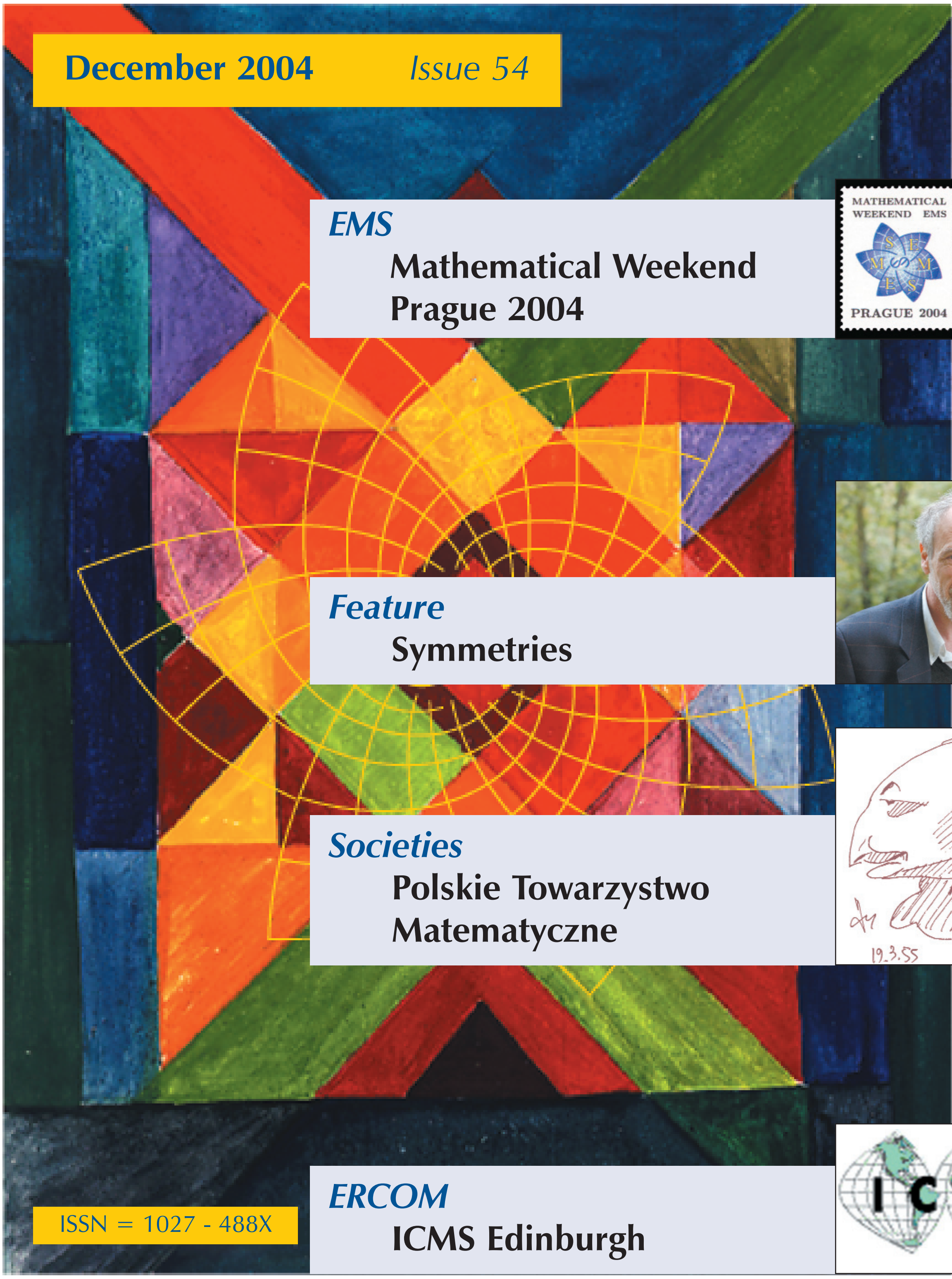
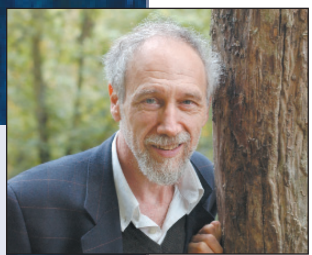
European Mathematical Society

December 2004 *Issue 54*

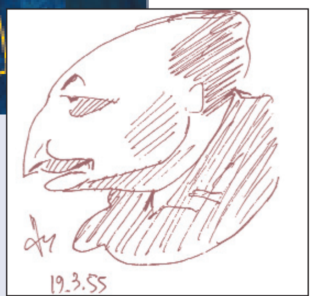


EMS
Mathematical Weekend Prague 2004

Feature
Symmetries



Societies
Polskie Towarzystwo Matematyczne



ERCOM
ICMS Edinburgh

ISSN = 1027 - 488X

NEWSLETTER

EUROPEAN MATHEMATICAL SOCIETY

NEWSLETTER No. 54

December 2004

Printed by Armstrong Press Limited
Crosshouse Road, Southampton, Hampshire SO14 5GZ, UK
telephone: (+44) 23 8033 3132 fax: (+44) 23 8033 3134
e-mail: info@armstrongpress.com

Published by European Mathematical Society
ISSN 1027 - 488X

The views expressed in this Newsletter are those of the authors and do not necessarily represent those of the EMS or the Editorial team.

NOTICE FOR MATHEMATICAL SOCIETIES

Labels for the next issue will be prepared during the second half of February 2005. Please send your updated lists before then to Ms Tuulikki Mäkeläinen, Department of Mathematics and Statistics, P.O. Box 68 (Gustav Hällströmintie 2B), FI-00014 University of Helsinki, Finland; e-mail: tuulikki.makelainen@helsinki.fi

INSTITUTIONAL SUBSCRIPTIONS FOR THE EMS NEWSLETTER

Institutes and libraries can order the EMS Newsletter by mail from the EMS Secretariat, Department of Mathematics and Statistics, P.O. Box 68 (Gustav Hällströmintie 2B), FI-00014 University of Helsinki, Finland, or by e-mail: (tuulikki.makelainen@helsinki.fi). Please include the name and full address (with postal code), telephone and fax number (with country code) and e-mail address. The annual subscription fee (including mailing) is 80 euros; an invoice will be sent with a sample copy of the Newsletter.

EMS Committee

EXECUTIVE COMMITTEE
PRESIDENT
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
Prof. LUC LEMAIRE (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. BODIL BRANNER (2001–04)
Department of Mathematics
Technical University of Denmark
Building 303
DK-2800 Kgs. Lyngby, Denmark
e-mail: b.branner@mat.dtu.dk

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
P.O. Box 4, FIN-00014
University of Helsinki, Finland
e-mail: olli.martio@helsinki.fi

ORDINARY MEMBERS
Prof. VICTOR BUCHSTABER (2001–04)
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
75252 Paris Cedex 05, France
e-mail: cioran@ann.jussieu.fr
Prof. PAVEL EXNER (2003-06)
Department of Theoretical Physics, NPI
Academy of Sciences
25068 Rez – Prague, Czech Republic
e-mail: exner@ujf.cas.cz
Prof. MARTA SANZ-SOLÉ (2001-04)
Facultat de Matematiques
Universitat de Barcelona
Gran Via 585
E-08007 Barcelona, Spain
e-mail: sanz@cerber.mat.ub.es
Prof. MINA TEICHER (2001–04)
Department of Mathematics and
Computer Science
Bar-Ilan University
Ramat-Gan 52900, Israel
e-mail: teicher@macs.biu.ac.il

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 Agenda

2005

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

19-27 February
EMS Summer School at Eilat (Israel)
Applications to Geometry, Cryptography and Computation.
Web site: http://www.cs.biu.ac.il/~eni/ann1-2005.html

16-17 April
EMS Executive Committee meeting, at the invitation of the Unione Matematica Italiana, in Capri (Italy)
Contact: Helge Holden: holden@math.ntnu.no

25 June – 2 July
EMS Summer School at Pontignano (Italy)
Subdivision schemes in geometric modelling, theory and applications

17-23 July
EMS Summer School and European young statisticians' training camp at Oslo (Norway)

11 - 18 September
EMS Summer School and Séminaire Européen de Statistique at Warwick (UK)
Statistics in Genetics and Molecular Biology
Web site: http://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: http://www.crm.es/RecentTrends/

16-18 September
EMS-SCM Joint Mathematical Weekend at Barcelona (Catalunya, Spain)

18-19 September
EMS Executive Committee meeting at Barcelona

12-16 December
EMS-SIAM-UMALCA joint meeting in applied mathematics
Venue: the CMM (Centre for Mathematical Modelling), Santiago de Chile

2006

3-7 July (to be confirmed)
Applied Mathematics and Applications of Mathematics 2006 at Torino(Italy)

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

2007

16-20 July
6th International Congress on Industrial and Applied Mathematics (iciam 07) at Zürich (Switzerland)
Web site: http://www.iciam07.ch/

2008

14-18 July
5th European Mathematical Congress at Amsterdam (The Netherlands)
Web site: http://www.5ecm.nl

Cost of advertisements and inserts in the EMS Newsletter, 2004

(all prices in British pounds)

Advertisements
Commercial rates: Full page: £230; half-page: £120; quarter-page: £74
Academic rates: Full page: £120; half-page: £74; quarter-page: £44
Intermediate rates: Full page: £176; half-page: £98; quarter-page: £59

Inserts
Postage cost: £14 per gram *plus* **Insertion cost:** £58 (e.g. a leaflet weighing 8.0 grams will cost 8x£14+£58 = £170) (weight to nearest 0.1 gram)

Editorial

Towards a European Research Council (ERC)

Luc Lemaire (EMS Vice-President, Bruxelles)

The project of giving the responsibility of distributing research grants to a European Research Council (ERC) is currently the subject of intense discussions in scientific and political circles in Europe. The EMS supports this project, and encourages all its members to promote it at political and scientific levels in their countries.

Briefly put, the ERC would be both an advisory council and a funding agency at the European level, with the specific aim of developing fundamental research in all disciplines.

A two-year history

The idea of an ERC, catering for fundamental research in Europe, was officially launched at an international conference in Copenhagen in October 2002, during the Danish EU presidency. An expert group was created by the Danish Minister for Science, Technology and Innovation, Helge Sander, under the leadership of Federico Mayor, and the group made explicit proposals in December 2003.

Meanwhile, thanks to the role taken by the European Life Science Forum (ELSF) and other organisations of life scientists and to the unbounded energy of Luc Van Dyck, the scientific community caught on to the idea and formed an informal platform of discussion, the Initiative for Science in Europe (ISE), and had further debates on the aims and the means of such a structure. They quickly had the idea to expand their vision to all sciences, including social sciences and humanities, and naturally mathematics.

At the time, the idea was wild: the European Union's activities were limited to research applicable to industrial development, with a component of training through the Marie Curie actions, and it was believed that the EU could not do anything else without violating the subsidiarity principle, implying that basic research should remain national. However, at a meeting in Dublin in October 2003, Achilleas Mitsos, Director General with the EC Directorate General (DG) Research, announced that the Commission supported the idea of an instrument for basic research and, for this purpose, would request a specific credit line from the EU budget.

The question of budget is of course a major problem, even though the EU member states committed themselves to reach the Barcelona objective (3% of the National Product to be invested in research - 1% public and 2% private funding) by 2010. However, if in 2002 all states agreed to have a much increased research budget by 2010, most decreased theirs within a few months!

Still, rowing against many currents, the group pursued its effort in favour of establishing an ERC, with the effect that it now appears as a real and solid perspective.

Clearly, the European Commissioner for Research, Philippe Busquin, has played an important role in this process by introducing the idea of a European Research Area and promoting it vigorously inside the EU. Under his guidance, the Commission made the explicit request that for the next financial period starting in 2007, the budget of research handled by the EC should be doubled. The budget of the Framework Programme (around four billion euros per year) would thus be supplemented by an equivalent budget, a large part of which would be attributed to the ERC.

At this stage, the research ministers of Europe support the project, but the finance ministers will have to include it in their global perspectives.

Basic principles

For the time being there is reasonable agreement (at all levels) on the principles to be implemented in the ERC.

The ERC would be in charge of basic, fundamental, scientist-driven research. Indeed, it is (finally!) admitted that this type of research is a necessary investment with a long-term perspective that also has to be supported at the European level.

Researchers would apply for grants from the ERC, and the selection would be based only on scientific quality, by a rigorous peer review process.

