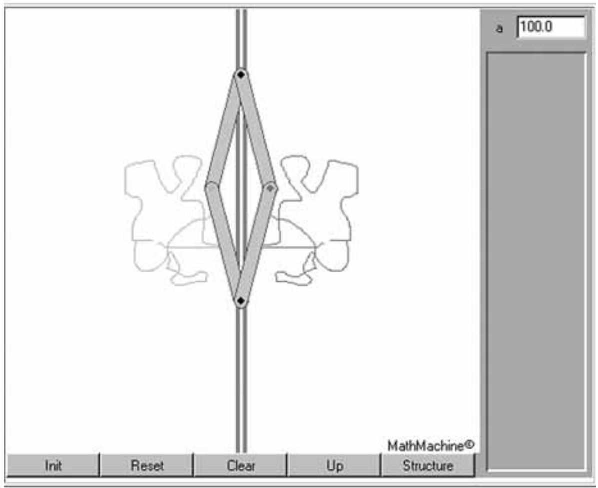


Fig. 8: The virtual machine

Some examples are useful. In (Bartolini Bussi et al., 2005), a theoretical framework is given to study the construction of meaning of mathematical objects such as the pyramid and the relationship with the modelling process of perspective drawing. The process is lead by the exploration of a model of the Dürer's glass (Figs 5 and 6) in the classroom. In the experiment, however, the introduction of some photorealistic animations of instruments for perspective shows that a deep and long term exploration of a concrete artefact allows the interpretation of a 'new' instrument often offered only in the virtual world (Maschietto et al., 2004, 2005).

In Fig.7 the girl is using a machine (studied by Delaunay in the XIX century) that allows the drawing of two symmetrical figures. This suggests the role of the muscle-perception in the construction of the meaning of symmetry. From the bodily perspective, the experience is not comparable with the experience of the java applet (Fig.8) where the left point (directing point), controlled by the

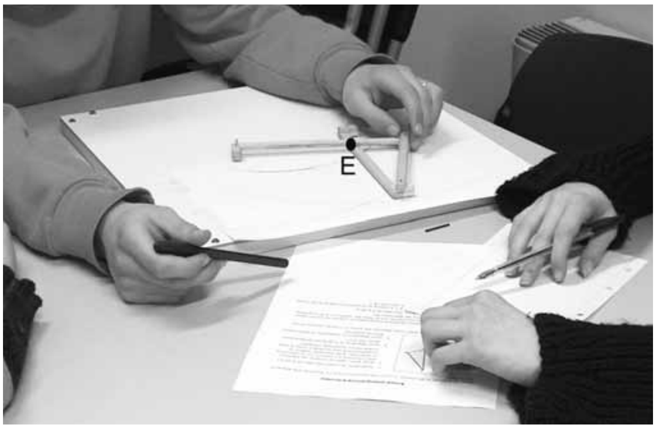


Figure 9: The ellipsograph

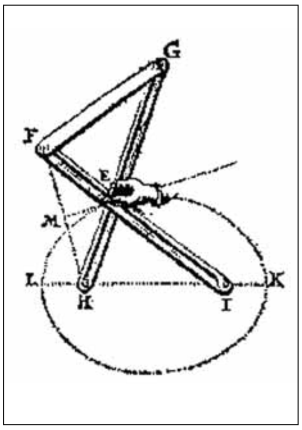


Figure 10: A drawing of the instrument (van Schooten)

hand though the mouse, provokes the motion of the right point (tracing point).

The muscular perception gives such instruments a big potentially to be used by blind students (a project is now ongoing for the construction and analysis of a special version of some mathematical machines).

With secondary school students, the approach to proof may be pushed beyond. In the experiments, the process of using instrument is analysed. Students have to explore in depth the linkage, in order to produce (and argue for) a conjecture concerning some geometrical properties which are related to all the configurations of the linkage.

For example, with respect to the exploration of the ellipsograph (Fig.9), the conjecture about the relationship between the articulated anti-parallelogram (HIGF, Fig.10) and the point E (it is the point tracing the curve) is not easy. However, the long process of producing a conjecture is essential in the following process of constructing the proof, which is a crucial point in the teaching of mathematics.

Collections of working mathematical instruments are more and more spread in many countries. They may be precious historical instruments, stored in closed windows (e. g. the *Hilbert Raum* of the Mathematics Institute in G_ttingen) or interactive exhibits in mathematics centres (e. g. Mathematikum in Giessen; la Cité des *Sciences et de l'Industrie* in Paris; *Atractor* in Oporto; the Giardino di Archimede in Florence). Aim of the activity of mathematics centres – that have been created according to the model of science centres - is the popularization of mathematics. The travelling exhibitions organized by our team share this aim. Yet the main aim of our permanent Lab at the Department of Mathematics of Modena is didactical research, i. e. research into the teaching and learning of mathematics, within a context that has proven to be really motivating and effective for hundreds of secondary school students.

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Maschietto, M., Bartolini Bussi, M.G. (2005), Meaning construction through semiotic means: the case of the visual pyramid, *Proceedings of PME29*, Melbourne, Australia

Michela Maschietto [mmaschietto@unimore.it] is a researcher at the Faculty of Education of the University of Modena-Reggio Emilia.

She studied at the Universities of Turin (Italy) and Paris 7 (France) for her PhD on the didactics of calculus at secondary school level within a graphic calculator environment.

She teaches mathematics and didactics of mathematics to pre-service and in-service teachers.

She works at the Laboratory of Mathematical Machines of Modena, where she manages the classroom activities, exhibitions and the website www.mmlab.unimore.it.

Her research project concerns the teaching and learning of mathematics with technological and non-technological tools. She is interested in the study of the mediation of instruments in the process of conceptualisation of mathematics at both primary and secondary school levels.

She was a team member of both the Topics Study Group 16 – Visualisation at ICME-10 (2004) and the Working Group 9 – Tools and technologies at CERME 4 (2005).

She enjoys painting and, in particular, likes watercolours. Her favourite sports are running and skiing.

ERCOM: Isaac Newton Institute, Cambridge

The Isaac Newton Institute for Mathematical Sciences opened for business in 1992, in a new building on the outskirts of Cambridge carefully designed as an environment for fruitful interaction in mathematical research. Since then it has played host to 61 research programmes in almost every possible area of mathematics and its manifold applications, and many thousands of scientists have worked within its walls.

The Institute Building, opened in 1992

A characteristic scene in the Institute

Kostya Khanin tests his understanding of dynamics

The founding fathers of the Institute, led by its first Director Sir Michael Atiyah, formed a very clear idea of the way it should operate. It should not have permanent research staff like most of the research institutes around the world, of which the archetype is the Princeton Institute of Advanced Studies. On the other hand, its programmes should be long enough to encourage the development of new, often interdisciplinary, research collaborations, so that it would not follow the Oberwolfach model of short intensive meetings.

This led to the template of a six month programme on a specific area, punctuated by short workshops, and this has proved an excellent model. It has been interpreted flexibly, because some topics benefit from somewhat shorter treatment, but no programme is shorter than four weeks, and most run for between four and six months. We always have two programmes running in parallel, offering some variety and possible serendipity, with 20 long term participants on each. A six month programme may have four workshops, each of which brings up to 100 more visitors, but often the most productive periods are the quiet intervals between workshops when ideas are developed in informal seminars around the omnipresent blackboards.

We are extremely fortunate to inhabit a building that positively encourages people to talk and argue and exchange ideas. It has a 3-dimensional design with different levels and an open but not empty atrium. We enjoy a good library, seminar rooms, computer facilities, but far more important are the informal communal areas, serviced by a continual supply of free coffee.

Of course, a commitment to spend several months in Cambridge is a major decision for anyone, especially if a young family must be moved. Programmes are planned three years ahead, so that those invited have time to negotiate with their universities, and their children, to get the necessary permissions. The success of a programme depends on attracting the key participants, and the success of the Institute can be measured by the world class mathematical scientists who have accepted invitations to take part.

The Institute's programmes have now been agreed up to the end of 2007, and details of these and much else about the Institute can be found on http://www.newton.cam.ac.uk. There is a strong pipeline of proposals for 2008 and beyond, being refereed for consideration by the Scientific Steering Committee (SSC). The Institute always welcomes ideas for future programmes, and the Director is happy to advise on what is likely to be successful.

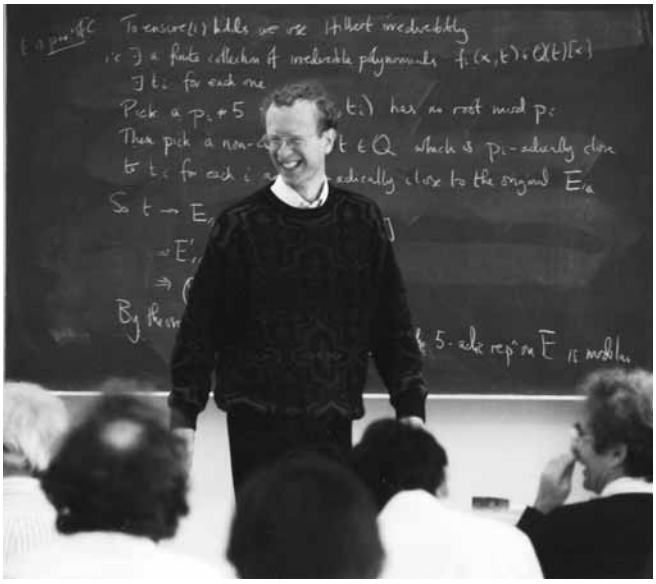
The SSC keeps a careful eye on the balance of programmes over time, and sometimes asks the Director to encourage proposals in timely areas that may not have been the subject of a programme. Nevertheless, the formal position is that the initiative comes from some independent group of scientists who put forward a proposal, often initially in outline form. This is sent to 6–8 referees, drawn from all over the world, and their reports go to the SSC for rigorous peer review. A promising proposal may well be sent back for elaboration or revision, but in the end the SSC will recommend either acceptance or rejection.

An accepted proposal will have an approved group of organisers, who may or may not be the original proposers, and a wider group of scientific advisers. The organisers have a meeting with the Director and Institute staff, at which an action plan is agreed so that everyone knows who is to do what, and when. Much of the routine preparation can be done by the Institute, but the organisers must give the scientific direction, and ensure that those whose participation is essential are persuaded in good time to commit to taking part.

Most programmes are to a greater or lesser degree interdisciplinary, and the participants may come from different scientific backgrounds. One of the most useful functions of this sort of research institute is that it can bring together people who do not naturally talk to one another, mathematicians and natural scientists, theorists and experimenters, analysts and geometers, in an environment that helps them to learn each other's language and to respect each other's skills. This is of enormous value, both in traditional areas of applied mathematics, and in the exciting new applications to biology, engineering, finance and so on. It is also valuable within mathematics, as new interconnections between diverse areas prove their worth.

Finally, after months of preparation, a programme begins. Participants arrive from far and near, are welcomed by Institute staff who initiate them into the mysteries of Cambridge life, and who solve the inevitable practical problems of housing, shopping, transport, schools. The aim is to lift all the worries of everyday life so that everyone can concentrate on mathematics. Judging from the reactions of our visitors, this aim is usually achieved.

It is tempting to judge the success of a programme by the buzz of activity around the building, by the enthusiasm of the visitors, by the attendance at workshops, and by the warmth of thanks to the staff. But the real impact only becomes clear in the months and years after the programme ends, as collaborations begun in Cambridge continue by e-mail around the world, and as papers and books appear with acknowledgement to the Newton Institute. These are carefully monitored, not least to prove to those who fund the Institute, whether public bodies or private benefactors, that it gives value for money.