There would be no notion of "juste retour" for the states funding the ERC through their EU contributions, and no criteria other than the scientific excellence, which in itself provides the added value for Europe.

A scientific council would be appointed, and be put in charge of managing the ERC without political interference, for instance on the choice of subjects.

The ERC should be funded thanks to the increase in the part of the EU budget going to research, and absolutely not by diminishing the corresponding amounts from those of the national research agencies.

The budget should be commensurate with the ambitions of the project. Current discussions (but not by those who will have to find the money!) mention amounts between one and four billion euros per year.

A serious problem is the risk of oversubscription. In the EU Framework Programmes, the rate of success of applications is sometimes down to 5%, which leads to the discouragement of the best scientists. The scientific council of a future ERC will have to handle this problem, but avoid artificial rules resulting in the exclusion of some proposals. It may think of putting a limit to the size, rotating subjects or using other means - but overcoming this difficulty without perverting the project will be necessary.

EMS and ISE

The ISE started informally with a dozen European associations. On October 25th 2004, alongside a meeting held in Paris, it was more officially created, and the EMS is one of its members. In fact, it is the only body representing mathematicians in this structure.

The ISE was created around the idea of supporting the ERC and will continue monitoring this initiative. It will also act as a reflection platform for the development of science in Europe in the future.

Its web site is http://www.initiative-science-europe.org

What you can do?

Right now we are in a position of great uncertainty. The idea of an ERC has moved from nothing to a fully-fledged project, with backing from the European Commission and (probably) the Council of European Ministers. However, whether the necessary budget will be made available is doubtful. A strong political argument has to be developed by scientists, in particular in the larger states of the EU, which at this stage do not approve of the idea of increasing the EU budget, thereby preventing the doubling of the research budget. The next few months will be crucial, and a determined action is required in the member states whenever an opportunity arises.

The idea that basic research is key to the future success of Europe is now better acknowledged, but further efforts are needed to convince the larger states that part of the scientific activities are better handled at a European level, and that a financial effort to make this possible at the right level must be made now. It is almost sure that the European Parliament will have a say in the process, and at this moment very few of the members have formed an idea on the project. It may be a good time to approach them, and discuss this issue with them. This could be a good starting point for further contacts since, as mathematicians, we could make our case in the context of a comprehensive project where all sciences are involved, but nevertheless of prominent significance for us, in view of the almost evanescent support now available for mathematicians in the Framework Programme.

References

More information on the project and its evolution can be found in the ELSF brochure http://www.elsf.org/elsfbrochures/elsferc03.pdf, and the site http://www.elsf.org/elsfercc.html provides access to a large collection of documents.

A letter of support for the ERC plan, signed by representatives of 52 associations, was published in August in Science, see http://www.initiative-science-europe.org/forms_maps/Science.pdf

A web search on ERC and ISE will show that the debate on ERC is developing, and that the advisory board of the Commission (EURAB) is very much in favour of the project, but sadly that some scientific bodies in large member states refuse to give up some of their national power.

New members of the EMS executive committee

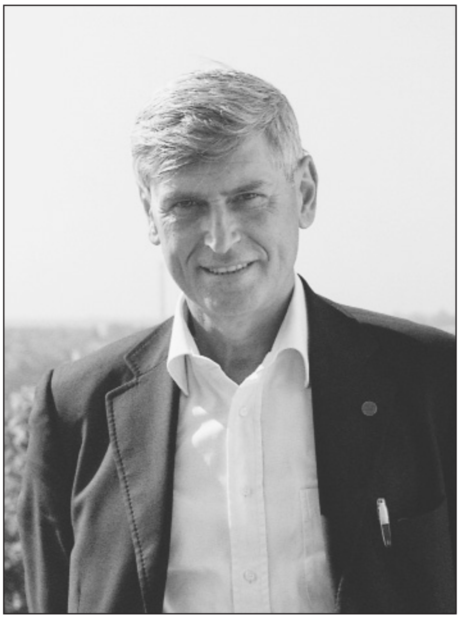
-At its meeting in Uppsala (Sweden) in June this year, EMS council elected three new members to the societies executive committee for a four-year period beginning in January 2005. Victor Buchstaber (Newsletter 38) was reelected. Thanks were given to Bodil Branner, Marta Sanz-Solé and Mina Teicher who leave the committee after several years of service.

Olga Gil Medrano received a Doctorado from the Universitat de Valéncia in 1982 and a Doctorate from the Université de Paris VI in 1985. She has been associate professor at the Universitat de Valéncia since 1986.

Her research interests lie in differential geometry and global analysis (in particular, variational problems on Riemannian manifolds). She has visited several universities, while working in cooperation with colleagues from Austria, Belgium, Brazil and France.

Olga has been a member of the Executive Committee of the Real Sociedad Matemática Española (Royal Spanish Mathematical Society, RSME) during the last four years, and she is now one of the vice-presidents. Amongst other things, she has been the Editor-in-Chief of the newsletter of the RSME from its beginning.

Carlo Sbordone was born in 1948 in Naples, Italy. He was a visiting researcher in the Scuola Normale Superiore of Pisa for two years, working with Ennio De Giorgi. He has also been a visiting professor at the University of Marlyland, University of Syracuse, University of Paris VI and the University of Umea. He became a full professor at the University of Naples in 1980.



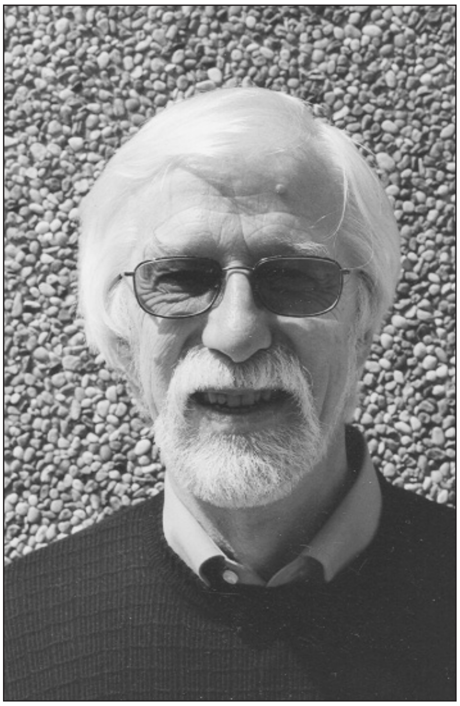
His research interests include: homogenization of linear and nonlinear partial differential operators, relaxation of integral functionals of calculus of variations, existence and regularity theory for solutions of variational problems, reverse Holder inequalities, weak minima of variational integrals, regularity theory of Jacobians and quasiconformal mappings.

He has organized several conferences in Italy and France, and he is a member of the editorial board of various journals including "Annali di Matematica", "Rendiconti dell' Accademia Nazionale dei Lincei", "Ricerche di Matematica" and "Bollettino dell'Unione Matematica Italiana", which he currently edits.

Carlo is a Fellow of the Accademia Nazionale dei Lincei, Vice-President of the Accademia Pontaniana and Secretary of the Società Nazionale di Scienze Lettere e Arti in Naples. He is the President of the Unione Matematica Italiana and a member of the Technical Secretariat of the Italian Minister of Education, University and Research. He is also a member of the Italian Committee for the OECD-PISA (Programme for International Student Assessment).

In his opinion the EMS has a very important role in promoting mathematical research and supporting the European mathematical community. The EMS also gives considerable attention to increasing the level of understanding by the public of the nature and importance of mathematics. The decline in the number of mathematics students in some European countries is one of his main concerns. He believes we need to continue and expand our efforts to attract good students into our subjects by diversifying graduate programs and promoting excellence in the teaching of mathematics. His main hobby is singing Neapolitan songs.

Klaus Schmidt received a PhD from the University of Vienna in 1968. In 1969 he went to Great Britain, first as a one-year post-doc at the University of Manchester, then as a lecturer at Bedford College, University of London, and in 1973/1974 he joined Warwick University, where he was promoted to professor in 1983. In 1994, he returned to the University of Vienna.



Klaus Schmidt's research is mainly in the area of ergodic theory and its connections with other branches of mathematics (like operator algebras and arithmetic). In 1993, he was awarded the Ferran Sunyer i Balaguer Prize for the monograph 'Dynamical Systems of Algebraic Origin'. He became a full member of the Austrian Academy of Science in 1997.

From 1995 - 2003 he was one of the two Scientific Directors of the Erwin Schrödinger International Institute for Mathematical Physics (ESI), Vienna, Austria, and he is now President of the ESI.

2nd Joint Mathematical Weekend

Prague, September 3-5, 2004

Jan Kratochvíl, Jiří Rákosník (Prague)

The framework

In order to support the growing sense of European identity that follows the political changes in Europe, the European Mathematical Society organizes many regular events, the European Mathematical Congresses being the largest and most important. To maintain more frequent contact with national societies and to help promote the ideas of cross-European collaboration, the EMS has launched a new series of annual meetings called the Joint Mathematical Weekends. The three-day meetings are financially supported by the EMS, under the requirement that the organizing national society arranges additional funds so that a large number of local, as well as other European mathematicians, may participate without paying an expensive conference fee. The meeting consists of several parallel minisymposia whose topics are chosen to represent the strongest areas of the organizing society. Each minisymposium is coordinated by a local expert who chooses one plenary speaker to represent the area and to give a general lecture introducing the subject to all participants of the conference. Together they select several leading European experts in the area as further invited speakers. Contributed talks are also accepted as the time schedule allows. The first meeting of this type was organized by the Portuguese Mathematical Society in Lisbon in September 2003.

The genius loci

The 2004 Joint Mathematical Weekend was organized by the Czech Mathematical Society in Prague, with further financial and logistic help from the Faculty of Mathematics and Physics of the Charles University in Prague and from the Czech national research centre Institute for Theoretical Computer Science (ITI), which is a platform for the cooperation of research teams from several institutions. The meeting took place in a faculty building at the Lesser Town Square in the close vicinity of Prague Castle, the Charles Bridge, the Astronomical Clock and other celebrated historical monuments. The participants enjoyed the beautiful atmosphere of the historical building, a former Jesuit seminar, blending with all the advantages of modern technology. A short explanation about its history was given by Ivan Netuka, the dean of the faculty, in his welcoming speech. The participants admired the skills the architects had performed during the recent renovation works, allowing the School of Computer Science to fit so well in a building with old stone doorframes and ceilings decorated with 300-year-old frescos.

The mathematical weekend (almost) got its own stamps!

Minisymposia and plenary lectures

The meeting itself was opened by Jan Kratochvíl, the president of the Czech Mathematical Society. The European Mathematical Society was represented by the welcoming address of Luc Lemaire, a vice-president of the EMS. The Friday afternoon programme started with the plenary lecture “Some recent applications of the classification of finite simple groups” by Jan Saxl from the University of Cambridge. His plenary talk introduced the minisymposium “**Discrete Mathematics and Combinatorics**”, organized by Jaroslav Nešetřil from Charles University in Prague and director of ITI. As the title of the talk suggests, it presented interactions of algebra and combinatorics, presenting applications in various areas of graph theory and discrete mathematics. In the programme of the following days, the invited speakers in this minisymposium were Peter Cameron (University of London), Gábor Tardos (Alfréd Rényi Institute of Mathematics, Budapest), Oriol Serra (Universitat Politècnica de Catalunya, Barcelona) and Patrice Ossona de Mendez (CNRS, Paris). Five contributed talks were also included.

The minisymposium “**Mathematical Fluid Mechanics**” was coordinated by Eduard Feireisl from the Mathematical Institute of the Academy of Science of the Czech Republic in Prague. Since his plenary speaker, H. Beirao da Veiga (Università di Pisa), could not attend the meeting due to an injury, E. Feireisl himself presented this minisymposium’s plenary talk “On the mathematical theory of viscous compressible fluids” on Saturday morning. He introduced the audience to methods used for modelling dynamical aspects of liquid and gas media. Invited speakers in this minisymposium were Josef Málek (Charles University, Prague), Victor Starovoitov (CAESAR, Bonn), Marius Tucsnak (Université Nancy), and Antonín Novotný (Université du Sud Toulon-Var). Moreover, there were three more contributed talks.

Mathematical models of the real world

were also the subject of the Saturday afternoon plenary talk “Probabilistic and variational methods in problems of phase coexistence”, given by Errico Presutti from Universita degli Studi di Roma Tor Vergata. This talk introduced the minisymposium “**Mathematical Statistical Physics**”, coordinated by Roman Kotecký from Charles University in Prague. The pattern of this minisymposium differed slightly from the other three. It had only three invited speakers Marek Biskup (University of California, Los Angeles), Dmitry Ioffe (Technion University, Haifa), and Kostya Khanin (Isaac Newton Institute, Cambridge), but the modus operandi hinged on informal discussions following each of the invited talks.

The last plenary talk “Some current trends in proof complexity” was given on Sunday morning by Alexander Razborov from Steklov Mathematical Institute in Moscow and the Institute for Advanced Studies in Princeton. This talk belonged to the minisymposium “**Complexity of Computations and Proofs**”, organized by Jan Krajíček from the Mathematical Institute of the Academy of Science of the Czech Republic in Prague. The audience was entertained not only by his very colourful presentation of methods and reasoning in contemporary theoretical computer science, but also by a malicious coincidence that some software-hardware communication problems delayed the beginning of this very computer science oriented talk. The invited talks of this minisymposium were given by Peter Buergisser (Universität Paderborn), Oleg Verbitsky (Lviv University), Peter Bro Miltersen (University of Aarhus), Albert Atserias (Universitat Politecnica de Catalunya, Barcelona), Stefan Dantchev (University of Leicester), and Pavel Pudlák (Mathematical Institute AS CR, Prague) and further six contributed talks were included.

After the last plenary session, Sir John Kingman, the president of the EMS, officially addressed all participants. He appreciated the importance and significance of this new series of meetings, emphasized the role of the EMS, invited the participants to join the society, and thanked the Czech Mathematical Society for hosting the Weekend.

Conference banquet and photo

On Saturday evening all participants were invited to a conference banquet in the basement of the building, to experience rooms that during the academic year serve as a cafeteria at lunch time and as the faculty club in the afternoons. The pleasant atmosphere was enhanced by toasts of Jaroslav Nešetřil, Bodil Branner and David Salinger, and later also by live music performed by some participants and organizers of the meeting.

Earlier that day the official conference photo was taken during the lunch break from the windows of the conference building. The participants were lined up in front of a historical plague column, one of the baroque sculpture jewels in Prague.

Additional meetings

Three important work meetings took place behind the scene at the weekend. The Czech Mathematical Society made use of this opportunity and called its general assembly meeting for Friday evening. One of the main agenda items was the change of name for the society. For almost one and a half centuries mathematicians and physicists of this region have been organized in the Union of Czech Mathematicians and Physicists, and they have always enjoyed this coexistence and cooperation of closely related sciences. Within the Union, they are grouped in professional units, one of them having been called the Mathematics Research Section since its foundation in 1970's. This name reflected the era of mainly Eastbound oriented international links, governed by the political situation in Europe in the second half of the 20th century, and always required tedious explanations to foreign colleagues. Therefore the name "Czech Mathematical Society" has been frequently, informally and somewhat illegally used in foreign correspondence in the last years. Now, after rigorous voting during the general assembly meeting, this name has become official and legal (with its Czech equivalent Česká matematická společnost). This does not, however, change the fact that we are still organized within the frames of the Union together with our sister Czech Physical Society. The first formal act accomplished under the new name of the Czech Mathematical Society was signing the agreement of collaboration and reciprocal membership with the Catalan Mathematical Society during the EMS weekend banquet, an act which fitted well the spirit of the EMS activities and of the Joint Weekend in particular. (The next agreement on cooperation was signed with the Royal Spanish Mathematical Society shortly after the Weekend.)

The other event associated with the Weekend, the meeting of the EMS Executive Committee, was perhaps less ceremonial but more busy. Most members of the Committee enjoyed the mathematical programme of the entire weekend, while their working meeting was scheduled on Sunday afternoon and Monday morning in hotel Vaníček. In recognition of the importance of the EMS, a festive dinner was given for the Executive Committee members by the president of the Academy of Sciences of the Czech Republic Helena Illnerová, the president of the Czech Mathematical Society Jan Kratochvíl, the dean of the Faculty of Mathematics and Physics of the Charles University Ivan Netuka and the director of the Mathematical Institute AS CR Antonín Sochor.

Finally, there was a meeting of the Czech National Committee for Mathematics - the body consisting of leading Czech mathematicians, established under the auspices of the Academy of Sciences of the Czech Republic to deal with basic conceptual and organizational questions of mathematical sciences in the country and to represent the Czech mathematical community in the IMU. One of the main topics was to discuss the somewhat dangerous features of a new evaluation system for the R&D being prepared by the government.

We can proudly admit that the organizing team, Jan Kratochvíl, Jiří Rákosník, Jiří Fiala, Daniel Hlubinka and Pavel Exner (the Czech Mathematical Society), Anna Kotěšovcová (Conforg Agency), Hana Polišenská (secretary of the ITI) and Jaroslav Nešetřil, Eduard Feireisl, Roman Kotecký and Jan Krajíček (the minisymposia coordinators), did a good job and prepared pleasant and friendly working conditions for the participants. As Luc Lemaire mentioned in his welcoming speech, one meeting does not make a series, two meetings in a row do. We in the Czech Mathematical Society feel honoured by the commission to organize the second joint weekend and proud of being present at the birth of a new tradition of what we all believe will prove to become a useful and important series of meetings of European mathematicians.

Jan Kratochvil [honza@kam.mmf.cuni. cz], born in 1959, did his Ph. D. in discrete mathematics at Charles University in Prague. Since 1994, he has been at the Department of Applied Mathematics of this university, and since 2003 he is the head of the department and a full professor. He has also lectured several times as a visiting professor at Computer and Information Science Department of the University of Oregon in Eugene, OR. His main research interests are graph theory and computational complexity. He is currently president of the Czech Mathematical Society.

Jiří Rákosník [rakosnik@math.cas.cz], born in 1950, graduated in mathematical analysis from Charles University in Prague. His research interest concentrates on theory of function spaces and theory of integral and differential operators. He is associated to the Mathematical Institute of the Academy of Sciences of the Czech Republic. Since 2001, he is also a member of the Academy Council of the AS CR, responsible for economic and financial matters of the Academy and for cooperation of the Academy in preparing legislation concerning research and development. He heads the Czech Editorial Unit of Zentralblatt MATH.

EMS executive committee meeting at Prague

David Salinger, EMS Publicity Officer

Meetings of the Executive would look dull to a traditional newspaper. No punch-ups, a calm business-like atmosphere predominates, but underlying it all is a sense that the committee is working for the good of mathematics and mathematicians. It was a particular pleasure to welcome future members, Olga Gil-Medrano and Carlo Sbordone, to the Prague meeting.

Mathematics and the EU

Certain issues come round each time. It is not just a routine complaint to observe that mathematics is under-represented on influential EU committees: members of the executive committee also do something about it, from lobbying ministers to sitting on extra committees, and generally, grabbing opportunities to do things whenever they arise. At Prague, Luc Lemaire was able to report on the panel session organised by the EMS and on his plenary lecture to the EuroScience Open Forum in Stockholm. Some good contacts were made, but attendance at sessions was poor. The Executive Committee resolved to encourage local mathematicians to get involved, when the Forum, now intended to be a two-yearly event, came their way.

Recognising the importance of contacts with the EU and the burden it placed on those members who were involved, the Executive Committee resolved to broaden the Group on Relations with Europe to the whole Executive Committee and to welcome the help of others who were prepared to lobby for mathematics in Brussels.

Membership and Representation

Individual membership remains stubbornly on a plateau of about 2,300, but institutional and corporate membership has grown. Nearly all the mathematical institutes which are ERCOM members have now joined. Statistical Societies have begun to join the Society, too and our Summer School programme includes events involving the Bernoulli Society. The EMS, naturally, believes that it's to the advantage of mathematics to have one society representing it at the European level and is working hard to include all strands of mathematics, including particularly applied mathematics and statistics, in its work (and in the committee membership). It has decided that, as applied mathematics is central to the Society's work, responsibility should no longer be devolved to a subcommittee, but should rest with the Executive Committee itself. A new committee will, however, be set up to look at applications of mathematics.

Meetings

The next 'mathematical weekend' will be in Barcelona in September 2005, jointly organised by the Catalan Mathematical Society and the EMS. In 2006 there will be a conference organised by the EMS and the French and Italian mathematical societies in Turin. We shall submit an application for further Summer Schools to the EU and have already advertised a call for proposals from members.

4ecm had been a high quality meeting, but had attracted rather too few participants. There was general satisfaction with the selection of EMS prize-winners, but some regret that it had proved impossible to award a Felix Klein Prize.

Subcommittees

Mina Teicher would become chair of the Education Committee. She submitted a list of suggested members and an outline plan of action. The committee on special events would be abandoned and its work taken over by the General Meetings Committee, which would lose the word 'general' from its name. Andrzej Pelczar was stepping down from the Committee on Eastern European mathematicians after many years of service to the Society. Jan Kratochvíl of the Czech Mathematical Society would take over the chair. The work of the Committee would take account of changing circumstances in Eastern Europe. Pavel Exner would become chair of the Committee on Electronic Publications: it was felt that an Executive member should take on that role because of the growing importance of the committee's remit and, in particular, because it oversees the Electronic Library on EMIS.

The Publications Committee was disbanded: the Executive itself would take on the task of dealing with issues concerning the Publishing House. It agreed to transfer the publication of the Newsletter from the Society to the Publishing House, as part of the task of persuading other mathematicians to publish with EMSph.

Closing Matters

Our stay in Prague had been most enjoyable, thanks in no small part to Pavel Exner and the Czech Mathematical Society, who had organised an exemplary Mathematical Weekend beforehand. The President also thanked the retiring members of the Committee: Bodil Branner, Marta Sanz-Solé and Mina Teicher. The next meeting would be in Capri (Italy) in April at the invitation of the Unione Matematica Italiana.

The new library of the Faculty of Mathematics and Physics,

Charles University in Prague

Ivan Netuka and Vladimir Souček (Prague)

The August floods in 2002 dramatically affected the mathematical and information science's part of the library that is situated in the Faculty's building in Karlin. The water reached a height of 2.90 meters above pavement level. 13000 books, 468 titles of journals, 6800 textbooks and 2000 diploma theses were damaged (see the information in EMS Newsletter, Issues 45 and 49).

In the period after the floods we received great support from foreign and home organizations, institutions, societies, universities and individual donors. Financial donations reached almost 104,000 euros. The principal financial support was provided by The Ministry of Education, Youth and Sports, and Charles University. In addition, the Faculty received 5907 books and 156 journal titles from 165 donors. The donors that were identified were being sent letters of thanks. Two press conferences were held on the occasion of the presentation of a large collection of books and journals from French and German mathematicians.

The mathematical library after the floods

... and after reconstruction

In September 2004, the construction of the new library was finished. After the previous unfortunate experience, it was decided to situate it on the first floor. The library has just been opened for the beginning of the academic year 2004/2005.

The Faculty of Mathematics and Physics would like to thank all the people and institutions that contributed to the renewal of the library with their understanding and help.

EUROPEAN MATHEMATICAL SOCIETY ARTICLE COMPETITIONS

The Committee for Raising Public Awareness of Mathematics of the European Mathematical Society (acronym RPA) believes that it is of vital importance for the recognition of mathematics in society that articles popularising mathematics are written. The experience gained from the first article competition organized by the RPA-committee of the EMS, completed in 2003, show that it is beneficial to distinguish between articles addressing the educated layman and articles addressing a general audience; see http://www.mat.dtu. dk/people/V.L.Hansen/rpa/resultartcomp. html. Therefore the EMS now wishes to encourage the submission of articles on mathematics to two competitions, one for articles for the educated layman and one for articles for a general audience. It is hoped that valuable contributions will be collected, which deserve translation into many languages. The EMS is convinced that such articles will contribute to raising public awareness of mathematics.

The RPA-committee of the EMS invites professional mathematicians, or others, to submit manuscripts for suitable articles on mathematics for one of two competitions.

Articles for the educated layman

To be considered an article must be published, or be about to be published, in an international magazine or a specialized national magazine, bringing articles on mathematics to an educated public. Articles for the competition shall be submitted both in the original language (the published version) and preferably also in an English translation. Articles (translations) may also be submitted in French, German, Italian or Spanish. The English (or alternative language) version should be submitted both electronically and in paper form.

Deadline for submission to this competition: August 1, 2005.

Articles for the general public

To be considered an article must be published, or be about to be published, in a daily newspaper or some other widely read general magazine, thereby providing some evidence that the article does catch the interest of a general audience. Articles for the competition shall be submitted both in the original language (the published version) and preferably also in an English translation. Articles (translations) may also be submitted in French, German, Italian or Spanish. The English (or alternative language) version should be submitted both electronically and in paper form.