A famous moment in June 1993 – Andrew Wiles presents his proof of Fermat's Last Theorem

Her Majesty the Queen visits the Institute in June 2005

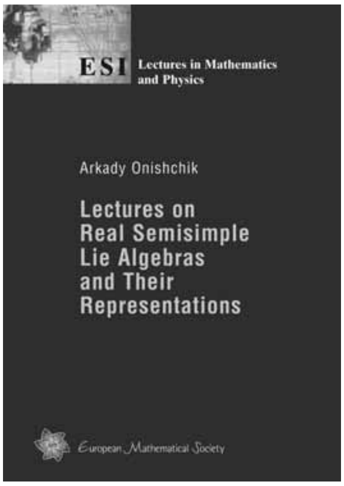
The vision of the founders has proved its value over the years. Sir Michael Atiyah was helped by many people, notably Peter Goddard (who now directs the Princeton Institute) and Peter Landshoff. Sir Michael was succeeded in 1996 by Keith Moffatt (now President of the International Union of Theoretical and Applied Mechanics), and since 2001 the Director has been Sir John Kingman, President of the European Mathematical Society. It has recently been announced that Sir John will in turn be succeeded in October 2006 by Sir David Wallace, at present Vice-Chancellor of Loughborough University.

However, the continued success of the Isaac Newton Institute depends on the contributions of many people, who have imaginative ideas for programmes and work hard at organising them, who referee proposals and sit on the SSC and guard the scientific quality, who attend programmes and participate actively, but above all to the devoted staff who offer our visitors a warm welcome and quietly efficient support.

Book review

An excellent introduction to the topic of real simple Lie algebras

Rutwig Campoamor-Stursberg (Madrid, Spain)



Arkady L. Onishchik (Yaroslavl State University, Russia)
Lectures on Real Semisimple Lie Algebras and Their Representations
ESI Lectures in Mathematics and Physics Vol. 1
European Mathematical Society Publishing House 2004
Pages: 96
ISBN 3-03719-002-7

The main purpose of these notes is to give a self-contained and complete exposition of the representation theory of real semisimple Lie algebras. Although various texts on the topic exist, the originality of this small book is the elegance of the exposition and the presentation of some important facts that are either absent in other treatises or only enumerated without further comment. Written by a prestigious expert in Lie theory, the text only demands a standard knowledge in the theory of complex Lie algebras and groups and constitutes therefore an excellent text as a complement to an advanced course on the classification of complex semisimple Lie algebras and their representation theory.

The problem of classifying real simple and semisimple Lie algebras and their representations arises from the geometry of homogeneous spaces and the first results in this direction were developed by E. Cartan in 1914. Using the more standardized algebraic theory and the work of Weyl, the study of real simple Lie algebras and groups was later expanded by various authors in order to develop a self-contained theory in analogy to the complex case. This work accomplishes this objective perfectly and also pays homage to the important work of the late Fridrikh Izrailevich Karpelevich,[1] who already solved many problems in the representation theory of real simple Lie algebras but whose papers are not widely known in the literature, other authors later rediscovering many of his results.

The text is divided into nine sections, which present the main results with detailed proofs, illustrated with examples using the special simple algebra sl(n,C). The choice of this algebra is justified by the role it plays in the characterization of self-dual complex irreducible representations of real forms. For the remaining algebras the reader is led to the appropriate references.

The first section reviews the classical theory of semisimple complex Lie algebras and fixes the notation that will be used in later chapters. The main material on compact groups that will be applied in obtaining real forms is briefly presented, such as the theorem of Weyl. As this is a summarising chapter, no proofs are given at this stage.

The second section deals with the complexification and realification of real and complex Lie algebras respectively. Two important examples of real forms of complex semisimple Lie algebras are introduced: the real normal form, which can intuitively be interpreted as the algebra obtained by restriction of scalars,[2] and the compact form, which will be central for the construction of the remaining non-compact real forms. The first structural results concerning real forms are presented, namely that real forms of simple complex algebras are simple while complexification of real simple algebras are either simple or semisimple complex algebras [the insertion of the classical Lorentz algebra would have been welcomed after example 4]. The third section introduces the main tool used in the classification of real forms, the involutive automorphisms of a complex semisimple algebra and its correspondence with the real forms. It follows in particular that the compact form is unique. In order to describe this correspondence, the next section is devoted to various technical results concerning the automorphisms of complex semisimple algebras. Having covered this machinery, the Cartan decomposition is discussed in detail. The conjugacy theorem for maximal compact subgroups of the adjoint linear group Int(g) is proved.

Section 6 is devoted to an important problem, which often appears in representation theory: given a homomorphism of complex semisimple Lie algebras f: $\hat{g}$ $\hat{h}$, which real forms of $\hat{h}$ contain the image by f of some real form of $\hat{g}$? A satisfactory answer to this problem is given by means of the involutive automorphisms corresponding to the real forms. The material of this section follows the original work of F. I. Karpelevich, which was done at the beginning of the fifties.[3] The material previously developed in chapter 3 concerning hermitian vector spaces is applied. Introducing a special class of morphisms, denoted S-homomorphisms,[4] the result is sharpened.

[1]For an obituary and list of works see *Uspekhi Mat. Nauk* 56 (2001), 147–152.

[2]It should be remarked that while any complex semisimple Lie algebra is rational, i.e. admits a basis with rational structure constants, not any complex Lie algebra has this property.

[3]More specifically, the keystone work published in *Trudy Moskov. Mat. Obshch.* 4 (1955), 3–112.

[4]The terminology S-morphism comes from the R- and S-subalgebras of complex semisimple Lie algebras introduced by Dynkin in his paper on the semisimple subalgebras of complex semisimple Lie algebras.

The seventh section is devoted to the extension problem for irreducible representations for the case of the special linear Lie algebra sl(n,R). Special attention is devoted to the Karpelevich index and the original formulae for computing this invariant are generalized to arbitrary involutive automorphisms. These results are applied in section 8 to classify explicitly the irreducible real representations in terms of highest weights, following the outline used by Iwahori in 1959. More precisely, real representations divide into two classes depending on the existence or not of an invariant complex structure. The last section, written by J. Šilhan, presents an alternative classification by means of Satake diagrams, i.e., a generalization of the classical Dynkin diagram based on the introduction of two colors and arrows relating vertices of one color. It is described how to read off the involutions using these diagrams and a characterization of self-dual complex irreducible representations is obtained. Additional material is presented in tabulated form at the end of this section.

In summary, this book is a very welcome reference on real simple Lie algebras and has the advantage of presenting material that is distributed in many technical papers in a compact and effective way. It should be expected that this work will become a classic on the topic among the specialists in Lie algebras.

Rutwig Campoamor-Stursberg [rutwig@mat.ucm.es] is associate professor at the Universidad Complutense de Madrid where he took his Ph.D. in Mathematics in 2000. He works on structure and representation theory of finite dimensional Lie algebras and their applications to physics and differential equations.

Forthcoming conferences

compiled by Vasile Berinde (Baia Mare, Romania)

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

September 2005

1–December 31: The Scientific Revolutions of the XVI and XVII Century, Centro di Ricerca Matematica Ennio De Giorgi – Scuola Normale Superiore, Pisa, Italy (http://www.crm.sns.it)
Information: crm@crm.sns.it
[For details, see EMS Newsletter 55]

6–10: Spanish relativistic meetings (ERE 2005), University of Oviedo, Spain
Information: http://fisi24.ciencias.uniovi.es/ere05.html

7–9: 4th IMA International Conference on Mathematics in Transport [A Conference in Honour of Richard Allsop]
Information: e-mail: conferences@ima.org.uk
Web site: www.ima.org.uk
[For details, see EMS Newsletter 55]

13–23: Advanced Course on Combinatorics; Centre de Recerca Matemàtica, Campus of the Universitat Autonoma de Barcelona, Spain
Information: e-mail: RecentTrends@crm.es
Web site: http://www.crm.es/RecentTrends
[For details, see EMS Newsletter 54]

14–16: XIV encuentro de Otoño de Matemática y Física, Bilbao, Spain
Information: Web site: http://www.ehu.es/wgp2005

16–18: EMS-Catalan Mathematical Society Joint Mathematical Weekend Barcelona, Spain
Information: Web site: http://www.iecat.net/scm/emsweekend
[For details, see EMS Newsletter 55]

16–21: Geometric Representation and Invariant Theory: Algebraic Quantization and Deformations, Sol Cress Conference Centre, Spa, Belgium
Information: Web site: http://www.esf.org/conferences/pc05197
[For details, see EMS Newsletter 56]

20–22: 7th Hellenic-European Research on Computer Mathematics and its Applications (HERCMA 2005) Conference, Athens, Greece
Information: Web site: http://www.aueb.gr/conferences/hercma2005
[For details, see EMS Newsletter 55]

23–24: 7th National Conference on Mathematical Analysis and Applications, Craiova, Romania
Aim: The Conference focuses on various modern trends in Analysis and their applications to Mathematical Physics, Variational Calculus and Optimal Control.
Organizers: Center of Nonlinear Analysis and Applications (Univ. of Craiova, Romania) and Romanian Mathematical Society
Plenary Speakers: D. Baleanu (Cankaya Univ., Ankara), O. Crjã (Al. I. Cuza Univ., Iasi), G. Dinca (Univ. of Bucharest), P. Jebelean (West Univ., Timisoara), R. Precup (Babes-Bolyai

Univ., Cluj-Napoca), M. Thera (Univ. de Limoges), I. Vrabie (Al. I. Cuza Univ., Iasi), C. Zalinescu (Al. I. Cuza Univ., Iasi), M. Willem (Université de Louvain).
Scientific Committee: V. Barbu (Romanian Academy), W. Breckner (Babes-Bolyai Univ., Cluj-Napoca), M. Megan (West Univ., Timisoara), P. Mocanu (Babes-Bolyai Univ., Cluj-Napoca), N. Popa (Univ. of Bucharest), T. Precupanu (Al. I. Cuza Univ., Iasi), O. Stănăşilă ("Politehnica" Univ., Bucharest)
Information: E-mail:cniculescu@central.ucv.ro; vicentiu.radulescu@ ucv.ro;
Web site: http://inf.ucv.ro/events/CAMA2005/

22–October 2: 2nd EMS Summer School on „Braid Groups and related topics – Applications to Geometry, Cryptography and Computation", Israel
Aim: The School is a continuation of the EMS School with the same title as the one that was held in Israel from February 19-27, 2005. Basically, it will be composed of three parts: 1) Preliminaries: Presentation of the results and methods presented in the first School; 2) Problem Session: This part will be an algorithmic and problems session; 3) Update: This part will include updates given by speakers from the first School as well as other speakers invited to address this School. Two poster sessions will allow the participants to present their work.
Invited speakers (tentative): F. Catanese (Bayreuth, Germany), P. Dehornoy (Caen, France), J. Gonzalez-Meneses (Sevilla, Spain), V. Kulikov (Steklov Institute Moscow, Russia), S. Manfredini (Pisa, Italy), M. Uludag (Istanbul, Turkey)
Director: Mina Teicher (Emmy Noether Research Institute for Math.)
Organizers: B. Kunyavski and T. Ben-Itzhak (Emmy Noether Research Institute for Mathematics); Conference administration: Debby Spero, debbyspero@hotmail.com,
Admittance: The school has a limited capacity and we therefore ask all interested parties to fill in the application form attached below and send it (by email) to the ENI administration, Debby Spero (debbyspero@hotmail.com) with cc to T. Ben-Itzhak (tzachi@omnitelecom.co.il), along with a CV. These must be sent no later than August 25th.
EMS Financial support: Candidates from EU countries (and associated countries such as Israel, Norway and Switzerland) who have received their MSc. or Diploma degree (or equivalent) within the past ten years are eligible for reimbursement of the following costs: travel, living expenses and registration fees. Europeans currently living outside the EU are eligible for financial support without any time constraints with regard to when they received their respective degrees. If you require financial support and are eligible to receive it, please mark the relevant box in your application form.
Accommodation: The School will take place in the north of Israel, a resort near Tiberias, an ancient city on the shores of the Sea of Galillee (Kineret). You might want to bring a laptop with you for the tutoring session.
Information: Web site: www.cs.biu.ac.il/~eni/GalilAnn1-2005.html

25–29: SYNASC 2005, 7th International Symposium on Symbolic and Numeric Algorithms for Scientific Computing, Timisoara, Romania
Information: e-mail: synasc05@info.uvt.ro;
Web site: http://synasc05.info.uvt.ro
[For details, see EMS Newsletter 56]