Deadline for submission to this competition: January 1, 2006.

Prizes and conditions for submissions

For each of the two competitions there will be prizes for the three best articles, to the sum of 200, 150 and 100 Euros respectively, and many of the winning articles will be published in the Newsletter of the EMS. Other articles from the competition may also be published if space permits.

By submitting an article for one of the competitions it is assumed that the author gives permission for the translation of the article into other languages and for its possible inclusion on a web site. Translations into other languages will be checked by persons appointed by relevant local mathematical societies and will be included on the web site.

Articles should clearly indicate to which one of the two competitions the article is being submitted and should be sent before the given deadlines to the chairman of the RPA-committee of the EMS:

Professor Vagn Lundsgaard Hansen,
Department of Mathematics,
Technical University of Denmark,
Matematiktorvet, Building 303,
DK-2800 Kongens Lyngby, Denmark.
e-mail: V.L.Hansen@mat.dtu.dk

Applied Mathematics and Applications of Mathematics

(AMAM, Nice, February 10-15, 2003)

In order to increase the place of Applied Mathematics in the EMS, its Council proposed to organize a conference on this subject, jointly with the French mathematical societies SMF and SMAI. This conference *Applied Mathematics and Applications of Mathematics* took place in February 2003 in Nice at the Palais des Congrès. The co-presidents of AMAM 2003 were Rolf Jeltsch (EMS), Michel Théra (SMAI) and Michel Waldschmidt (SMF). The Scientific Committee was co-chaired by Pierre Louis Lions (France) and Sergey Novikov (Russia), both Fields medalists. The Organizing Committee was co-chaired by Doina Cioranescu (SMAI) and Mireille Martin-Deschamps (SMF).

The Scientific Committee established the following list of topics:

1) Applications of number theory, including cryptography and coding.
2) Control theory, optimization, operations research and system theory.
3) Applications of mathematics in biology, including genomics, medical imaging, models in immunology, modeling and simulation of biological systems.
4) Scientific computation, including ab initio computation and molecular dynamics.
5) Meteorology and climate, including global change.
6) Financial engineering.
7) Signal and image processing.
8) Nonlinear dynamics.
9) Probability and statistics, inverse problems, fluid dynamics, material sciences and other applications.

The conference consisted of 9 plenary speakers, 38 mini-symposia, two round tables (Mathematics in developing countries, and Education) and two poster sessions (with 92 presentations). More than 500 mathematicians from 25 countries took part into the conference. Almost 20% of the total budget was dedicated to 30 grants which supported the participation of young researchers, students or mathematicians from East European countries, Asia and Africa.

The conference showed the unity of mathematics and their role in various fields of science and technology. It also emphasized the interest of the EMS in promoting Applied Mathematics in the community of mathematicians in general. It should be mentioned that more and more women are now choosing scientific careers. Among the participants, 27 % were women. The conference also exposed to young European students, various topics in mathematics.

In conclusion, AMAM 2003 reinforced the links between Pure and Applied Mathematics and presented new challenges and issues for mathematicians, arising from varied areas of science and technology. It also showed the unity of mathematics and their role within the modern world. (*taken from the report to the EMS Council on* http://www.math.ntnu.no/ems/council 04/uppsalapapers/Report_AMAM_typeset.pdf).

Inaugural Address

Sergey Novikov (University of Maryland, College Park, USA, and Landau Institute for Theoretical Physics, Moscow)

Dear Colleagues,

I apologize that for personal reasons I cannot attend this Conference. However, I would like to say a few words for the Opening Ceremony.

It was a great pleasure for me to work jointly with my co-chair, Professor P.-L. Lions, Scientific Secretary, Professor A. Damlamian and other members of the Committee, in selecting the main speakers. I remember it as a parade, demonstrating a series of great achievements in many different areas of applied mathematics, displaying many beautiful mathematical applications. It covers a broad spectrum of subjects including the practical use of mathematics in business and finance, practical cryptography, and the impressive development of computational and theoretical methods in the natural sciences. Many times I felt sorry that we were restricted in the number of invited talks. I believe we made extremely good choices and left many excellent candidates for future meetings.

The mathematicians who founded the European Mathematical Society over 10 years ago always believed in the unity of mathematics, artificially divided into pure and applied parts. It is the duty of mathematics to support its applied component. I always treated the opposing point of view as something non-serious, a sort of philosophy made from scientific weakness no matter how broad it became distributed.

Our unity is especially important now. Mathematical education has reached a state of terrible crisis in all civilized countries. What is going to happen to the most fundamental exact theoretical sciences of the past century like mathematics and theoretical physics? According to my observations, mathematics has a better chance at survival than theoretical physics, but our unity is necessary for that.

It was already obvious to everybody in the 1990s that biology had become the main candidate for the position of "Miss Science - XXIst Century". Unfortunately, we have also been witnesses to the decay of theoretical physics during the last decade. What does this mean for those of us who have dedicated their scientific activity to the interaction of mathematics with the natural sciences? Of course, we are happy to support all realistic and useful mathematically based investigations made for the needs of biology. Some of them are represented in this conference. No doubt we should help to increase their number.

However, the connection of mathematics and physics was so deep that we should say a few words about today's crisis. In a sense, theoretical physics has always been considered as the mathematics of the real world, a main source of mathematical ideas since the XVII century, the main driving force for the development of 90% of mathematics, and the main road joining mathematics with other natural sciences. In the XXth Century, theoretical physics reached its highest level. It became a leading exact theoretical science. It was era of dinosaurs for physics. Its great leaders were capable of using and sometimes of creating very deep abstract mathematics when it was needed for the study of the real world. New fundamental laws of nature were discovered and they invented great new technology. It changed our world forever.

At the same time, there was a splitting of the communities of physicists and mathematicians. As a corollary, several important mathematical achievements made by physicists (such as quantum field theory, for example) remain, until now, outside the mathematics community. Mathematical education knew nothing about them even in the best times. Its language became incompatible with the mathematical language of physics of the early stages. Pure and applied mathematics have both lost contact with high-level modern physics in the past century. Mathematical language and the technique of theoretical physics were especially designed as the best mathematical tools for the solution of real world problems. In trying to replace them with something absolutely formal and rigorous, you make them useless. Therefore, pure mathematics alone will not be capable of adjusting itself to "physical mathematics".

We see now that the era of dinosaurs is probably over and theoretical physics is going down. Maybe it happened as a consequence of overdevelopment? Is it possible that some unexpected great achievement will return its momentum?

If not, let me ask the following question: Who is going to preserve this great knowledge? Certainly it will remain important for many engineering applications and it would be dangerous for humanity to forget it.

To my opinion, only the joint forces of pure and applied mathematics may help here. I do not know any other part of science capable of preserving this great mathematical knowledge.

I have no doubts that this conference is going to be very successful. I wish you great working days in Nice.

COMMITTE FOR DEVELOPING COUNTRIES: A SUMMARY OF WORK AND PLAN

(Chair: Herbert Fleishner; vice-chair: Tsou Sheung Tsun)

The following is a slightly edited version of a paper presented by Tsou Sheung Tsun to the IMU Developing Countries Strategy Group meeting, 16-17 October 2004, at ICTP, Trieste, Italy.

What are we doing?

We have active individual members working with their own programmes/organizations: CIMPA, ISP, Vietnam, etc. I hesitate to add China, as her status of being a developing country is unsure. We exchange experience and liaise closely.

We have a well-supported book/journal donation scheme, the shipping costs of which are almost entirely funded by ICTP. There is a vast source of books and journals, from retirees and libraries going electronic in the developed world.

We have a good network of distribution centres, particularly in Africa. These are departments or institutes, mostly where there is some personal contact with members of our committee so that we can make sure that the books and journals are used properly, e.g. made available to all mathematicians. If material is donated that a particular centre cannot use, or already have, they promise to send that to nearby institutions.

We have shipped about one and a half tonnes of such material, with a couple of 100kg being processed at the moment.

The recipients where we have contacts are well monitored: sub-Saharan Africa, Zimbabwe, and Vietnam.

Referees' honorarium donation: this is a scheme by which referees donate their honoraria from publishers, usually augmented if exchanged for books. Princeton University Press has donated some. Zentralblatt has donated twice, amounting to some 1500 euros. We have talked with John Ewing of the American Mathematical Society and we are currently devising some variant of the above scheme with him.

A good point about this programme is that the recipient, typically a department with a small active group of researchers, can choose the books they need, even though it is a small number of books.

This could involve the whole mathematical community, and would raise awareness about situations in the developing world.

What do we hope (in the short- and medium-term)?

Expand the book donation scheme: to include more distribution centres, particularly to have a wider geographical spread.

Lecture notes distribution: we have just started this scheme with the help of ICTP. The idea is to make a collection of undergraduate lecture notes and make them available to the developing world, in the form of a CD for example. I have already collected those available from Oxford. We hope to extend this scheme to other languages, e.g. French and Spanish. We shall be looking for good universities in these language groups in the developed world.

Organize short-term placements (say 3 months) for visitors from the developed world to give a lecture course in a developing country. This may interest mathematicians who have recently retired, or fresh PhDs.

Mobilize support for mathematicians in a developing country to attend conferences: I suppose this is done by the IMU-CDE.

Consolidate and expand existing MSc and PhD programmes in countries regularly visited by our members.

Closer liaison with IMU, ICTP, CIMPA, LMS, AMS, IMPA, AIMS, etc.

What do we need?

Continued support from ICTP for the book donation scheme.

Help to start and develop the lecture notes distribution in English, French and Spanish.

Funds for sending lecturers to developing countries for short periods. Subsistence can usually be provided locally.

Conference support for participants from developing countries.

What can we offer?

Good field knowledge and contacts in Africa, South East Asia, and some parts of Latin America, through personal experience and the contacts of our members.

Good network of book distribution, with monitoring.

Enthusiasm and some new ideas.

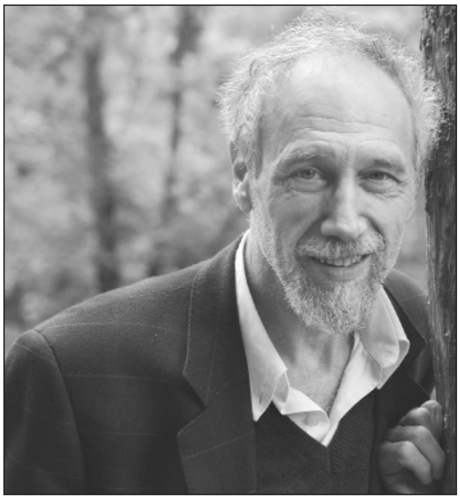
Finally, an appeal

We are in need of funds for our various activities and urge our colleagues in the developed world to help with donations, however small. Donations can be made directly to the EMS-CDC account:

Account number: 157230-381160
Nordea Bank Finland Plc
Swift: NDEAFIHH
IBAN: FI7815723000038116O

Symmetries

Alain Connes (Paris)



This article appeared originially (in French) in the magazine Pour la Science, no. 292, Feb. 2002. *It was submitted to the article competition of the* EMS Raising Public Awareness Comittee *by the journal's director Philippe Boulanger and was given a runner-up award, cf. issue 50 of the Newsletter. The Newsletter thanks Alain Connes and Philippe Boulanger for the permission to republish the article.*

The concept of symmetry goes well beyond that of simple geometric symmetries. From the fair organisation of the final stages of soccer competitions to the solving of equations, via the icosahedral game and Morley's theorem, we'll discover the multiple aspects of this concept.

The purpose of this article is to introduce the reader to the mathematical notion of symmetry, by way of a few illustrative examples.

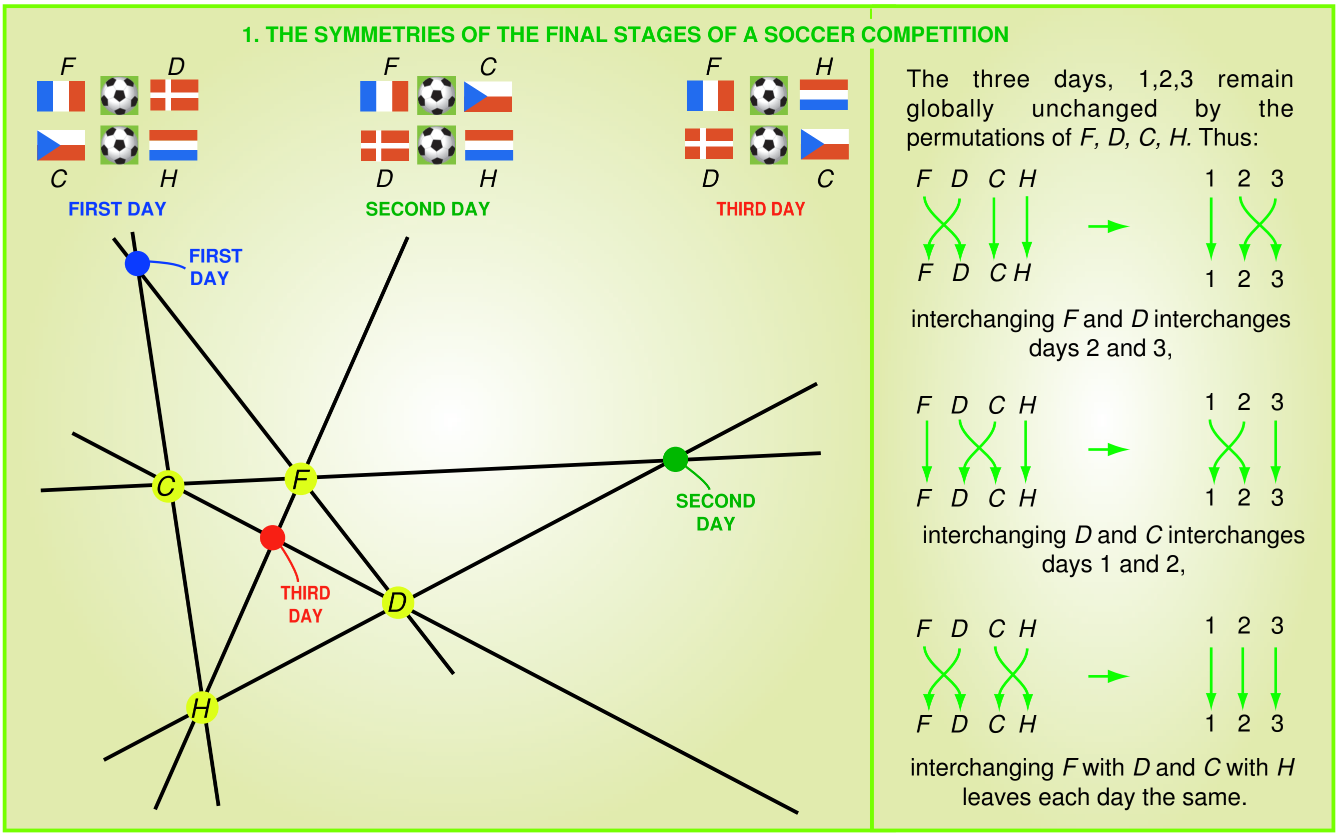
To demonstrate the ubiquity of this concept, as a mathematician understands it, we'll start by evoking the connection between the final stages of soccer competitions and the way we solve quartic equations.

As we move to equations of higher degree, we describe the icosahedral game and the 'icosions', defined in the nineteenth century by the Irish mathematician, William Hamilton.

We finish with a commentary on a theorem in geometry, proved by Frank Morley around 1899, where the symmetry of an equilateral triangle arises miraculously from an arbitrary triangle, by taking the intersection of consecutive 'trisectors' (the two straight lines which divide an angle into three equal parts). In 1988, I gave an algebraic formulation of this result and a proof which we shall see below.

The final stages of a soccer cup

Let's start with the organisation of a soccer competition, for example, the



millennial European Cup. During the final stage, teams were placed in pools of four, and arrived at an order of merit within each pool. For example, one group consisted of Denmark, France, Holland, and the Czech Republic (here abbreviated to *D*, *F*, *H*, and *C*).

To arrive at an order of merit fairly, each team had to play each of the three others, which meant that games had to played on three days. For instance, when *D* and *F* met, then *H* and *C* could meet on the same day and so three days were enough for all possible configurations of matches.

In that European Cup, the matches were, *FD* and *CH* on the first day, *FC* and *DH* on the second, and *FH* and *DC* on the third. Intuitively we can see that this is a fair procedure, because none of the teams has an advantage. One checks indeed that, if we arbitrarily permute certain teams, for instance, if we interchange *D* and *H*, this amounts to a simple permutation of the first and third days.

We can visualise the symmetry which is at work by putting the letters *D*, *F*, *C*, *H* (representing the teams) at four points of the plane. The line joining two points represents a match between the corresponding teams. Each of the three days corresponds to the point of intersection of the lines representing the matches on that day. Thus the matches *FD* and *CH* are associated with the intersection of the lines *FD* and *CH*. Continuing for the two other pairs, the second day is at the intersection of the lines *FC* and *DH* and the third is at the intersection of the lines *FH* and *DC*.

The figure thus constructed, formed by four points and six lines, is called a complete quadrilateral. It is perfectly symmetrical (in an abstract sense, even if none of the usual geometric symmetries – symmetries with respect to a point or a line – are present), because each of the four points *F*, *D*, *C*, and *H* plays exactly the same role as the others, and the same is true for the points of intersection representing the three days.

Having visualised this complete quadrilateral, we can also give an algebraic formulation of the symmetry under discussion. In the following way: the quantity α, determined from the four numbers a, b c and d by the formula $\alpha = ab + cd$ only takes three values altogether when we permute a, b, c and d. The other values are $\beta = ac + bd$ and $\gamma = ad + bc$.

Resolution of quartic equations by radicals

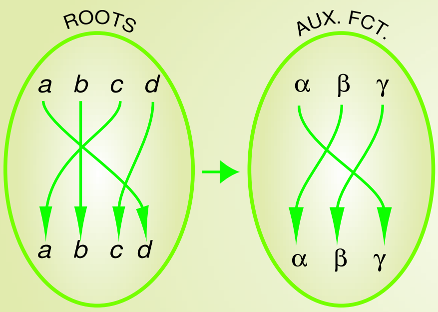
This surprising symmetry underlies the general method for solving quartic equations 'by radicals'. The solution amounts to expressing the zeros a, b, c, and d of the polynomial $x^4 + nx^3 + px^3 + qx + r = (x-a)(x-b)(x-c)(x-d)$ as a function of the coefficients n, p, q, and r using the extraction of roots.

To understand this assertion, we must go back in time and look at the solution of equations of degree lower than four.

Though the technique of solving quadratic equations goes back to furthest antiquity (Babylonians, Egyptians...), it wasn't extended to cubic equations until much later and was published only in 1545 by Girolamo Cardano in Chapters 11 to 23 of his book *Ars magna sive de regulis algebraicis*. In fact, it wasn't realised until the 18th century that the key to the solution by radicals of the cubic equation $x^3 + nx^2 + px + q = 0$, with zeros a, b, and c (the 'roots'), lay in the existence of a polynomial function $f(a, b, c)$ of a, b, and c, which takes only two different values under the action of the six possible permutations of a, b, and c.

2. SYMMETRY AND THE SOLUTION OF CUBIC AND QUARTIC EQUATIONS BY RADICALS

Solving polynomial equations by radicals requires the construction of auxiliary functions of the roots, which display symmetries when the roots are permuted.



The set of these auxiliary functions is globally unchanged by permutations of the roots of the equations. For cubic and quartic equations, the auxiliary functions enable us to reduce the solution to that of a "reduced" equation of lower degree.

1) The cubic equation:

$x^3 + 3px + 2q = (x-a)(x-b)(x-c) = 0.$

Reduced equation: $x^2 + 2qx - p^3 = (x-\alpha)(x-\beta)$.

Three roots:	Two auxiliary functions:	Symmetry:	Solutions:
$a, b, c.$	$\alpha = [(a + bj + cj^2)/3]^3$ $\beta = [(a + bj^2 + cj)/3]^3$ where $j = (-1+i\sqrt{3})/2$, $j^2 = (-1-i\sqrt{3})/2$, with i being a square root of -1, so that $j^3 = 1$ and $j^2 + j + 1 = 0$.	The symmetry given by any permutation of a, b, and c leaves the set of auxiliary functions $\{\alpha,\beta\}$ globally invariant.	Let $u = \sqrt[3]{\alpha}$ and $v = \sqrt[3]{\beta}$ such that $uv = -p$. Then $a = u + v$ $b = j^2u + jv$ $c = ju + j^2v$.

2) The quartic equation:

$x^4 + px^2 + qx + r = (x-a)(x-b)(x-c)(x-d) = 0$

Reduced equation:

$x^3 - px^2 - 4rx + (4pr - q^2) = (x-\alpha)(x-\beta)(x-\gamma) = 0$

Four roots:	Three auxiliary functions:	Symmetry:	Solutions:
a, b, c, d	$\alpha = ab + cd$ $\beta = ac + bd$ $\gamma = ad + bc$	The symmetry given by any permutation of a, b, c, and d leaves the set of auxiliary functions $\{\alpha, \beta, \gamma\}$ globally invariant.	1) Knowing $\alpha = ab+cd$ and $r = (ab)(cd)$, gives the products ab and cd. 2) If $ab \neq cd$, the system $(a+b)+(c+d) = 0$ and $cd(a+b) + ab(c+d) = -q$, gives $a+b$ and $c+d$. 3) Knowing ab and $a+b$ gives a and b. Similarly for c and d.

Cardano's method amounts to writing $\alpha = [(1/3)(a + bj + cj^2)]^3$, where the number j is the first cube root of unity, namely $(-1 + i\sqrt{3})/2$, with i denoting the square root of -1. The cyclic permutation taking a to b, b to c, and c to a simultaneously, clearly leaves α invariant and the only other value obtained from the six possible permutations of a, b and c is $\beta = [1/3(a + cj + bj^2)]^3$, where, for example, b and c have been transposed. As the set consisting of the two numbers α and β is invariant under all the permutations of a, b, and c, it is easy to express the quadratic equation whose roots are α and β, in terms of the coefficients of the initial equation
$x^3 + nx^2 + px + q$: it is $x^2 + 2qx - p^3 = (x + q + s)(x + q - s)$, where s is one of the square roots of $p^3 + q^2$ and where we have also rewritten the initial equation in the equivalent form $x^3 + 3px + 2q$ (without the square term) by an appropriate translation of the roots. We introduced the factors 2 and 3 to simplify the formulas.

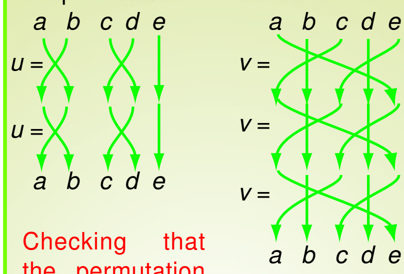
A simple calculation then shows that each of the roots a, b, and c of the initial equation can be expressed as the sum of one of the three cube roots of α and one of the three cube roots of β. These two choices are connected by the fact that their product must equal $-p$ (so there are only three pairs of choices to account for, which is reassuring, instead of the nine possibilities which we might have thought of a priori).

These formulas logically required the use of complex numbers. Indeed, even in the case where the three roots are real numbers, $p^3 + q^2$ can be negative, and then α and β are necessarily complex.

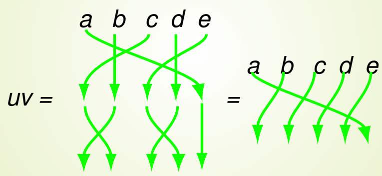
The solution of cubic equations, described above, took a long time to reach its final form (we know that at least one of the special cases was being worked out by Scipione del Ferro between 1500 and 1515). On the other hand, the solution of quartic equations followed quickly, because it is also in the *Ars magna* (Chapter 39), where Cardano attributes it to his secretary Ludovico Ferrari, who apparently found it between 1540 and 1545 (René Descartes would publish another solution in 1637). And it is this solution which brings us back to the first symmetry we met, that of the organisation of soccer finals, the complete quadrilateral, and the expression $ab + cd$. Here again, we can start with a polynomial with no term in x^3 (using the same technique as before), namely $x^4 + px^2 + qx + r = (x - a)(x - b)(x - c)(x - d)$. The set of three numbers $\alpha = ab + cd$, $\beta = ac + bd$, and $\gamma = ad + bc$, is invariant under each of the 24 permutations acting on a, b, c, and d. The numbers α, β and γ are thus the roots of a cubic equation whose coefficients are easily expressed as a function of p, q, and r. A calculation shows that the polynomial $(x - \alpha)(x - \beta)(x - \gamma)$ equals $x^3 - px^2 - 4rx + (4pr - q^2)$. It can thus be decomposed, as we have seen above, to yield α, β and γ. Indeed, it's enough to find one of these roots, α say, to determine a, b, c, and d (because we then know the sum α and the product r of the two numbers ab and cd, thus giving these numbers via a quadratic equation; all we then have to do is to exploit the equations $(a + b) + (c + d) = 0$ and $ab(c + d) + cd(a + b) = -q$ to determine $a + b$ and $c + d$ and hence, finally, a, b, c, and d).