27–30: Workshop on Graphs, Morphisms and Applications, Centre de Recerca Matemàtica, Bellaterra, Spain
Participants (tentative list): J. Barajas, M. Bodirsky, P. Cameron, V. Dalmau, J. Diaz, J. Fiala, G. Hahn, P. Hell, W. Imrich, J.B. Jensen, A.V. Kostochka, D. Kral, J. Kratochvil, H. Lefmann, A. Lladó, M. Loebl, L. Lovasz, C. McDiarmid, B. Mohar, A. Montejano, J. Moragas, R. Naserasr, M. Noy, P. Ossona, A. Raspaud, V. R_dl, M. Ruszinko, M.J. Serna, E. Sopena, C. Szabo, Cl. Tardif, J.A. Telle, D. Thililós, B. Toft, G.J. Woeginger and X. Zhu.
Co-ordinators: J. Nesetril (Charles Univ., Prague); O. Serra (Universitat Politécnica de Catalunya)
Information: e-mail: WorkshopGraphs@crm.es
Web site: http://www.crm.es/WorkshopGraphs

October 2005

3–7: 2nd Workshop on Tutte Polynomials and Applications, Centre de Recerca Matemàtica, Bellaterra, Spain
Participants (tentative list): M. Bousquet-Mélou, P Cameron, R. Cordovil, R. Cori, J.E. Ellis-Monaghan, G. Farr, I. Gitler, L. Helme-Guizon, P. Hlineny, B. Jackson, J.P. Kung, M. Las Vergnas, M. Loebl, J. Makowsky, C. Merino, R. Read, D. Rossin, J. Salas, I. Sarmiento, G. Schaeffer, R. Shrock, A. Sokal and D.G. Wagner.
Co-ordinators: J.E. Bonin (George Washington University); M. Noy (Universitat Politécnica de Catalunya)
Information: e-mail: WorkshopTutte@crm.es
Web site: http://www.crm.es/WorkshopTutte

6–8: New Mathematical Methods in Risk Theory. Workshop in honour of Hans Bühlmann, Florence, Italy
Aim: 2005 is the year of Hans Bühlmann's 75th birthday and the 35th anniversary of his capital book *Mathematical Methods in Risk Theory*. To celebrate both these events the Department of Mathematics for Decisions of Florence University organizes a Workshop aimed to offer an overview of important current topics in Risk Theory, in the spirit of interaction among insurance themes, financial instruments and mathematical methods that Hans Bühlmann has pioneered and given fundamental contributions to.
Topics: A non exhaustive list of arguments includes : Correlated Risks and Copulas; Management of Risks and Investments; Credit Risk; Risk Measures; New Techniques in Ruin Probability; Fair Valuation; Catastrophe and Weather Derivatives;
Main speakers: The following scholars have already accepted to deliver keynote lectures at the Workshop: H. Bühlmann (ETH Zurich); P. Embrechts (ETH Zurich); H. Geman (Univ. Paris Dauphine and ESSEC); H. Gerber (HEC, Univ. of Lausanne); F. Moriconi (Univ. of Perugia); H. Schmidli (Univ. of Cologne); R. Frey (Univ. of Leipzig); S. Ogawa (Ritsumeikan Univ., Kyoto); R. Cont (École Polytechnique, Paris)
Information: Web site: http://www.riskworkshop.it

6–8: Joint Finnish-French conference "Teaching mathematics: beyond the PISA survey"
Location: Institut Finlandais, 60 rue des Ecoles, F-75005 Paris

(Oct. 6–7); Institut des Hautes Etudes Scientifiques, 35 route de Chartres, F-91440 Bures-sur-Yvette (Oct.8).
Organisers: Finnish Mathematical Society, French mathematical Society, Society of Applied and Industrial Mathematics
Information: smf.emath.fr/VieSociete/Rencontres/France-Finlande-2005/

11–18: EMS Summer School and Séminaire Européen de Statistique, Statistics in Genetics and Molecular Biology, Warwick, UK
Information: e-mail: b.f.finkenstadt@warwick.ac.uk
Web site: http://www2.warwick.ac.uk/fac/sci/statistics/news/semstat/
[For details, see EMS Newsletter 54]

14–16 Conference on Applied and Industrial Mathematics (CAIM 2005), Pitesti, Romania
Information: e-mail: cgeorge@univ-ovidius.ro, geocv@yahoo.com, averionro@yahoo.com, adelinageorgescu@yahoo.com
[For details, see EMS Newsletter 56]

17–21: Nonlinear Parabolic Problems, Helsinki, Finland
Information: Web site: http://www.math.helsinki.fi/research/FMSvisitor0506
[For details, see EMS Newsletter 54]

November 2005

25–December 1: 8th International Conference of The Mathematics Education into the 21st Century Project, Hotel Eden Garden, Johor Bharu, Malaysia
Information: e-mail: arogerson@vsg.edu.au for all information
Web site: www.sigrme.org/announce/MalaysiaFA.htm
[For details, see EMS Newsletter 56]

February 2006

13–17: Barcelona Conference in Planar Vector Fields, Centre de Recerca Matemàtica, Bellaterra, Spain
Speakers: F. Dumortier (Limburgs Universitair Centrum); L. Gavrilov (Univ. Paul Sabatier); Yu. Ilyashenko (Cornell Univ. and Steklov Mathematical Institute); C. Li (Peking Univ.); F. Mañosas (Universitat Autonòma de Barcelona); J. S. Muldowney (Univ. of Alberta); R. Roussarie (Univ. de Bourgogne); M. Sabatini (Univ. di Trento); J. Sotomayor (Univ. de Sao Paulo); M. Antonio Teixeira (IMEE-UNICAMP); J. Yang (Peking Univ.); M. Zhitomirskii (Technion Univ.)
Co-ordinators: A. Gasull (Universitat Autònoma de Barcelona); J. Llibre (Universitat Autònoma de Barcelona)
Information: e-mail: PlanarVectorFields@crm.es
Web site: http://www.crm.es/PlanarVectorFields

20–25: Advanced Course on Arakelov Geometry and Shimura Varieties, Centre de Recerca Matemàtica, Bellaterra, Spain
Speakers: C.-Li Chai (Univ. of Pennsylvania): Integral models of Shimura varieties. H. Darmon (Mc Gill Univ.): Heegner points, Stark-Heegner points, and values of L-series. D. Roessler (Univ. Paris 7): Riemann-Roch formulae in Arakelov geometry and applications.
Co-ordinators: José Ignacio Burgos, Jörg Wildeshaus
Registration and payment: Fee: 200 euros
Deadline: November 18, 2005
Grants: The CRM offers a limited number of grants for registration and/or accommodation addressed to young researchers. The deadline for application is October 7, 2005.
Information: e-mail: ShimuraVarieties@crm.es
Web site: http://www.crm.es/ShimuraVarieties

May 2006

8–19: CANT'2006 International School and Conference on Combinatorics, Automata and Number Theory, Liège, Belgium
Aim: The proposed international school is aimed at presenting and developing recent trends in Combinatorics (with emphasis on Combinatorics on Words), Automata Theory and Number Theory. On the one hand, the newest results in these areas shall benefit from a synthetic exposition, and on the other hand, emphasis on the connections existing between the main topics of the school will be sought. Concurrently to the school, there will be an international conference focusing on the same topics. Courses and lectures will be organized in the morning, while the afternoon sessions will be devoted to the conference.
Main Invited Speakers: J.-P. Allouche (CNRS, Univ. Paris-Sud), Y. Bugeaud (Univ. of Strasbourg), F. Durand (Univ. of Picardie, Amiens), P. Grabner (Techn. Univ. of Graz), J. Karhumäki (Turku Univ.), H. Prodinger (Univ. of Stellenbosch), J. Sakarovitch (CNRS, ENS Telecom.), J. Shallit (Univ. of Waterloo), B. Solomyak (Univ. of Washington), W. Thomas (RWTH Aachen)
Format: Five invited lecturers per week. Participants can decide to attend to one of the two weeks of this event. Talks will be selected on the basis of an extended abstract (max. 6 pages)
Deadline: for the submission of abstracts 1st April 2006.
Organising Committee: V. Berthé (CNRS, Montpellier), M. Rigo, P. Lecomte (Liège)
Location: Institute of Mathematics, University of Liège, Belgium
Information: e-mail: M.Rigo@ulg.ac.be
Web site: http://www.cant2006.ulg.ac.be

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

June 2006

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

19–23: Conference "Modern stochastics: theory and applications", Kyiv National Taras Shevchenko University, Kyiv, Ukraine

Dedicated to the 60th anniversary of Department of Probability Theory and Mathematical Statistics of Kyiv University and to the memory of Prof. M.I.Yadrenko (16.04.1932–28.09.2004)
Topics: Theory of random processes and fields, stochastic analysis, stochastic differential equations, infinite-dimensional analysis, Markov and semi-Markov processes, Gaussian and related processes, fractal analysis, statistics of stochastic processes, limit theorems, methods of financial mathematics and risk theory.
Program Committee: V. Buldygin, O. Ivanov, N. Kartashov, P. Knopov, Yu. Kozachenko, V. Korolyuk, O. Kukush, N. Leonenko, R. Maiboroda, S. Makhno, M. Portenko, M. Pratsevytyj, D. Silvestrov, N. Zinchenko.
Organizing Committee: O. Zakusilo (Chairman), Yu. Mishura (Vice-chairman), O. Borisenko, O. Kurchenko, M. Moklyachuk, A. Olenko, O. Ponomarenko, L. Sakhno, O. Vasylyk (Secretary), R. Yamnenko (Secretary), G. Bagro (Secretary), G. Shevchenko (Secretary).
Deadline for application: 1 March 2006.
Information: e-mail: probab.conf.2006@univ.kiev.ua.
Web site: http://www.mechmat.univ.kiev.ua/probbility/ Events/ 2006/informletterengl.html

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

Recent books

edited by Ivan Netuka and Vladimir Souček (Prague)

H. Amann, J. Escher: Analysis I*, Birkhäuser, Basel, 2004, 426 pp., EUR 58, ISBN 3-7643-7153-6*
This book is the first part of a three-volume introduction to analysis, based on courses taught by the authors at various universities. The book is self-contained and is prepared mainly for students and instructors beginning courses in analysis. Together with theoretical material, the book also contains problems, exercises and other supplementary material allowing it to be used for self-study. The main feature of the book is its modern and clear presentation. The reader will find classical notions mixed with advanced ones (e.g. the discussion of Banach spaces and algebras). The book consists of five chapters, the first containing necessary foundation material – basics of logic; sets, functions, relations, and operations; natural numbers and countability; groups, rings, fields and polynomials; rational, real and complex numbers; vector and affine spaces and algebras. Chapter 2 deals with limits (and sums of series) of real numbers. The notion of continuity of functions is treated in chapter 3, which also introduces basic elementary functions. Differentiability, the mean value theorem and the Taylor theorem are described in the fourth chapter. The last chapter contains a discussion of sequences of functions (in particular uniform convergence, continuity and differentiability for sequences of functions, analytic functions and polynomial approximations). The material is presented in a fresh form and it is pleasant to read. Abstract concepts are presented using specific applications, which helps to build a solid understanding of modern mathematical analysis. (pp)

G. I. Arkhipov, V. N. Chubarikov, A. A. Karatsuba: Trigonometric Sums in Number Theory and Analysis*, de Gruyter Expositions in Mathematics, vol. 39, Walter de Gruyter, Berlin, 2004, 554 pp., EUR 128, ISBN 3-11-016266-0*
The theory of multiple trigonometric sums (also called "exponential sums"), as constructed systematically in this monograph, has reached the same degree of completion as the theory of one-dimensional trigonometric sums. Compared to the one-dimensional case, numerous new effects appear because there is a wide variety both of domains of the summation variables and of functions in the exponent. The first nine chapters of the monograph are the translation of the original Russian book (1987, Nauka, Moscow), while chapters 10 to 12 are devoted to several new applications of trigonometric sums and integrals to problems of number theory and analysis: estimates of trigonometric (oscillating) integrals and applications of the p-adic method in estimating trigonometric sums and in solving additive problems, including the Waring problem and the Artin conjecture on a local representation of zero by a form. The book will be useful for a wide range of mathematicians. (zv)