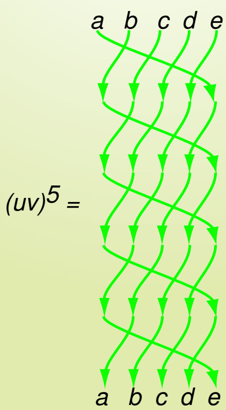
3. THE ORDER OF A PERMUTATION

The order of a permutation is the least integer n such that if the permutation is applied n times, we get the identity permutation. Thus the permutation u has order 2 and the permutation v has order 3 :



Checking that the permutation *uv* has order 5.





The fundamental role of the permutations of the roots a, b, c... and of the auxiliary quantities α, β..., was brought to light by Joseph Louis Lagrange in 1770 and 1771 (published in 1772) and, to a lesser degree, by Alexandre Vandermonde in a memoir published in 1774, but written around 1770, as well as by Edward Waring in his *Meditationes algebraicae* of 1770 and by Francesco Malfatti. Today we rightly call those auxiliary quantities 'Lagrange resolvents'.

The resolvents are not unique (we could equally well have put
$\alpha = (a + b - c - d)^2$ in the case of the quartic equation, which corresponds to Descartes' method), but they are the key to all general solutions by radicals.

Abel and Galois

Of course, mathematicians wanted to go further: Descartes certainly tried, and he wasn't alone. The next step would clearly be that of the quintic equation. This was found to pose apparently insuperable obstacles, and since the time of Abel and Galois (who obtained their results around 1830) we have known why the search was in vain.

In all the previous cases, we were able to find a family of $n - 1$ numbers α, β, γ..., determined as polynomials of the n roots a, b, c, and d... (with n less than or equal to 4). This family was globally invariant under the permutations of the roots. More precisely, if we let S_n denote the group of bijections of the set $\{a, b, c, d \dots\}$ with itself, what can be done for n strictly less than 5 is to define a mapping of S_n onto S_{n-1} which preserves compositions of permutations.

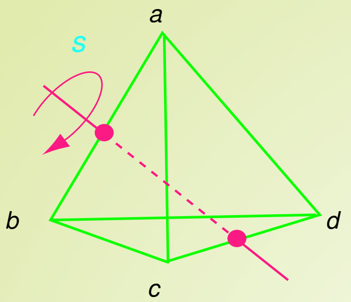
Since the beginning of the nineteenth century, we have known that this is impossible for n larger than 4. The same is true for a (non-constant) composition-preserving mapping of the group A_n of permutations of even order (the products of an even number of transpositions) onto the group S_m when m is less than n and n is greater than 4. This shows that Lagrange's method can't be extended to the case $n = 5$ or to higher values of n, but is, of course, not enough to show that a solution by radicals is impossible for the general equation of degree 5 or higher: other, more general, methods might succeed where

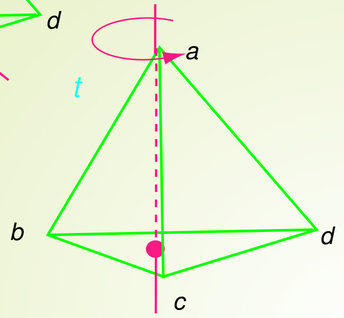
4. THE GROUPS A_4 AND A_5

A) THE GROUP A_4

1) The group A_4 is the group of the even permutations of the four letters *(a,b,c,d)*. This group is generated by the permutations $s = \begin{bmatrix} a & b & c & d \\ b & a & d & c \end{bmatrix}$, which maps *a* to *b*, *b* to *a*, *c* to *d* and *d* to *c*, and $t = \begin{bmatrix} a & b & c & d \\ a & c & d & b \end{bmatrix}$, which maps *a* to *a*, *b* to *c*, *c* to *d* and *d* to *b*. They obey the rules:
$s^2=1$, $t^3=1$, and $(st)^3=1$.

2) There's a geometric representation of the group A_4 : it's the group of rotations preserving the regular tetrahedron *a,b,c,d* .





s is represented by the symmetry with respect to the line joining the midpoints of *ab* and *cd*.
t is represented by a rotation through an angle $2\pi/3$ about the axis of the tetrahedron passing through *a*.
$st = \begin{bmatrix} a & b & c & d \\ b & d & c & a \end{bmatrix}$ is the rotation through $2\pi/3$ about the axis through *c*.
The patient reader may check that the rules of simplification $s^2=1$, $t^3=1$, $(st)^3=1$ form a presentation of the group, that is, together with the group law, they are enough to show that there are only twelve distinct "words" formed out of the letters *s* and *t*.

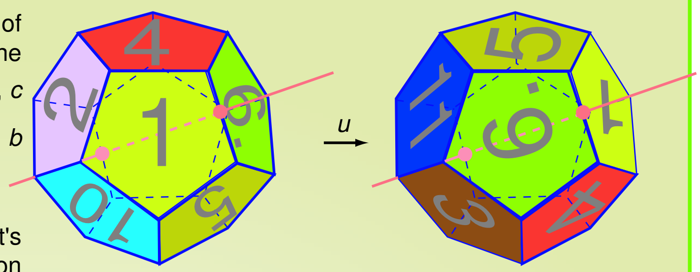
B) THE GROUP A_5

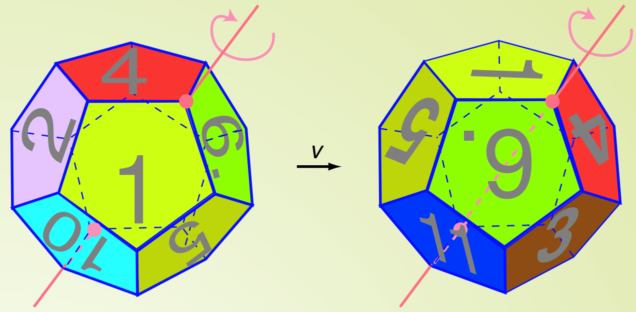
1) The group A_5 is the group of the even permutations of the five letters *(a,b,c,d,e)*. This group is generated by the permutations $u = \begin{bmatrix} a & b & c & d & e \\ b & a & d & c & e \end{bmatrix}$, which maps *a* to *b*, *b* to *a*, *c* to *d*, *d* to *c*, and *e* to *e*, and $v = \begin{bmatrix} a & b & c & d & e \\ e & b & a & d & c \end{bmatrix}$ which maps *a* to *e*, *b* to *b*, *c* to *a*, *d* to *d*, and *e* to *c*. These obey the rules: $u^2=1$, $v^3=1$, $(uv)^5=1$ (of course, *u* and *v* do not commute).

2) This group has 60 elements and is isomorphic to the group of rotations of a regular dodecahedron.

Thus *u* is one of the 15 symmetries with respect to a line joining the midpoints of two edges which are themselves symmetric about the centre.

Similarly, *v* is one of the 20 rotations through $2\pi/3$ about a line joining two vertices which are symmetrically placed about the centre.





C) PRESENTATION OF A_5

The patient reader may check that the simplifying rules $u^2=1$, $v^3=1$, $(uv)^5=1$ together with the group law, are enough to show that there are only 60 distinct words formed out of the letters *u* and *v*. We start by putting $s = u$ and $t = k^{-2}uk$ (where $k = uv$), and then show that *s* and *t* are generators of A_4, that is, they obey the simplifying rules $s^2=1$, $t^3=1$, $(st)^3=1$. We then show, using the simplifying rules above, that every word formed from the letters *u* and *v* can be written in the form $k^m h$, where *m* equals 0,1,2,3,4 and *h* is a word formed from the letters *s* and *t*.
As there are precisely 12 distinct words *h,* we see that the group A_5 is given by the above relations.

D) A_5: A GROUP OF MATRICES

1) Let F_5 denote $Z/5Z$, the field of remainders modulo 5. In this field, 4 + 2 =1, 3 + 2 =0, 4 x 2 = 3, 3 x 2 =1, etc.

2) We represent *u* and *v* as the following mappings of the projective space $P_1(F_5)$. This projective space contains the five points of F_5, together with a point "at infinity", denoted by 1/0. Let us put $u(z) = -1/z$, for a point *z* in $P_1(F_5)$. Clearly, $u^2(z)=z$, that is $u^2=1$. Now let us put $v(z) = -1/(z+1)$: we can check that $v^3=1$. We see that we have a representation of A_5 because $k=uv$ is given by $k(z) = z+1$ and $k^m(z) = z+m$, so that $k^5=1$ since 5 equals 0 in F_5.

3) We give a matrix representation of the elements *u* and *v*. If *a,b,c,d* are elements of F_5, with $ad - bc = 1$, we associate the matrix $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$ with the mapping *f* of $P_1(F_5)$, given by:

$$\begin{bmatrix} f(z) \\ 1 \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} z \\ 1 \end{bmatrix}$$

The group of mappings obtained in this way is called $PSL(2,F_5)$, for "Projective Special Linear" group of F_5. Then *u, v, k,* and *t*, y are represented by the matrices:

$$u = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} \quad v = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix} \quad k^m = \begin{bmatrix} 1 & m \\ 0 & 1 \end{bmatrix} \text{ and } t = \begin{bmatrix} -2 & -3 \\ 1 & 1 \end{bmatrix}$$

Tel est le fondement de toutes les méthodes qu'on a trouvées jusqu'ici pour la résolution générale des équations du quatrième degré, comme je l'ai fait voir ailleurs en détail. *Voyez* les Mémoires de l'Académie de Berlin, pour l'année 1770.

A l'égard des équations du troisième degré, leur résolution générale dépend d'une fonction linéaire des trois racines α, β, γ, telle que $\alpha + m\beta + n\gamma$; cette fonction, en faisant toutes les permutations possibles entre les trois quantités α, β, γ, aura ces six valeurs différentes

$$\alpha + m\beta + n\gamma, \quad \alpha + m\gamma + n\beta,$$
$$\beta + m\alpha + n\gamma, \quad \beta + m\gamma + n\alpha,$$
$$\gamma + m\beta + n\alpha, \quad \gamma + m\alpha + n\beta;$$

qui pourront être les racines d'une équation dont les coefficiens seront déterminables par des fonctions rationnelles des coefficiens de l'équation proposée. Or, si l'on prend pour m et n les deux racines cubiques imaginaires de l'unité, qu'on peut représenter par r et r^2, en faisant $r = \frac{-1+\sqrt{-3}}{2}$, il arrive qu'en supposant

$$t = \alpha + r\beta + r^2\gamma$$
et
$$u = \alpha + r\gamma + r^2\beta,$$

les six racines dont il s'agit deviennent, à cause de $r^3 = 1$, t, u, rt, ru, r^2t, r^2u; de sorte qu'en prenant y pour l'inconnue de l'équation qui aura ces six racines, le produit des trois facteurs simples $y-t, y-rt, y-r^2t$, sera (à cause de $1+r+r^2=0$ et $r^3=1$) y^3-t^3, et le produit des trois facteurs semblables $y-u, y-ru, y-r^2u$, sera pareillement y^3-u^3; multipliant ensemble ces produits, on aura

$$y^6 - (t^3+u^3)y^3 + t^3u^3 = 0,$$

équation du sixième degré, résoluble à la manière des équations du second degré, et dont les deux coefficiens t^3+u^3 et t^3u^3 seront nécessairement des fonctions invariables de α, β, γ.

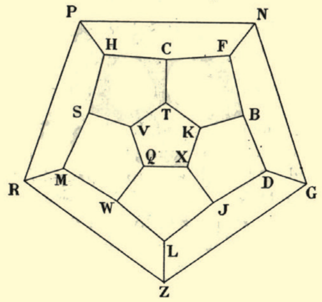
* Ff 2

Figure 5: Lagrange's text on 3rd degree equations (1772)

294 TROISIÈME PARTIE

Les 5 pentagones en étoile étant relevés autour du fond pentagonal forment une corbeille à cinq panneaux latéraux ayant vers le haut 5 pointes. Si l'on prend une deuxième corbeille identique à la première mais retournée, il suffit de les emboîter de manière que les dents de l'une viennent dans les creux de l'autre, et inversement, pour avoir un dodécaèdre parfait.