W. P. Barth, K. Hulek, Ch. A. M. Peters, A. Van de Ven: Compact Complex Surfaces, *second enlarged edition, A Series of Modern Surveys in Mathematics, vol. 4, Springer, Berlin, 2004, 436 pp., EUR 99,95, ISBN 3-540-00832-2*
This volume is the second and substantially enlarged edition of the book that appeared for the first time in 1984. K. Hulek has joined the authors of the first edition as a fourth co-author. During the last two decades, there have been several interesting developments in the theory of complex surfaces and they are reflected in this new edition. There are new sections in chapter 4 (including a discussion of Kähler structures on surfaces, a treatment of pluricanonical maps of surfaces based on the Reider theorem, Bogomolov's stability for rank 2 vector bundles and an introduction to nef-divisors) and chapter 8 (mirror symmetry for projective K3-surfaces, special curves on K3-surfaces and applications to hyperbolic geometry). Chapter 9 is an important addition, which is devoted to a study of topological and differentiable structures on surfaces. It contains an introduction to the Donaldson and the Seiberg-Witten invariants. The bibliography has been substantially extended, covering new developments. Already a classic in the field, this book is recommended both to mathematicians interested in this mathematical topic and physicists working in the modern theoretical physics. (jbu)

A. Beilinson, V. Drinfeld: Chiral Algebras*, AMS Colloquium Publications, vol. 51, American Mathematical Society, Providence, 2004, 375 pp., USD 69, ISBN 0-8218-3528-9*

Chiral algebras are objects living on algebraic curves. They are 'quantizations' of structures given by local Poisson brackets on a space of 'classical' fields. In the special case, where the underlying curve is the affine line *Spec*($C[t]$), chiral algebras invariant under translations are the same as vertex algebras. Requiring invariance under the whole affine group and the Virasoro algebra leads essentially to conformal vertex algebras. Taking the disc *Spec*($C[[t]]$) instead of the affine line gives quasi-conformal vertex algebras. In this sense, chiral algebras comprise the basic features of conformal field theory. The aim of the book under review is to set up rudiments of chiral algebras theory. The first chapter of the book gives some necessary algebraic foundations of pseudo-tensor categories and the related 'compound' geometry. The second chapter is devoted to 'coisson' algebras, which is the authors' name for local Poisson algebras (an abbreviation for 'compound Poisson'). The third chapter deals with the chiral algebras proper. In the final chapter the global theory in the formalism of chiral homology is developed. The book is aimed at students and researchers interested in vertex algebras, quantization, and applications of geometry to mathematical physics in general. It assumes a solid preliminary knowledge of algebraic geometry and homological algebra. (mm)

R. Berndt, O. Riemenschneider, Eds.: Erich Kähler: Mathematische Werke/Mathematical Works*, Walter de Gruyter, Berlin, 2003, 971 pp., EUR 228, ISBN 3-11-017118-X*

This book is a collection of mathematical papers written by Erich Kähler, together with almost 200 pages of commentaries on his mathematical work and an appendix with three of his philosophical papers. The book begins with a short description of his life (by R. Berndt and A. Bohm) and a survey of his contribution to mathematics (by R. Berndt and O. Riemenschneider). In the second part of the book, 32 of Kähler's mathematical articles are reproduced. The third part offers commentaries on the mathematical work of Kähler covering the main parts of his research. It includes papers by W. D. Neumann (Topology of hypersurface singularities), J.-P. Bouguignon (The unabated vitality of Kähler geometry), H. Nicolai (Supersymmetry, Kähler geometry and beyond) and I. Eceland (Some applications of the Cartan-Kähler theorem to economic theory). Comments on the philosophical work of Kähler are written by R. Berndt and K. Maurin. E. Kähler was a mathematician of broad interests and his influence is clearly visible in many fields of mathematics and mathematical physics (e.g. notions of Kähler and Einstein-Kähler metrics, Kähler and hyper-Kähler manifolds and Kähler groups). The book offers a summary of his work and makes it more accessible to contemporary readers. (jbu)

D. P. Blecher, C. Le Merdy: Operator Algebras and Their Modules: An Operator Space Approach*, London Mathematical Society Monographs New Series 30, Clarendon Press, Oxford, 2004, 387 pp., GBP 85, ISBN 0-19-852659-8*

This monograph is devoted to a study of operator algebras and their modules by means of operator space theory. The book is divided into eight chapters and an appendix. The first chapter contains basic facts on operator spaces and completely bounded maps. In the second chapter, a study of operator algebras begins. An operator algebra is just a closed subalgebra of the space $B(H)$ of bounded linear operators on a Hilbert space H. Hence it has a Banach algebra structure and an operator space structure. This leads to the definition of an abstract operator algebra – it is a Banach algebra A with an operator space structure such that there exists a completely isometric homomorphism of A into some $B(H)$. The rest of the chapter describes basic constructions of operator algebras. The third chapter contains an introduction to operator modules. An operator module is an operator space that is also A-module for a Banach algebra A and satisfies an additional property. Many examples and some subclasses (Hilbert modules, operator modules over operator algebras) are described. The remaining five chapters deal with more advanced or special topics. They include 'extremal theory' (noncommutative Shilov boundaries and related things), a completely isomorphic theory of operator algebras (in addition to the completely isometric one considered in the second chapter), tensor products of operator algebras, selfadjointness criteria and C*-modules. The book ends with an appendix containing basic facts from operator theory, Banach space theory, Banach algebras and C*-algebras. (okal)

M. Boileau, S. Maillot, J. Porti: Three-dimensional Orbifolds and Their Geometric Structures*, Panorama et Synthèses, no. 15, Société Mathématique de France, Paris, 2003, 167 pp., EUR 25, ISBN 2-85629-152-X*

A classical result in two dimensions says that a compact surface is diffeomorphic to the quotient of one of three model geometries (the sphere, the Euclidean plane and the hyperbolic plane) by a discrete subgroup of the group of all isometries. In three dimensions, there are eight model geometries. The Thurston geometrization conjecture claims, roughly speaking, that any compact three-dimensional manifold is uniquely decomposable along a finite set of embedded surfaces into quotients of model three-dimensional geometries. It results in a few other important conjectures (including the famous Poincaré conjecture). Studying quotients of manifolds by discrete subgroups, it is natural to work in a broader category of orbifolds. The main aim of the book is to describe this circle of ideas. The authors discuss in turn homogeneous 3-dimensional geometries, canonical decompositions, Haken orbifolds, Seifert fibered orbifolds, the Thurston hyperbolization theorem, varieties of representations, hyperbolic Dehn filling for orbifolds and the orbifold theorem. The Perelman results based on different techniques (the Ricci flow equation) are not included. The book is well organized and nicely written. (vs)

K. M. Brucks, H. Bruin: Topics from One-Dimensional Dynamics*, London Mathematical Society Student Texts 62, Cambridge University Press, Cambridge, 2004, 297 pp., GBP 22,99, ISBN 0-421-54766-0, ISBN 0-521-83896-7*

The book introduces the reader to a large number of basic dynamical concepts, including topological dynamics (transitivity, recurrence, topological conjugacy, entropy), measurable dynamics (Poincaré recurrence, ergodicity), symbolic dynamics and quadratic complex dynamics (Julia and Fatou sets and the Mandelbrot set). Developments of advanced combinatoric tools (Hofbauer towers, kneading maps) and in number theory (Farey trees, continued fractions) are used to give a more detailed description of the dynamics of several classes of 1d maps, including unimodal and tent maps, circle maps, rigid rotations

and β-transformations. Simpler results are often presented in the form of exercises, hence the book is particularly useful for students/beginners in the field. Due to an extensive bibliography, it will also serve as a very good reference book. (dpr)

***L. Chaumont, M. Yor: Exercises in Probability: A Guided Tour from Measure Theory to Random Processes, via Conditioning**, Cambridge Series in Statistical and Probabilistic Mathematics, Cambridge University Press, Cambridge, 2004, 252 pp., GBP 35, ISBN 0-521-82585-7*

Organized into 6 chapters, this book presents 100 solved exercises in probability ranging from those of standard difficulty to more advanced problems. A good background in measure theory and a basic level knowledge of probability is needed. The aim of the book is to help students make the transition between simple and advanced probabilistic frameworks. Chapter 1 contains exercises aimed to emphasize the measure theoretical background of probability (e.g. monotone class theorem, uniform integrability, L^p-convergence, measure preserving and ergodic transformations, conditioning). Chapter 2 contains exercises related to the topic of the chapter: independence and conditioning. Chapter 3 is devoted to Gaussian variables and Gaussian vectors. Chapter 4 contains various exercises showing how to establish the distribution of functions of random vectors with a focus on families of beta and gamma variables and on stable distributions. Chapter 5 deals with various types of convergence of random variables and vectors, in particular with the convergence in law, including the convergence to Brownian motion and the convergence of empirical processes. Chapter 6 deals with deeper properties of Brownian motion and general stochastic processes. This is an advanced concept, with some exercises inspired by results recently appearing in research journals. Each exercise consists of several questions, references for preliminary and further reading, hints and comments, ending with a very detailed solution. The book is extremely useful for graduate and postgraduate students and those who want to better understand advanced probability theory. (zp)

***G. Choquet et al.: Autour du centenaire Lebesgue**, Panoramas et Synthèses, no. 18, Société Mathématique de France, Paris, 2004, 156 pp. EUR 26, ISBN 2-85629-170-8*

On April 29, 1901, Henri Lebesgue published a note in Comptes-Rendus de l'Académie des Sciences with the title Sur une généralisation de l'intégrale définie. On the occasion of the centenary of the birth of the Lebesgue integral, the conference "La mesure de Lebesgue a 100 ans" was organized by l'Ecole Normale Supérieure de Lyons. The book under review results from this celebration and provides various viewpoints on Lebesgue's heritage in an excellent way.

The contribution by G. Choquet provides a vivid testimony to mathematics and mathematicians of Lebesgue's era including E. Borel and R. Baire. It mentions their predecessors, their personalities, the sources of their inspiration and their mutual relations. P. de la Harpe presents a nice exposition of results on paradoxical decompositions and invariant finitely additive measures. The importance of this subject for group theory is emphasized. Classical as well as contemporary results are analyzed and at the end of the paper, several open problems on amenability for groups are proposed. B. Sévennec's article surveys some equidistributive results in compact groups. The beautiful von Neumann's proof of existence and uniqueness of Haar's measure is presented as an illustration on how the measure may be obtained as a limit of "equidistributed" measures with finite support. The "spectral gap" of averaging operators is discussed and recent applications are given (e.g. to Ruziewicz's problem from 1916 on uniqueness of invariant finitely additive invariant measure on the Lebesgue measurable sets). T. De Pauw's paper is devoted to the divergence theorem from the point of view of non-absolutely convergent integrals. It is a nice survey on Henstock-Kurzweil integration, sets of finite perimeter and W.F. Pfeffer's approach to the divergence formula. The contribution by H. Pajot presents the recent progress on understanding the notion of rectifiability in relation to the analytic capacity or the Cauchy operator. At about 150 pages, the book yields rich material on very attractive subjects. All papers have a high level of exposition, are well organized and readable. A preface by J.-P. Kahane highlights Lebesgue's influence in the course of 20th century. It presents a nice synthetic viewpoint on the history and the development of mathematics during the last hundred years. This extremely interesting book can be recommended to anybody who likes mathematics. (in)

***P. T. Chruşciel, E. Delay: On Mapping Properties of the General Relativistic Constraints Operator in Weighted Function Spaces with Applications**, Mémoirs de la Société Mathématique de France, no. 94, Société Mathématique de France, Paris, 2003, 103 pp., EUR 25, ISBN 2-85629-145-7*

The Einstein equations admit an initial value formulation. A three-dimensional oriented manifold with a Riemannian metric g and a symmetric tensor K of rank 2 forms the corresponding vacuum initial data. The Gauss-Codazzi equations provide constraints on this initial data. The main aim of the booklet is to study properties of solutions of the constraint equations. J. Corvino and R. Schoen have recently developed a new method to study asymptotics of the vacuum constraint equations. The book describes a generalization of the method to a large class of weighted function spaces and, in particular, applications to various perturbation, gluing and extension results (including a proof of existence of initial data, which is exactly Kerrian outside of a compact set or a construction of large classes of initial data with controlled asymptotic behaviour). (vs)