L'icosien. — On peut à la rigueur se dispenser de faire un tel dodécaèdre et il n'y a qu'à prendre une planchette sur laquelle on a dessiné la figure ci-contre ou toute autre



analogue, à l'imitation d'un jeu anglais appelé jeu icosien et qui se prête fort bien aux recherches du problème d'Hamilton. Avec un peu d'imagination on y reconnaît la forme du dodécaèdre précédent. Supposons en effet que notre dodécaèdre soit formé d'une feuille de caoutchouc vide à l'intérieur et que la face du fond ZRPNG ait été supprimée et réduite à son contour. Mettons la main dans le trou ainsi formé et agrandissons-le considérablement de façon à former avec tout notre dodécaèdre creux en caoutchouc une grande plaque plane pentagonale qui est justement celle que nous venons de représenter. On voit qu'à tout voyage autour du monde représenté sur le dodé-

Figure 6: Icosahedral game and Hamiltonian circuit according to Sainte Lagüe

Lagarange had failed. Nowadays, because of Abel and Galois, we know that even such a generalisation is impossible.Many of the most celebrated mathematicians were interested in this fundamental and complex problem, among them Leonhard Euler, who returned to it several times and, above all, Karl Friederich Gauss (1801) and Louis-Augustin Cauchy (1813).

We'll stay with the case of the quintic equation. Descartes, for one, was convinced that no formula like that of Cardano could be found. In 1637 Descartes suggested a graphical solution – using the intersection of circles and cubic curves – which he had invented for the purpose. From 1799 to 1813 (the date of publication of his *Riflessioni intorno alla solutione delle equazioni algebraiche generali*), Paolo Ruffini published diverse attempts at proofs, each of them more refined than the last, attempting to demonstrate the impossibility of solving the general quintic equation by radicals. He had the correct idea of assigning, to each rational function of the roots, that group of permutations of the roots which left the function invariant. However, he assumed incorrectly that the radicals involved in solving the equation necessarily had to be rational functions of the roots.

In the event, it was 1824 before Niels Abel, in his *Mémoire sur les équations algébriques*, justified Ruffini's intuition. Abel, having at first thought, on the contrary, that he had found a general method of solution, proved the impossibility of solving the general quintic by radicals in his 1826 *Mémoire sur une classe particulière d'équations résolubles algébriquement*, in which he sketched a general theory which would only be fully worked out by Galois, towards 1830. Galois' work inaugurated a new era in mathematics where calculations gave way to the consideration of their potential, and concepts, such as those of abstract group or of algebraic extension, occupied the foreground.

Galois' great insight was to associate to an arbitrary equation a group of permutations which he defined in these terms:

Let an equation be given which has roots $a, b, c \ldots m$. It will always have a group of permutations of the letters $a, b, c \ldots m$ with the following properties:

1. *every function of the roots which is invariant by substitutions of this group, will be rationally determined;*
2. *conversely, every rationally determined function of the roots will be invariant under these substitutions.*

Galois then studied how this group of 'ambiguities' could be modified by adjoining auxiliary quantities thenceforth considered 'rational'. Solving an equation by radicals was then reduced to solving its Galois group.

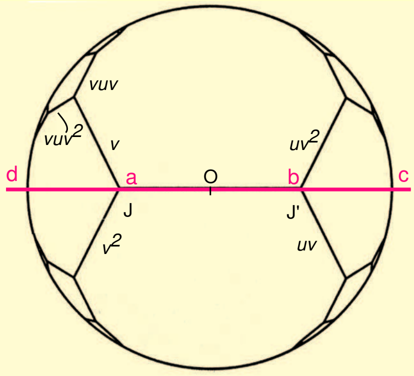
The impossibility of reducing the quintic equation to equations of lower degree comes from the 'simplicity' of the group A_5 of the sixty even permutations of the five roots a, b, c, d, and e of the quintic. We say that an abstract group is 'simple' if there is no non-constant composition-preserving mapping of the group into a smaller group.

The group A_5 is the smallest non-commutative group which is simple, and it arises very frequently in mathematics. This group can be described very economically: it is generated by two elements u and v satisfying the relations $u^2 = 1$, $v^3 = 1$ and $(uv)^5 = 1$, which gives us an excuse to move to Hamilton's icosions.

Hamilton's icosions

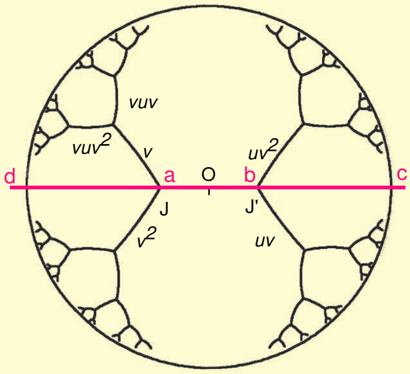
After discovering quaternions, William Hamilton tried, in 1857, to construct a new algebra of generalised numbers, which he called icosions. Two of them, denoted by u and v, which Hamilton termed 'non-commutative roots of unity', were to satisfy $u^2 = 1$, $v^3 = 1$ and $(uv)^5 = 1$. A childishly simple calculation shows that, if $uv = vu$, then we have $v = 1v = u^5v^5v = u^5v^6 = (u^2)^2u(v^3)^2 = u$, so $u = v = vu^2 = v^3 = 1$. So we can't represent u and v as elements of the groups S_n for n less than or equal to 4. To represent u and v as elements of the group A_5 of even permutations of the five letters a, b, c, d, and e, it is enough to put $u = (b, a, d, c, e)$, the permutation which fixes e but exchanges a with b and c with d, and to put $v = (e, b, a, d, c)$, the permutation which fixes b and d but changes a to $e = v(a)$, c to $a = v(c)$, and e to $c = v(e)$. The product uv is then the cyclic permutation $(eabcd)$ which is indeed of order 5. In fact, we could similarly represent u and v in altogether 120 separate (but pairwise isomorphic) ways as elements of A_5.
The group A_5 is isomorphic to the group of rotations preserving a regular icosahedron or, which amounts to the same thing, a regular dodecahedron (these are the two most interesting of the five platonic solids, whose other members are the regular tetrahedon, the cube and the regular octahedron, formed by the six centre of the faces of the cube. These are the only regular convex polyhedra which exist in our usual three-dimensional space).
To construct the isomorphism referred to above, it is enough to associate u with one of the 15 rotations of order two (a symmetry whose axis is one of the 15 lines joining the midpoints of parallel edges) and to associate v with one of the 20 rotations of order three (whose axis of symmetry connects one of ten pairs of two diametrically opposite vertices of the dodecahedron, or the centres of two parallel faces of the icosahedron) in such a way that the product uv is one of

7. THE UNIVERSAL COVERING AND NON-EUCLIDEAN GEOMETRY



***A* KLEIN'S MODEL**

Length of segment
[a,b] = Log $\frac{ac \times bd}{ad \times bc}$



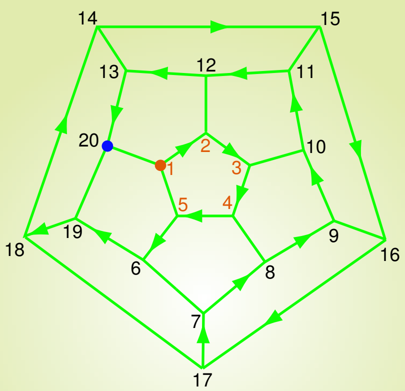
***B* POINCARÉ'S MODEL**

To get a geometric understanding of the group generated by two elements *u* and *v* and presented by the relations u^2=1, v^3=1, and $(uv)^5$=1, we start by considering the two first relations (u^2=1, v^3=1). The group thus generated is the group PSL(2,Z) which can be understood by looking at its action on an infinite tree T in which three edges exit from each vertex. The third relation ($(uv)^5$=1) can then be understood by identifying the tree T with the universal covering of the graph in box 8 below. The universal covering, in the sense of Poincaré, is obtained by considering all the paths which follow the edges of the regular dodecahedron.
The infinite tree T is represented by two models of non-Euclidean geometry: Klein's model *(A)* and Poincaré's model *(B)*. In each model, the set of points of plane geometry lie in the interior of a disk. In Klein's model, the straight line joining two points is the same straight line as in Euclidean geometry, only the length of the line is changed. In this model, the length of a straight line is given by the logarithm of the cross-ratio (ab,cd) of ab with the points c and d where the line ab intersects the circle C. Thus, [a,b] = log $\frac{ac \times bd}{ad \times bc}$. The edges of the tree T are line segments of equal length.
In the Poincaré model, the "straight lines" are arcs of circles otrhogonal to the circle *C*, and the idea of angle remains the same as in Euclidean geometry. The distances are given by 2log(ab, cd) where the cross-ratio is calculated on the circle through (a,b,c,d), and where the factor 2 arises in comparing (A) with (B).
The group PSL(2, Z) is represented by isometries of non-Euclidean geometry. A presentation of this group is given by the relations u^2=1 and v^3=1. The element *u* is given by symmetry about the origin O, and the element *v*, by the non-Euclidean rotation with centre J and angle 2π/3. We operate on the edge JJ' by the transformations represented by the words (such as *uvvuuuvuv...*) whose letters are the elements *u* and *v*. This gives exactly the tree T of the universal covering of the graph of Hamilton's icosion game. In particular, each Hamiltonian path is a point of the universal covering.
We get the dodecahedron by identifying the edges of the tree T which are congruent modulo 5. This congruence means that we pass from one edge to another by a non-Euclidean isometry given by an element $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$ of the group PSL(2, Z) satisfying *a* = 1 (modulo 5), *b* = 0 (modulo 5), *c* = 0 (modulo 5), and *d* = 1 (modulo 5). In this way, the group A_5 whose presentation requires the extra relation $(uv)^5$ = 1, arises from quotienting PSL(2, Z) by the normal subgroup G generated by $(uv)^5$.The quotient of T by G is precisely the graph formed by the edges of the dodecahedron. The quotient group PSL(2, Z)/G is the group PSL(2, F_5) of box 4.

the 24 rotations of order five (whose axis of symmetry connects one of the six pairs of centres of parallel faces of the dodecahedron, or pairs of diametrically opposed vertices of the icosahedron). The 60 rotations preserving either solid can be expressed simply as products of the generators u and v. Even though the two icosions u and v generate the group A_5 and satisfy the relations $u^2 = 1$, $v^3 = 1$ and $(uv)^5 = 1$, it's not immediate that these relations constitute a presentation of the group, that is, it's not immediate that every relation between u and v follows from these. There are two ways, algebraic or geometric, of showing this (boxes 4 and 7).

The graph of the edges of the dodecahedron, which has the same symmetries as that of the icosahedron, gave rise to Hamilton's 'icosahedral game' which he also called the 'game of non-commutative roots of unity'. This game is the first example of what is now called the search for a Hamiltonian circuit, which is a very important concept in modern graph theory (box 8). The challenge is to pass precisely once through each vertex of the dodecahedron, using only the edges, and to finish at a vertex which is joined by an edge to the starting point. A remarkable account of this is given in André Sainte-Laguë's 1937 essay *Avec des nombres et des lignes*, reissued by Vuibert in 1994.

8. THE GAME OF ICOSIONS



In his book *Avec des nombres et des lignes* Sainte-Lagu brought the game of icosions, invented by the Irish mathematician Hamilton (1805-1865), back to life. The game consists of completing the circuit going through all the vertices of an icosahedron once and once only: to start, the first six vertices are given. Here's and example: (1, 2, 3, 4, 5, 6, 19, 18, 14, 15, 16, 17, 7, 8, 9, 10, 11, 12, 13, 20).

Morley's triangle

It is wrong to oppose the 'angel of geometry' with the 'devil of algebra'. What takes place is a fruitful co-operation between the visual parts of the brain, which can perceive the harmony of a configuration at a glance, and those parts of the brain which process language and distil that harmony into algebraic formulae. We shall end this introduction to the idea of symmetry with a nice example of that co-operation by way of Morley's theorem. This is a subject where concrete symmetries arising from geometry become abstract and algebraic when we look at them from a different angle. Their forceful interplay gives a genuine sense of beauty.

The British mathematician Frank Morley was one of the first university teachers in America. At the end of the nineteenth century, while pursuing research into families of cardioids tangent to the three sides of a given triangle, he discovered the following property: the three pairs of trisectors of the angles of a triangle (that is, the straight lines which divide the interior angles into three equal parts) intersect in six points, of which three are vertices of an equilateral triangle.