***M. P. Coleman: An Introduction to Partial Differential Equations with MATLAB**, Chapman & Hall/CRC Applied Mathematics and Nonlinear Science Series, Chapman & Hall/CRC Press, Boca Raton, 2004, 671 pp., USD 89,95, ISBN 1-58488-373-1*

This textbook presents the most important topics from PDE theory. It is suitable for a two-semester course for students who have basic skills with ordinary differential equations, multivariable calculus and surface integration. The material presented in the book is arranged according to methods of solving PDE. Each chapter is introduced with a Prelude motivating the themes of the chapters: Introduction, The Big Three PDEs, Fourier series, Solving the Big Three PDEs, Characteristics, Integral transforms, Bessel Functions and Orthogonal Polynomials, Sturm-Liouville Theory and Generalized Fourier Series, PDEs in Higher dimensions, Nonhomogeneous Problems and Green's Functions and Numerical Methods. The book has several appendices providing supplementary tools and information (Uniform Convergence; Differentiation and Integration of Fourier Series; Other Important Theorems; Existence and Uniqueness Theorems; A Menagerie of PDEs). The material presented is supplemented with many examples and selected exercises are answered at the end of the book. Some exercises are also partially formulated (mainly the plotting part) as MATLAB tasks. The MATLAB codes for figures and exercises are included in an appendix. The MATLAB source files are available on-line on the publisher's web pages. The book presents very useful material and can be used as a basic text for self-study of PDEs. (pp)

***P. A. Davidson: Turbulence**, Oxford University Press, Oxford, 2004, 657 pp., GBP 35, ISBN 0-19-852949-X*

This comprehensive textbook, based on the author's course taught at Cambridge University, combines maximum physical insight with an explanation of all necessary mathematical techniques. In spite of the intensive effort of mathematicians, physicists and other scientists, there are still profound difficulties in our attempt to understand these chaotic three (or two) dimensional processes. On the other hand, impressive progress has been made over the decades while some of the best minds of the last centuries from Taylor (and arguably even Leonardo da Vinci) to Landau, Kolmogoroff and others were devoted to the subject. The book mirrors all these achievements, and gives a lucid explanation of many aspects of the phenomenon in a carefully written text, full of instructive examples, interesting comments and excellent illustrations.

In Part I, the reader can find the classical picture of turbulence (together with historical remarks and a general overview of the ubiquitous nature of turbulence), equations of fluid mechanics, origins of turbulence, turbulent shear flows, simple closure models and the phenomenology of Taylor, Richardson and Kolmogoroff. Part II includes facts on homogeneous turbulence, numerical simulations, isotropic turbulence and the Fourier transform. Part III contains special topics, such as the influence of rotation, stratification, magnetic fields and two-dimensional turbulence. The book ends with appendices (Vector identities, isolated vortices, long range pressure forces in isotropic turbulence, Hankel transforms, etc.). To summarize, this is a very useful book addressed to a wide audience, a book on "one of the greatest unsolved problems of classical physics", a phenomenon which is all around us. (mzahr)

***D. G. Duffy: Transform Methods for Solving Partial Differential Equations,** second edition, Chapman & Hall/CRC, Boca Raton, 2004, 708 pp., USD 99,95, ISBN 1-58488-451-7*

The book is devoted to a classical subject: solving linear PDEs by means of Laplace, Fourier and the lesser known Hankel transforms. Preliminary knowledge of complex integration (including multi-valued functions) and Bessel functions is assumed, though a short introduction is given. The core of the book consists of several hundred mostly worked solutions of PDEs, typically on two-dimensional (semi)infinite domains. Both Cartesian and polar coordinates and various combinations of boundary conditions are present. Each section is devoted to a particular transform or a combination of these. The last chapter deals with a more advanced Wiener-Hopf technique. An extensive bibliography of papers using each particular method is given. Special attention is paid to computing inverse transforms and various analytic and numerical techniques are discussed. The discussed solutions typically involve quite difficult algebra, while non-trivial mathematical steps, such as a change of order of integration or expansion into infinite series (product) are not justified. This gives the book more of an 'engineering' flavour; nonetheless it is certainly of interest to a wider audience. (dpr)

***P. Duren, A. Schuster: Bergman Spaces**, Mathematical Surveys and Monographs, vol. 100, American Mathematical Society, Providence, 2004, 318 pp., USD 79, ISBN 0-8218-0810-9*

Bergman spaces A^p are subspaces of holomorphic L^p functions on the unit disc. In many respects, they resemble the Hardy spaces H^p, which were intensively studied from the 30s till the 50s. However, a majority of problems turned out to be much more difficult in the Bergman space setting and for decades they remained essentially intractable. This situation has changed radically in the 90s. Many significant advances have taken place, attracting in turn a lot of research activity in the area. The present book gives a systematic overview of the current state of this exciting subject.

The first two chapters present a crash course on the classical theory of Hardy spaces, the Bergman kernel function, hyperbolic geometry, biharmonic Green functions and a lot of other prerequisites, thus making the book very self-contained and accessible to anyone with basic knowledge of complex function theory and functional analysis. Chapter 3 deals with properties of individual functions in Bergman spaces (growth and boundary behaviour, Taylor coefficients, etc.). Chapters 4 and 5 develop properties of zero-sets of A^p functions and of the Hedenmalm canonical zero-divisors (analogues of Blaschke products), respectively. Chapters 6 and 7 contain an exposition of Seip's beautiful theory of interpolation and sampling in A^p spaces. Finally, Chapters 8 and 9 are devoted to the structure of invariant subspaces of A^p spaces, including the study of cyclic elements and the proofs of what may be the most profound result in the area, the Aleman-Richter-Sundberg analogue of Beurling's theorem. The exposition is on a masterly level, neatly and tightly organized, and yet highly readable.

So is, by the way, an earlier book on the subject, *Theory of Bergman spaces* by Hedenmalm, Korenblum and Zhu (Springer, 2000); there is, of course, a lot of overlap between the two books, but the current one contains more of the prerequisites (especially on H^p spaces), discusses some material not covered by the other book and treats some material in a different way. Similarly, the HKZ book contains several topics barely dealt with in the present volume, such as the invertible noncyclic functions or the log-subharmonic weights. It is extremely likely that both books are going to become standard references on the subject and should not be missing on the shelf of anyone seriously interested in this area. (men)

***P. P. G. Dyke: Managing Mathematical Projects – with Success!**, Springer, London, 2004, 266 pp., EUR 34,95, ISBN 1-85233-736-2*

More than 20 years of the authors' experience in supervising and assessing mathematical projects have resulted in this book, the title of which can hardly be more eloquent. Moreover, the eloquence persists from the first to the last page. The features of individual projects, group projects and case studies are carefully described as well as their assessment together with aspects like interim and final reports, verbal presentation, classification and moderating. Each of the three mentioned types of projects are then carefully studied in detail in separate chapters, which contain valuable observations and advice for students preparing projects as well as for their supervisors (selecting projects, forming student groups and all the other aspects that have a bearing on the final result). As the author says, "One can often learn much from reading the work of the other students, … " and so some verbatim extracts from student projects are added as examples, followed by some other examples of projects, by students who have gained their degrees. Three individual projects have been included in full in three separate appendices. In the last few decades, the teaching of mathematics has undergone some remarkable changes mirroring deeper influences on other sciences and areas. The book reflects these changes. It is a sheer joy reading it and appreciating the authors' refined style and humor. From the viewpoint of students, supervisors, as well as of assessors, this book must be unanimously marked as excellent. (jd)

E. B. Dynkin: Superdiffusions and Positive Solutions of Nonlinear Partial Differential Equations*, University Lecture Series, vol. 34, American Mathematical Society, Providence, 2004, 120 pp., USD 29, ISBN 0-8218-3682-X*

This book is written by a well-known specialist in the theory of Markov processes and partial differential equations and is devoted to applications of probability theory to the theory of positive solutions of the equation $Lu = \psi(u)$, where L is an elliptic differential operator of second order and ψ is a differentiable positive function. The equation under consideration contains as a particular case the equation $\Delta u = u^a$, whose positive solutions were studied by M. Marcus and L. Veron with purely analytical methods. The author has applied both analytic and probabilistic approaches. The Choquet capacities are one of the principal tools for the study of the equation $\Delta u = u^a$. This probabilistic tool is closely connected with the use of super diffusion theory. The book will be useful for anybody interested in applications of probabilistic methods to mathematical analysis. (lk)

Y. Eidelman, V. Milman, A. Tsolomitis: Functional Analysis: An Introduction*, Graduate Studies in Mathematics, vol. 66, American Mathematical Society, Providence, 2004, 322 pp., USD 55, ISBN 0-8218-3646-3*

This text corresponds to material for two semester courses. Part I covers Hilbert spaces and basic operator theory including Fredholm theory of compact operators, self-adjoint operators and their spectral decomposition. Part II, called Basics of Functional Analysis, deals with spectral theory of unitary operators, unbounded self-adjoint and symmetric operators in Hilbert space and basic theorems of linear functional analysis. The proof of the open mapping theorem is based on properties of perfectly convex sets in Banach spaces and the Banach-Steinhaus theorem is proved using the notion of perfectly convex functions. Weak topologies are studied, the Alaoglu theorem is proved with reference to the Tikhonov theorem, and the Eberlain-Schmulian theorem is shown to be a consequence of James' theorem, stated without proof. The Krein-Milman theorem is also included. The chapter on Banach algebras is accompanied by applications to Wiener's theorem on absolutely convergent trigonometric series, to spectral theory, to a multiplicative generalized limit and to the Ramsey theorem. Each chapter includes exercises, in total 195 of them, all provided with solutions at the end of the book. The text is as self-contained as possible; prerequisites for the first part are linear algebra and calculus, while some knowledge of topology and measure theory is useful. The authors have taken special care to be brief and not to overload the students with the enormous amount of information available on the subject. (in)

J. Fauvel, R. Flood, R. Wilson, Eds.: Music and Mathematics: From Pythagoras to Fractals*, Oxford University Press, Oxford, 2003, 189 pp., GBP 39,50, ISBN 0-19-851187-6*

This book is a collection of 10 essays written by different authors on the topic, split into four chapters: 'Music and mathematics through the history', 'The mathematics of musical sound', 'Mathematical structure in the music' and 'The composer speaks'. Starting from historical remarks (on tuning strings in connection with Pythagorean scales and the theory of rational numbers), the authors move on to the differences between tempered and non-tempered tuning and the Pythagorean comma, before explaining why an octave consisting of 53 rather than 12 tones would be better for tuning. Through the notion of musical cosmology, the reader is led to more scientific aspects of music, namely the analysis of the oscillograph traces – a way to capture music in a manner close to the recording of sounds. For a mathematician, it is interesting to see how the notion of rationality and irrationality and the notion of continued fractions is employed in describing music.

The theory of consonant tones – the tones that sound faintly together with the main tone – is also studied. Later, the way of writing down music is touched: its geometrical aspect as well as its effectiveness. Finally, the authors present the compositional dimension of connections between the two fields, namely the influence of a mathematical approach to the composing process, adding to the common composition techniques the technique of mathematically constructed or "scientific" music. The book presents a comprehensive look at the connections between music and mathematics. While the former is mostly considered as a pure intuitive, aesthetical discipline, the latter is often perceived as a pure technical and logical one. The book suggests, however, that the two disciplines have much in common. This nicely written book would be appreciated by all who want to delve deeper into the connections between the two fields. However, even though the book is written as a collection of essays, the presence of some formulas could mean that the book will be more appreciated by mathematicians interested in music than vice versa. (mrok)

L. Gasiński, N.S. Papageorgiou: Nonsmooth Critical Point Theory and Nonlinear Boundary Value Problems*, Series in Mathematical Analysis and Applications, vol. 8, Chapman & Hall/CRC, Boca Raton, 2004, 775 pp., USD 99,95, ISBN 1-58488-485-1*

This book provides a complete presentation of nonsmooth critical point theory. It collects together tools and results from nonsmooth analysis into a systematic survey of advances that have been made by many people working in the field since the early 1980s. After offering a comprehensive treatment of nonsmooth critical point theory, the authors study nonlinear second order boundary value problems both for ODEs (Chapter 3) and elliptic equations (Chapter 4). They do not limit themselves to problems in variational form, also studying in detail equations driven by the p-Laplacian, its generalizations and their special properties, considering a wide variety of problems and illustrating the powerful tools of modern nonlinear analysis. The presentation includes many recent results, including some that were previously unpublished. Detailed appendices outline the fundamental mathematical tools used in the book and a rich bibliography forms a guide to the relevant literature. The book can be recommended to all readers interested in nonlinear analysis and also as a reference book. (oj)

G. Gasper, M. Rahman: Basic Hypergeometric Series*, second edition, Encyclopedia of Mathematics and Its Applications 96, Cambridge University Press, Cambridge, 2004, 428 pp., GBP 65, ISBN 0-521-83357-4*

This book is a monograph on a special branch of mathematics that is losing its special status as it becomes more incorporated in other areas of mathematics and applications. The book is a comprehensive synopsis of hypergeometric series and is written in a friendly way, yielding an easy access to notation, which in this area is rather complicated and thus seems formidable and discouraging. The first five chapters build the general theory, the next five deal with applications (e.g. orthogonal polynomials, the Askey-Wilson integral, q-series) and the last one is devoted to the elements of theta, or elliptic hypergeometric series. Of three very useful appendices, the first two summarize identities and summation formulas and the third concerns transformation formulas. Numerous exercises, varying from elementary problems to those containing new results, that did not find place in the main text complete each chapter and provide a challenge to the reader. The book ends with an extensive list of references. It is a very modern, self contained, comprehensive and successful monograph, interesting and useful, for physicists as well as for mathematicians from various branches, who wish to learn about the subject. (jd)

J. Gasqui, H. Goldschmidt: Radon Transforms and the Rigidity of the Grassmannians*, Annals of Mathematics Studies, Princeton University Press, Princeton, 2004, 376 pp., GBP 29,95, ISBN 0-691-11899-X, ISBN 0-691-11898-1*

The main problem treated in this book is the following basic question: is it possible to characterize metrics on a given symmetric space of a compact type by means of the spectrum of its Laplacian? The book is devoted to a study of the infinitesimal version of the problem. In particular, infinitesimal isospectral deformations belong to the kernel of a certain Radon transform (defined in terms of integration over the flat totally geodesic tori of dimension equal to the rank of the space). A special version of the problem is to determine all symmetric spaces of compact type for which the Radon transform is injective in a suitable sense. The Guillemin criterion for infinitesimal spectral rigidity is also described and new methods for studying this type of rigidity are introduced. Projective spaces and real, complex and quaternionic Grassmanians are presented as main examples. There is a discussion and proofs of rigidity of Grassmanians. In the last part non-rigidity of the product of irreducible symmetric spaces is proved. The methods used in the book include harmonic analysis on homogeneous spaces and a resolution of the sheaf of Killing vector fields constructed by means of the theory of linear overdetermined PDEs. (jbu)

D. Hankerson, A. Menezes, S. Vanstone: Guide to Elliptic Curve Cryptography, *Springer, New York, 2004, 311 pp., EUR 64,95, ISBN 0-387-95273-X*

This is a very useful handbook for anybody who is or must be interested in practical elliptic curve cryptography and its applications. The content includes basic finite field arithmetic, elliptic curve arithmetic, cryptographic protocols (including known attacks on the elliptic curve discrete logarithm problem, a description of the generation and validation of domain parameters, key pairs, signature schemes, public-key encryption and key establishment) and software and hardware implementations (together with an introduction to side-channel attacks and the corresponding countermeasures). All this is presented in a rather non-theoretical way and at a beginner to intermediate level. On the other hand, researchers should find the book useful because of the extensive survey of the related literature (each chapter ends with notes and further references, the bibliography containing almost 500 items). (tk)

S. Hedman: A First Course in Logic*, Oxford Texts in Logic 1, Oxford University Press, New York, 2004, 431 pp., GBP 29,99, ISBN 0-19-852981-3, ISBN 0-19-852980-5*

This book contains an introduction to classical fundamental branches of mathematical logic: propositional and first-order topics, including a part of a basic model theory and Gödel's incompleteness theorems. Moreover, we can find here three further subjects: Computability and complexity (chapter 7), Beyond first-order logic (chapter 9) and Finite model theory (chapter 10). The book is therefore useful for students of mathematics, computer science and logic. In the last section of the chapter Models of countable theories, the author gives an overview of concepts and results of modern model theory. A finite model theory is treated in the last chapter and apart from other things, some connections with problems of complexity theory are presented here. The book contains many examples and appropriate exercises and offers an inspiration in many directions. (jmlc)

C. Y. Ho, P. Sin, P. H. Tiep, A. Turull, Eds.: Finite Groups 2003*, Walter de Gruyter, Berlin, 2004, 417 pp., EUR 168, ISBN 3-11-017447-2*

This volume is related to the conference held in honor of John G. Thompson on his 70th birthday at the University of Florida. The book is a collection of 28 refereed papers prepared specifically for the proceedings, not necessarily representing a record of talks as given at the conference (the list of talks is included in the book). The papers cover a wide variety of topics, most of them containing original research results, while a few are survey articles from which students and non-experts can learn about the present state of knowledge and promising directions for further research. (sh)

R. Illner, C.S. Bohun, S. McCollum, T. van Roode: Mathematical Modelling. A Case Studies Approach*, Student Mathematical Library, vol. 27, American Mathematical Society, Providence, 2005, 196 pp., USD 35, ISBN 0-8218-3650-1*

The book presents a case approach to mathematical modeling. It is written as a one-term course on modeling to be read by third year students of mathematics. The material covers several areas of mathematical applications in a very interesting way and

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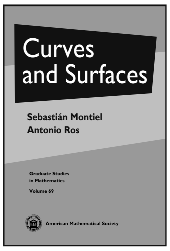

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For Classroom Use

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

This introductory textbook projects a clear and focused point of view on the differential geometry of curves and surfaces emphasizing the global aspects. It contains an excellent collection of exercises (with hints) that will give students an edge in learning the material and is a nice entry point to differential geometry. It is suitable for graduate students and researchers studying differential geometry, in particular the differential geometry of curves and surfaces.

For a complete description, go to www.ams.org/bookstore-getitem/item=gsm-69

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

Graduate Studies in Mathematics, Volume 69; 2005; approximately 387 pages; Hardcover; ISBN 0-8218-3815-6; List US$59; All AMS members US$47; Order code GSM/69

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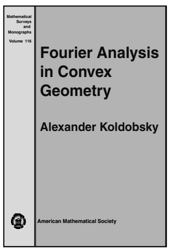
Frank Morgan, *Williams College, Williamstown, MA*

Written by award-winning author and professor, Frank Morgan, this is a clear and sophisticated exposition for undergraduates studying real analysis. Through Morgan's insightful writing, students will learn about the theory behind calculus directly from the basic concepts of real numbers, limits, and open and closed sets in $\mathbb{R}^n$. They will find efficient proofs and how to derive them. Excellent exercises are accompanied by select solutions. The book will fit nicely into one semester. Morgan received the Haimo teaching award from MAA as well as teaching awards from Rice University and MIT.

For a complete description, go to www.ams.org/bookstore-getitem/item=real

2005; 151 pages; Hardcover; ISBN 0-8218-3670-6; List US$39; All AMS members US$31; Order code REAL



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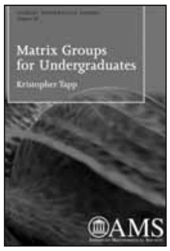
For Classroom Use

Alexander Koldobsky, *University of Missouri, Columbia, MO*

A new Fourier analysis approach is discussed in this book. The idea is to express certain geometric properties of bodies in terms of Fourier analysis and to use harmonic analysis methods to solve geometric problems. The volume is suitable for graduate students and researchers interested in geometry, harmonic and functional analysis, and probability.

For a complete description, go to www.ams.org/bookstore-getitem/item=surv-116

Mathematical Surveys and Monographs, Volume 116; 2005; 170 pages; Hardcover; ISBN 0-8218-3787-7; List US$59; All AMS members US$47; Order code SURV/116



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For Classroom Use

Kristopher Tapp, *Williams College, Williamstown, MA*

Matrix groups are a beautiful subject central to many fields in mathematics and physics. They touch upon an enormous spectrum within the mathematical arena. This textbook brings them into the undergraduate curriculum. It gives a concrete and example-driven presentation with geometric motivation and rigorous proofs. There is a nice balance of rigor and intuition describing basic objects of Lie theory: lie algebras, matrix exponentiation, Lie brackets, and maximal tori. The book is suitable for graduate students and researchers interested in group theory.

For a complete description, go to www.ams.org/bookstore-getitem/item=stml-29

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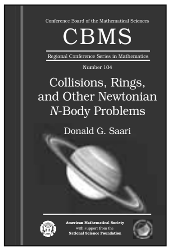

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Donald G. Saari, *University of California, Irvine, CA*

Written by well-known expert, Donald Saari, this book is directed toward readers who want to learn about the Newtonian *N*-body problem. It is also intended for students and experts who are interested in new expositions of past results, previously unpublished research conclusions, and new research problems.

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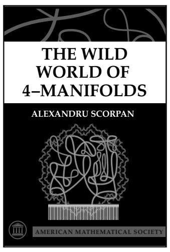

The Wild World of 4–Manifolds

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

This book offers a panorama of the topology of simply-connected smooth manifolds of dimension four and includes illustrations and historical notes. Dimension four is unlike any other dimension; it is large enough to have room for wild things to happen, but too small to have room to undo them.

This book surveys higher dimensions and topological 4-manifolds. The author investigates the main invariant of a 4-manifold—the intersection form—and its interaction with the topology of the manifold. He then reviews complex surfaces as an important source of examples. The last part of the book presents gauge theory. Copious notes augment the end of each chapter, presenting many extra details, proofs, and developments. There are over 250 illustrations and an extensive index. The book is suitable for graduate students and research mathematicians interested in low-dimensional topology.

For a complete description, go to www.ams.org/bookstore-getitem/item=fourman

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pleasant style. Selected problems are studied, starting from the real situation before deriving the suitable mathematical model, solving and modifying it to obtain results that fit to the real situation. Chapters are devoted to the following problems: Crystallization Dynamics, Will the Valve hold?, How Much Will that Annuity Cost Me?, Dimensional analysis, Predator-Prey Systems, A Control Problem in Fishery Management, Formal Justice, Traffic Dynamics: A Microscopic Model, Traffic Dynamics: Macroscopic Modeling. Chapters end with examples and suggestions for further research. Some topics are "classical", but several problems are rather new and cannot be found in other textbooks on modeling. This book can be used in seminars or for student mathematical modeling competitions. (pp)

A. Jeffrey: Mathematics for Engineers and Scientists*, sixth edition, Chapman & Hall/CRC, Boca Raton, 2004, 994 pp., USD 59,95, ISBN 1-58488-488-6*

In a terse and elegant form, foundations of differential and integral calculus, linear algebra and differential equations, accompanied by elements of Fourier series, probability and statistics, numerical analysis and symbolic algebraic manipulation are put forth for engineers and scientists. Not just the introductory chapters but the whole text is written in a reader friendly way without loss of exactness or avoiding proofs. It contains motivation for every topic and is self contained, hence suitable for private study. Theoretical sections are accompanied by many solved examples and each chapter ends with problems giving the reader an opportunity for training his skill in techniques just developed. Appropriate figures at appropriate places help elucidate discussed notions. In this (sixth) edition, the book has been expanded, with a new chapter on manipulation by computer software (e.g. MAPLE and MATLAB) to reflect the influence of computer techniques on teaching and applications of mathematics. The textbook will be very useful for engineering students and their teachers and for scientists or anyone interested in improving their mathematical knowledge and skill. (jd)

Y. Komori, V. Markovic, C. Series, Eds.: Kleinian Groups and Hyperbolic 3-Manifolds. Proceedings of the Warwick Workshop*, September 2001, London Mathematical Society Lecture Note Series 299, Cambridge University Press, Cambridge, 2003, 392 pp., GBP 40, ISBN 0-521-54013-5*

The field of hyperbolic 3-manifolds and Kleinian groups is at present very active. This book contains the proceedings of a workshop held in Warwick in 2001, which was devoted to this topic. This first part of the book contains 8 papers on hyperbolic three-dimensional manifolds. The contribution by Y. N. Minsky is a revised form of a series of six lectures at the workshop devoted to a generalization of the Thurston ending lamination conjecture to general surfaces. The second part includes a paper by T. Jørgensen on pairs of once-punctured tori together with four other related papers. The book ends with three review papers on related topics (including the paper by D.B.A Epstein, A. Marden and V. Markovic containing counterexamples to the equivariant K=2 conjecture for hyperbolic convex hulls). (vs)

T. Y. Lam: Introduction to Quadratic Forms over Fields*, Graduate Studies in Mathematics, vol. 67, American Mathematical Society, Providence, 2005, 550 pp., USD 79, ISBN 0-8218-1095-2*

This book is devoted to quadratic forms over fields of characteristic not equal to two. Besides the basics of the theory, it contains both classical and more recent topics and results, which makes it a good reference book for researchers in many areas of mathematics. The chapter titles are: Foundations, Witt Rings, Quaternion Algebras, Brauer-Wall groups, Clifford Algebras, forms over local and global fields, forms under algebraic and transcendental field extensions, forms over formally real fields and pythagorean fields, Pfister forms and field invariants. In comparison with 'The Algebraic Theory of Quadratic Forms' (1972) from the same author, there are two new chapters. These are divided into quite independent sections covering some recent topics in the theory, including forms of low dimension, classification theorems, biquadratic extensions and quadratic invariants of fields.

The book reads very well; notions and statements are supported by examples involving cases over both finite and infinite fields. At the end of every chapter, there are a number of exercises that could be useful, especially for teachers using the book as a basis for their course. Longer proofs are divided into series of lemmas or steps, which help the reader extract the main idea of the proof. These lemmas are in some cases inserted between the statement and its proof. The reader will also appreciate that definitions are recalled when they are used later in the book. Since the emphasis of the book is not on connections with other parts of mathematics, it is a comprehensive and self-contained introduction to the theory of quadratic forms. Although particular chapters are reworked and two more are added, both the style and the organization of the book has remained the same as that of the above-mentioned book and thus it will appeal to a wide range of readers from students to researchers. (jhor)

P. B. Larson: The Stationary Tower: Notes on a Course by W. Hugh Woodin*, University Lecture Series, vol. 32, American Mathematical Society, Providence, 2004, 132 pp., USD 23, ISBN 0-8218-3604-8*

This book is an introduction to the stationary tower, a method that offers a tool for a construction of generic elementary embeddings. H. Woodin invented the method in the 80s. It produces, among other things, some interesting results concerning forcing-absoluteness, the axiom of determinacy and the descriptive set theory, which follow from various assumptions that there is a class of large (Woodin) cardinals. These facts are discussed in the third chapter. The first chapter provides some background material, while the second presents the stationary tower and its basic properties. These two chapters are an adapted version of lecture notes from a graduate set theory course given by H. Woodin at Berkley in 1996. The book is aimed at graduate students and assumes some familiarity with ultrapowers, forcing and constructability. It contains many examples and also a summary of facts from forcing, collected together in the appendix. (jmlc)

J. C. Lennox, D. J. S. Robinson: The Theory of Infinite Soluble Groups, *Oxford Mathematical Monographs, Clarendon Press, Oxford, 2004, 342 pp., GBP 75, ISBN 0-19-850728-3*

This book covers nearly all major parts of the theory of infinite soluble groups. The areas include soluble linear groups, finitely generated soluble groups, soluble groups of various finite ranks, finitely presented soluble groups, soluble groups satisfying various finiteness conditions, algorithmic problems on finitely generated soluble groups, modules over corresponding group rings and applications of cohomological methods. The presentation of the material mentioned is excellent and the text, albeit necessarily somewhat comprehensive, is easy to follow. A comprehensive bibliography is provided. The book will certainly become a standard reference text on the subject. (tk)

***T. Lyons, Z. Qian: System Control and Rough Paths**, Oxford Mathematical Monographs, Clarendon Press, Oxford, 2002, 216 pp., GBP 53, ISBN 0-19-850648-1*

This book describes a novel mathematical development with potential for applications to engineering. Intended for mathematicians and engineers with a good mathematical background, the book describes the evolution of complex non-linear systems influenced by rough or rapidly fluctuating stimuli. It focuses on an analysis of the relationship between the control and the response of the system. An essential problem is to identify the point at which two different stimuli produce the same (or almost the same) response from the class of receivers. Here we deal with an essentially non-linear problem that requires new mathematics. The book focuses on systems responding to such rough external stimuli, and demonstrates that the natural reduction approximates the stimuli as a sequence of nilpotent elements. The main result of the book is represented by a theorem on continuity: "the response of the system depends continuously on these nilpotent elements". An interesting mathematical object is the notion of a rough path, which is based on a combination of the notion of a p-variation of Wiener with the iterated integral expansions of paths introduced by K. T. Chen. The continuity theorem for rough paths gives a new way to construct solutions of stochastic differential equations. (lk)

***M. K. Ng: Iterative Methods for Toeplitz Systems**, Numerical Mathematics and Scientific Computation, Oxford University Press, Oxford, 2004, 350 pp., GBP 60, ISBN 0-19-850420-9*

Many problems in various applications of mathematics in physics and engineering lead to a search for a solution of large linear systems with Toeplitz or Toeplitz-related matrices. In recent years, a lot of research has focused on such systems. The book deals primarily with iterative methods, pre-conditioners and applications. It is divided into three parts. The first part (Introduction) deals with basic concepts and results in linear algebra (especially the conjugate gradients method). No specific applications are mentioned here. The second part (Theory) contains a discussion of solutions of Toeplitz systems. This includes direct, and in particular iterative, methods with theoretical background for using circulant and non-circulant matrices as preconditioners. The author also discusses ill-conditioned Toeplitz systems or Toeplitz-like systems. The third part (Applications) provides a theoretical framework for various fields of use. Here partial differential equations, queuing networks, signal and image processing and integral equations are considered. The book gives an excellent overview of the research and results in this area during the last few decades. The book may attract interest from graduate students, mathematicians and other specialists working in applied mathematics and scientific computing. (jzit)

***J. Ockendon, S. Howison, A. Lacey, A. Movchan: Applied Partial Differential Equations**, revised edition, Oxford University Press, Oxford, 2003, 449 pp., GBP 27,50, ISBN 0-19-852771-3*

The importance of partial differential equations (PDEs) for both pure analysis and applied mathematics is beyond any doubt and a number of books written on the topic stand testament to this widely accepted fact. In view of this, it is a hard task to write a book that would be recommended as one of the first to read on the topic. The authors seem to have fulfilled the task quite well. Almost all the basic notions of PDEs are covered and studied in the book.

In the context of first order quasilinear systems, we learn about characteristics and a question of blow-up of the smooth solution due to the nonlinear structure of characteristic fields, we are led to solutions with discontinuities and the concept of a weak solution. In the system case, the quasilinear phenomena are studied with mention to the classical Cauchy-Kowalevskaya theorem and proceeding to the concept of hyperbolicity and more non-trivial concepts such as Riemann invariants, domain of dependence, the concept of entropy and the discussion of its connection to the notion of viscosity. For the second order equations, the book confronts the classical classification into elliptic, parabolic and hyperbolic equations, dealing with all classical concepts such as the maximum principle and energy methods and the methods of the Green function. Moreover, there is an extensive and instructive employment of various integral transforms (e.g. Mellin, Hankel, Fourier, and Radon transforms). The reader can also learn some non-standard (or not very frequently used) techniques such as the hodograph method, methods of conformal mappings and the Wiener-Hopf method in 2D setting. The problem of free boundaries is also touched upon. Physicists will be pleased to find not only the notion of the Laplace and Poisson equations, Helmholtz' equation, heat and mass transfer and convection-diffusion problems but also the Maxwell equations, gravitation, heat transfer, acoustics, etc. The book is very well written, equipped with numerous exercises and applications and will serve as a very good textbook both for masters and PhD students. (mrok)

***M. Ohtsuka: Extremal Length and Precise Functions**, Gakuto International Series: Mathematical Sciences and Applications, vol. 19, Gakkotosho, Tokyo, 2003, 343 pp., ISBN 4-7625-0428-9*

Sobolev spaces of first order are spaces of functions that are integrable together with their distributional p-th derivatives. An element of a Sobolev space is itself an equivalence class of functions, which mutually agree almost everywhere. A single function in this equivalence class is called a representative. It is often desirable to distinguish between 'good' and 'bad' representatives as many statements admit finer formulations for the good representatives. Following Beppo Levi, classes of functions that are absolutely continuous along almost all lines parallel to coordinate axes (ACL functions) are often considered. A refinement of this idea leads to the definition of AC functions. These are intended to be functions that are absolutely continuous on almost all curves. Therefore we need to know which families of curves can be regarded to be exceptional. Let Γ be a family of curves. A function ρ is called admissible if the integral of ρ over any curve in Γ is at least one. Then the p-modulus of Γ is defined as the infimum of integrals of the p-th power of ρ where ρ runs over all Γ-admissible functions. The reciprocal of the modulus is called the extremal length. We can neglect a family of curves that has vanishing p-modulus and define *p*-precise functions as functions absolutely continuous along *p*-almost every curve (in the sense of modulus) with *p*-power integrable gradient.

The presentation begins with an introduction of the notion of extremal length and related topics. An interesting section is the treatment of tubes and the computation of their extremal length. Next, the theory of various types of absolutely continuous and precise functions is developed with their comparison and analysis of exceptional sets. Inequalities for Hardy-Littlewood maximal functions, Calderón-Zygmund operators and Riesz potentials, Sobolev and Poincaré inequalities, extension theorems and trace theorems are presented. Finally, it is shown how extremal distance leads to an approach to capacity and both qualitative and quantitative properties of capacities are studied. In particular, various symmetrization results for capacities are given. Most of the material is presented in the setting of weighted spaces. The book is a valuable source for a considerable amount of useful material on Sobolev functions and their representatives and on important inequalities in analysis. It is worth noticing that the extremal length approach to representatives is not often fully recognized and thus this book fills a gap in expository literature. (jama)

J .C. Robinson: An Introduction to Ordinary Differential Equations*, Cambridge University Press, Cambridge, 2004, 414 pp., GBP 24,99, ISBN 0-521-53391-0, ISBN 0-521-82650-0*
This book grew out of lecture notes prepared by the author for the first year Warwick differential equation course. It covers a wide scale of elementary methods of obtaining explicit solutions to ordinary first order differential equations and to linear equations and systems of two linear equations with constant coefficients and special cases of nonconstant coefficients (Euler equations) with remarks on power series solutions. One chapter is devoted to numerical solutions (Euler's method) and difference equations. Special attention is given to the dynamical system approach, starting with the qualitative behaviour for one equation (stability, bifurcation) and phase portraits of linear systems and moving on to nonlinear systems modelling pendulum motion and predator-prey systems, the Poincaré-Bendixson theorem and remarks on chaos. More complicated dynamics are shown on the Lorentz system. An overview of needed background material is given in appendices A, B and C, dealing with real and complex numbers, elements of linear algebra and derivatives and Taylor expansions. Needed elements of integration are contained in the main text. The presentation is vivid and informal, careful to minimize requirements on the reader's previous knowledge. New ideas and general concepts are well documented on worked examples. The text is richly illustrated (with figures generated mostly by Matlab). Individual work by the student is encouraged by exercises at the end of each section (including exercises suggested for computer aided graphical investigation) and a list of books recommended for further reading. The book will be useful to anybody wanting to teach or learn elements of ordinary differential equations in the beginnings of their mathematical studies. (jsta)

S. Rudich, A. Widgerson, Eds.: Computational Complexity Theory*, IAS/Park City Mathematics Series, vol. 10, American Mathematical Society, Providence, 2004, 389 pp., USD 69, ISBN 0-8218-2872-X*
This book is devoted to modern topics in complexity theory. It contains lectures given during the three-week summer school organized by IAS/Park City Mathematics Institute in 2000. The lectures were given by ten leading researchers in complexity theory. Computational power of machines with limited resources is the central notion of this area. The book describes a significant development of this area during the last thirty years. The results lead to a fundamentally new and important way of understanding many central notions beyond computation itself, e.g. proof, knowledge, randomness, cryptography, etc.

The book is divided into three parts; the first part (the first week of the school) contains lectures given by S. Rudich, A. Wigderson, S. Arora and R. Raz. It contains a survey of basic models, techniques, results and open problems (given by S. Rudich), a survey of average-case complexity (given by A. Wigderson), reduction techniques (given by S. Arora) and quantum computation (given by R. Raz). The second part (the second week) is formed from lectures by R. Raz concerning communication and circuit complexity and by P. Beame concerning proof complexity. The last part (the third week) is devoted to randomness in computation. Lectures were given on pseudorandomness by O. Goldreich and L. Trevisan, on interactive proof systems and zero-knowledge by S. Vadhan and on probable checkability proofs by M. Sudan. This interesting book serves students and researchers of the complexity theory and also students and researchers in adjacent fields using computation tools. (vkou)

H. Schenck: Computational Algebraic Geometry*, London Mathematical Society Student Texts 58, Cambridge University Press, Cambridge, 2003, 208 pp., GBP 18,99, ISBN 0-521-53650-2, ISBN 0-521-82964-X*
The aim of this book is to present an understandable introduction to classical questions of commutative algebra and algebraic geometry using new computational tools (computer algebra package Macaulay 2). The book starts with basics of commutative algebra, followed by the definition and simple properties of projective spaces and projective varieties, graded rings and modules and the Hilbert function and series. Free resolutions and regular sequences of modules are introduced and Groebner bases and syzygies are used. The next section is devoted to algebraic topology and combinatorics, namely simplicial complexes and homology and related algebraic theory (localization, functors, and tensor products with applications to geometry of points in projective space). More facts on chain complexes are presented in the second part of the book (derived functors, Tor and Ext functors, the Hilbert syzygy theorem being an easy exercise). In the last part, a quick introduction to sheaves, Čech cohomology and divisors on algebraic curves is given. There is also a description of the Riemann-Roch theorem and its applications. More advanced topics (projective dimensions of modules, Cohen-Macaulay modules) are also studied. In the appendices, basic facts from algebra and complex functions theory are summarized. The author presents the book as an advertisement for other, more advanced texts. It is a very good introduction to this circle of ideas and it will undoubtedly attract the interest of students to the field. (jbu)

***S. Schmitt, H. G. Zimmer: Elliptic Curves: A Computational Approach**, de Gruyter Studies in Mathematics, vol. 31, Walter de Gruyter, Berlin, 2003, 367 pp., EUR 78, ISBN 3-11-016808-1*

The aim of this book is to give an elementary introduction to the arithmetic of elliptic curves over number fields from a computational point of view, i.e. the text is equipped with the corresponding algorithms. In the book, the most important topics of elliptic curves are discussed, including the determination of torsion groups, computations concerning the Mordell-Weil group (in particular concerning the rank and a basis of that group), height calculations and the determination of integral and S-integral points. The computer algebra system SIMATH, developed by the second author, focuses just on elliptic curves and all elementary algorithms used in the book are implemented in SIMATH. (pso)

***P. Solín, K. Segeth, I. Dolezel: Higher-Order Finite Element Methods**, Studies in Advanced Mathematics, vol. 41, Chapman & Hall/CRC Press, Boca Raton, 2004, 408 pp., USD 89,95, ISBN 1-58488-438-X*

This book is concerned with the treatment of basic principles of higher-order finite element techniques. It consists of six chapters; the first is an introduction, giving a survey of function spaces, defining finite elements, orthogonal polynomials and presenting a one-dimensional example. Chapter 2 is devoted to hierarchic higher-order master elements in 2D and 3D. This chapter contains a number of formulae of shape functions for H^1-, H(curl)- and H(div)-conforming elements. Chapter 3 explains basic principles of general higher-order finite element methods in 2D and 3D, namely projection-based interpolation, transfinited interpolation, construction of reference maps, technology of discretization in 2D and 3D and constrained approximations including the case of hanging nodes discretization. Moreover some software aspects are discussed. Chapter 4 deals with higher-order numerical integration for various types of finite elements in two and three space dimensions, e.g. Newton-Cotes, Chebyshev, Lobatto (Radau) and Gauss quadratures and formulae for reference triangle, quadrilateral, brick, tetrahedron and prism. Chapter 5 discusses numerical algorithms for the solution of the finite element discrete problem: direct methods (Gauss elimination, matrix factorization) and iterative methods (steepest decent, ORTHOMIN, conjugate gradients, MINRES, GMRES, preconditioning, block iterative methods, multigrid) and methods for the solution of large systems of ordinary differential equations. Finally, in Chapter 6, mesh optimization, reference solutions and hp-adaptivity are presented. Here, various adaptive strategies and goal adaptivity approaches are treated. The book represents an excellent and useful introduction to higher-order finite element techniques. It is well written and contains a lot of important material. It will satisfy the interest of applied mathematicians as well as engineers. The book is also suitable for advanced undergraduate, graduate and postgraduate students of mathematics and technical sciences. (mf)

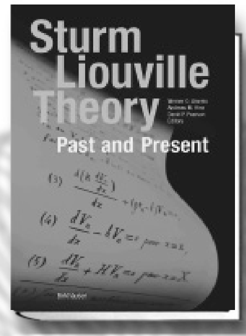
***M. A. Sumbatyan, A. Scalia: Equations of Mathematical Diffraction Theory**, Differential and Integral Equations and Their Applications, vol. 5, Chapman & Hall/CRC Press, Boca Raton, 2004, 291 pp., USD 99,95, ISBN 0-415-30849-6*

Let us consider a given incident wave p arriving from infinity. Diffraction is any change of this wave due to its interaction with some given obstacle. In this book, the diffraction is studied for different bounded and unbounded obstacles as interior and exterior of sphere, round disc, layer of constant thickness etc. Since the main processes that are studied are harmonic in time, i.e., $p(x,t)=Re(exp(-i\omega t)q(x))$, this leads to the study of the elliptic problem $\varnothing p+k^2p=0$ on various domains. In the equation $k=\omega/c$, ω is the angular frequency and c stands for the wave speed. In dependence on the properties of an obstacle (if it is acoustically hard or soft) the equation is equipped with Neumann or homogeneous Dirichlet boundary conditions. The main problems under consideration are: "How do we determine diffraction from the shape of the obstacle?" and "How do we determine the shape of the obstacle from known diffraction?" and "How to implement these methods numerically?"

The authors prefer to use a classical approach for the study of the problems, for example the method of Green's function, the method of potentials and the Fourier transform. They decided not to be extremely formal and rather clearly explain main ideas. The book is readable and self-contained, assuming only knowledge of fundamentals of real, complex and functional analysis. Basic preliminaries are summarized in the first chapter. It follows that students interested in the subject can read it and as there are different problems studied by different methods it will serve for engineers when solving a given practical problem. An expert in this area would find that there were some original results from the authors of the book. (pkap)

***S. Zheng, Nonlinear Evolution Equations**, Monographs and Surveys in Pure and Applied Mathematics, vol. 133, Chapman Hall/CRC, Boca Raton, 2004, 287 pp., USD 99,95, ISBN 1-58488-452-5*

This book explains several methods for investigation of the existence of solutions of nonlinear evolution equations and asymptotic properties of global solutions. The first chapter has introductory outlines and contains also a list of important evolution equations. Linear contraction semigroups are briefly introduced in chapter 2 and their properties are used in proving the existence results for semilinear equations. The compactness method and the method of monotone operators are described in chapter 3. It is shown in chapter 4 how the comparison principle can be used for the convergence of monotone iterations. Construction of invariant regions is also explained in this section. The methods given in chapters 2–4 generally yield solutions that can blow up in finite time. The problem of the existence of small global solutions is examined in chapter 5. In particular, a priori estimates in L^p-norms are presented here. Chapter 6 is devoted to the convergence of global solutions to stationary ones and the existence of global attractors. Since the book concentrates on the main features of describing methods and leaves out various technical generalizations it is readable and is recommended mainly to graduate students in various fields of nonlinear science with a good background in mathematics. (jmil)



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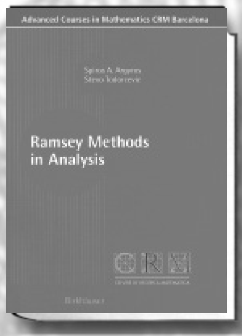
Sturm-Liouville Theory, Past and Present

2005. 360 pages. Hardcover
€ 78.– / CHF 128.–
ISBN 3-7643-7066-1

This is a collection of survey articles based on lectures presented at a colloquium and workshop in Geneva in 2003 to commemorate the 200th anniversary of the birth of Charles François Sturm. It aims at giving an overview of the development of Sturm-Liouville theory from its historical roots to present day research. It is the first time that such a comprehensive survey has been made available in compact form. The contributions come from internationally renowned experts and cover a wide range of developments of the theory. The book can therefore serve both as an introduction to Sturm-Liouville theory and as background for ongoing research.
The volume is addressed to researchers in related areas, to advanced students and to those interested in the historical development of mathematics.



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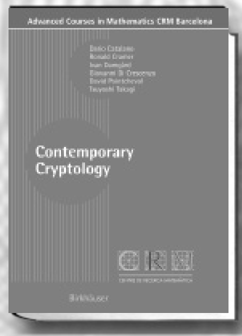
Ramsey Methods in Analysis

2005. 272 pages. Softcover
€ 38.– / CHF 58.–
ISBN 3-7643-7264-8
ACM – Advanced Courses in Mathematics – CRM Barcelona

This book introduces graduate students and researchers to the study of the geometry of Banach spaces using combinatorial methods. The combinatorial, and in particular the Ramsey-theoretic, approach to Banach space theory is not new: it can be traced back as early as the 1970s. Its full appreciation, however, came only during the last decade, after some of the most important problems in Banach space theory were solved, such as the distortion problem, the unconditional basic sequence problem, and the homogeneous space problem. The book covers most of these advances, but one of its primary purposes is to discuss some of the recent advances that are not present in survey articles of these areas. It shows, for example, how to introduce a conditional structure to a given Banach space under construction that allows to essentially prescribe the corresponding space of non-strictly singular operators.



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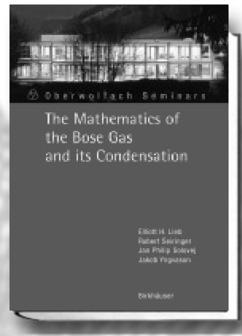
Contemporary Cryptology

2005. 208 pages. Softcover
€ 32.– / CHF 54.–
ISBN 3-7643-7294-X
ACM – Advanced Courses in Mathematics – CRM Barcelona

The aim of this text is to treat selected topics of the subject of contemporary cryptology, structured in five quite independent but related themes: Efficient distributed computation modulo a shared secret, multiparty computation, modern cryptography, provable security for public key schemes, and efficient and secure public-key cryptosystems.
The aim of this text is to treat selected topics of the subject of contemporary cryptology, structured in five quite independent but related themes.



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The Mathematics of the Bose Gas and its Condensation

2005. 216 pages. Softcover
€ 32.– / CHF 52.–
ISBN 3-7643-7336-9
OWS – Oberwolfach Seminars 34

This book contains a unique survey of the mathematically rigorous results about the quantum-mechanical many-body problem that have been obtained by the authors in the past seven years. It addresses a topic that is not only rich mathematically, using a large variety of techniques in mathematical analysis. The book provides a pedagogical entry into an active area of ongoing research for both graduate students and researchers. The book also provides a coherent summary of the field and a reference for mathematicians and physicists active in research on quantum mechanics.

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