The original proof is quite difficult and depends on ingenious calculations based on a profound mastery of analytic geometry. There are now many proofs of this result, as well as generalisations which produce 18, or 27 (or even more) equilateral triangles which can be constructed from the 108 points of intersection of the 18 trisectors obtained from the original ones by rotations of $\pi/3$. These proofs include ones by trigonometric calculation as well as purely geometrical ones, such as that given by Raoul Bricard in 1922.

There is a proof which is entirely different, which illuminates the result from an interesting angle, because it lets us extend the result (a priori entirely Euclidean) to the geometry of affine lines over an arbitrary field k. The purely algebraic result, which includes and extends the trisector property, is so general that its proof becomes a simple verification (a very general result is often easier to prove than a particular case, because the generality can reduce the number of hypotheses).

The statement is as follows:

If G is the affine group of a commutative field k (that is, the group of mappings g of k into k which can be written in the form $g(x) = ax + b$, where $a = a(g)$ is non-zero), then for each triple (f, g, h) of elements of G such that $j = a(fgh)$ is not the identity and such that fg, gh, and hf are not translations, the following two assertions are equivalent:

a) $f^3 g^3 h^3 = 1$ (the identity mapping $1(x) = x$);

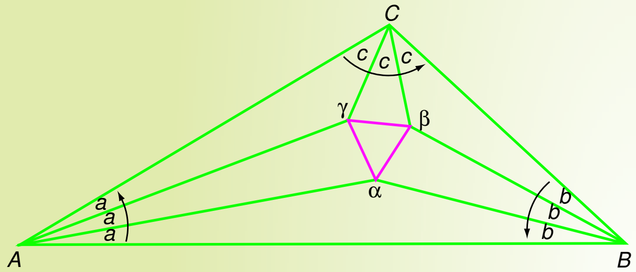
b) $j^3 = 1$ and $\alpha + j\beta + j^2\gamma = 0$, where α is the unique fixed point of fg, β that of gh, and γ that of hf.

We need to show how this very abstract property helps us better understand (and, at the same time, prove) Morley's theorem. We shall take k to be the (field of) complex numbers. Its affine group is that of the direct similarities and has the rotations as a subgroup (precisely when a has modulus 1). We let f, g and h be the rotations about the three vertices of the triangle with each angle of rotation being two-thirds of the relevant angle of the triangle. Thus f is the rotation with centre A and angle $2a$ (the internal angle at A being denoted by $3a$), g is that with centre B and angle $2b$ and h that with centre C and angle $2c$. The product of the cubes $f^3 g^3 h^3$ is 1, because, for instance, f^3 is the product of the two symmetries with respect to the sides of the angle at A, so that these symmetries simplify pairwise in the product $f^3 g^3 h^3$.

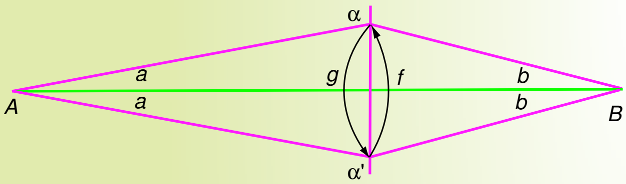
The equivalence above shows us that $\alpha + j\beta + j^2\gamma = 0$, where α, β, and γ are the fixed points of fg, gh, and hf, and where the number $j = a(fgh)$ is the first cube root of unity, which we have already met in the course of this article. The relation $\alpha + j\beta + j^2\gamma = 0$ is a well-known characterisation of equilateral triangles (it can be written in the form $(\alpha - \beta)/(\gamma - \beta) = -j^2$, which shows that we pass from the vector $\beta\gamma$ to the vector $\beta\alpha$ by a rotation through $\pi/3$).

An old recipe, well-known to those thoroughly trained in the rigours of classical geometry, shows that the point α, defined by $f(g(\alpha)) = \alpha$, is none other than than the intersection of the trisectors of the angles A and B ly-

9. MORLEY'S THEOREM

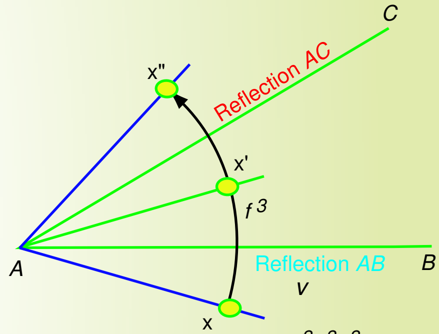


Morley's theorem states that the three meeting points α, β, γ of the trisectors of an arbitrary triangle *ABC*, as indicated in the diagram, form an equilateral triangle. (n red).



f, g, h are the three rotations about the vertices of the given triangle, through angles which are two thirds of the angles at the vertices.

So *f* is the rotation through 2*a* about *A*, *g* is the rotation through 2*b* about *B*, and *h* is the rotation through 2*c* about *C*. We shall look at the properties of these rotations. The rotation *g* takes the point α to α', which is the reflection of α through *AB*. The rotation *f* takes the point α϶ to α: so α is a fixed point of the product of rotations *fg*. Similarly, β is a fixed point of the product of rotations *gh*, and γ is a fixed point of the product of rotations *hf*.



Now we consider the product $f^3g^3h^3$. The rotation f^3 through an angle 6*a* about *A* is the product *s(AC) s(AB)* and the reflection *s(AB)* in the side *AB*, and the reflection *s(AC)* in the side *AC*. Similarly, g^3 is the product *s(AB) s(BC)* and h^3 is the product *s(BC) s(AC)*. So $f^3g^3h^3$ = *s(AC) s(AB) s(AB) s(BC) s(BC) s(AC)*. As the square of a reflection is equal to 1 this, together with the algebraic theorem, shows that the triangle is equilateral.

ing closest to the side AB. The reader can be convinced of this by checking that the rotation g, centred on B, of angle $2b$, transforms the point of intersection into its symmetric image with respect to the line AB and that the rotation f, centre A, of angle $2a$, returns the point to its original place. The same applies to the points β and γ. We have thereby shown that the triangle ABC is equilateral. As a bonus, we can see that, in this order, the triangle is described in a positive direction (anticlockwise). This proof applies equally to the other Morley triangles: the 18 trisectors obtained from the interior trisectors by rotations through $\pi/3$ enable us to modify f, g and h without changing the product of their cubes, thus giving new solutions of equation a), and new equilateral triangles.

The evident duality of algebra and geometry in the examples above allows us to expand the boundaries of our knowledge of geometry, already liberated from its Euclidean chains by the arrival of non-Euclidean geometries (box 7).

The discovery of quantum mechanics and of the non-commutativity of the coordinates of phase space for an atomic system has given rise, during the past twenty years, to what can be seen as an equally radical evolution of geometric concepts, freeing the idea of space from the commutativity of coordinates.

In non-commutative geometry, the idea of symmetry becomes more subtle, the groups sketched in this article being replaced by the algebras invented by the mathematician Heinz Hopf, exemplifying Hermann Weyl's fine definition, taken from his book *Symmetries* '…the idea [of symmetry] is by no means restricted to spatial objects;…symmetric means something like well-proportioned, well-balanced, and symmetry denotes that sort of concordance of several parts by which they integrate into a whole.'

Alain Connes [connes@ihes.fr] is a winner of the Fields Medal and the Crafoord Prize. Recently, he received the Gold Medal 2004 of the French CNRS. He is a professor at the Collège de France and the Institut des Hautes Etides Scientifiques. *He would like to thank André Warusfel for his invaluable help in preparing this article, originally a lecture organised by Jean-Pierre Bourgignon at the Centre Georges Pompidou in September 2000.*

The Newsletter would like to thank David Salinger (Leeds, UK) for the translation of the article into English, and also Martin Qvist (Aalborg, Denmark) for help with the management of the figures.

Apology

Unfortunately, a very disturbing mistake occurred during the printing process of the recent issue 53 of the Newsletter. In the feature article *25 years of Kneser's conjecture* by Marc de Longueville, p.16 – 19, all *minus*-signs in the formulas and also the *line break*-signs disappeared. The Newsletter wishes to apologise sincerely for the inconvenience that this has caused for the readership; its apologies go also to the author. A corrected version of this article can be read and downloaded as a PDF-file from the following URL `http://www.emis.de/newsletter/current/current9.pdf`.

Mathematics is alive and well and thriving in Europe

Luc Lemaire (Universit´e Libre de Bruxelles)

This is the text of a lecture given at the first Euroscience Open Forum in Stockholm in August 2004. The text will keep unashamedly the characteristic of the lecture: no previous mathematical knowledge is assumed.

Numbers

This being about mathematics, I may as well start with numbers, and shall write three short formulas.

The **first formula** will have essentially no ingredients, except the positive integers : 1,2,3,4,... Let us write :

$$1 + \frac{1}{2^2} + \frac{1}{3^2} + \frac{1}{4^2} + \ldots = A.$$

Whenever I stop summing after a finite number of terms, I just have a sum of fractions that can be computed by hand or with a pocket calculator.

But the ... means that I want to continue summing forever, writing the sum of an infinite number of terms. This should not frighten anybody, we know of other examples of such infinite sums yielding a finite number, like

$$\frac{3}{10} + \frac{3}{100} + \frac{3}{1000} + \ldots = 0,3333... = \frac{1}{3}.$$

In the first formula, the sum also gives a number, which we'll call A.

The **second formula** will have more complicated ingredients, namely the complete list of prime numbers. Recall that a prime number is an integer ≥ 2 which has no divisor except 1 and itself. So 6 is not prime because $6 = 2 \times 3$, and 7 is prime because such a decomposition does not exist. The first prime numbers are $2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31...$ Prime numbers have always fascinated mathematicians and Euclid, 24 centuries ago, proved that there is an infinite supply of primes.

Note that his proof is so perfect, short and elegant that it is still the best proof of this result, in fact it can be used as a first illustration of what a proof is.

And now we consider the infinite product

$$\left(1-\frac{1}{2^2}\right)\left(1-\frac{1}{3^2}\right)\left(1-\frac{1}{5^2}\right)\left(1-\frac{1}{7^2}\right)\left(1-\frac{1}{11^2}\right)\ldots$$

Like the infinite sum above, this yields a (finite) number and we write :

$$B = \frac{1}{\left(1-\frac{1}{2^2}\right)\left(1-\frac{1}{3^2}\right)\left(1-\frac{1}{5^2}\right)\left(1-\frac{1}{7^2}\right)\ldots}$$

The **third formula** will use an ingredient from a totally different area, namely classical geometry. As we all know, the length of a circle of radius R is given by $2\pi R$, where π has approximate value

$$\pi = 3.14159265358979323846...$$

Let us write

$$C = \frac{\pi^2}{6}$$

So we have written three numbers, coming from different areas, with no apparent relation. Yet, one can show that $\boldsymbol{A = B = C}$, they are the same number.

It you pause to think about it (do it!) this is unbelievable. It means in particular that some facetious god of mathematics has encoded the length of a circle in the list of prime numbers, totally unrelated a priori.

We draw three first conclusions:

1) Mathematics has beauty and magic.

2) Mathematics is not about specific fields like algebra, geometry, analysis,... but is about the relations between different areas, allowing us to use methods of one to solve problems of the other.

3) Ancient notions and proofs are as fresh today as 24 centuries ago.

Let us push a bit further. In the above formulas, could we replace the squares by cubes? In fact we have

$$1 + \frac{1}{2^3} + \frac{1}{3^3} + \frac{1}{4^3} + \ldots = \frac{1}{(1-\frac{1}{2^3})(1-\frac{1}{3^3})(1-\frac{1}{5^3})\ldots}$$

but this is no longer a fraction times π^3.

Likewise, provided x is a real number greater than 1, we have

$$1 + \frac{1}{2^x} + \frac{1}{3^x} + \ldots = \frac{1}{(1-\frac{1}{2^x})(1-\frac{1}{3^x})(1-\frac{1}{5^x})\ldots}$$

This has now become a function of the number x, called the zeta function of Riemann : $\zeta(x)$.

In 1859, in a prodigious paper, Riemann analyses this function and shows its deep relation with number theory, and the distribution of prime numbers in particular.

For that, he shows that ζ can be extended as a function defined also for $x < 1$, and even to the case of $\zeta(z)$, where $z = x + \sqrt{-1}y$ is a complex number. He states his belief that the zeros of zeta, i.e. the values of z for which $\zeta(z) = 0$, beyond the "easy" ones $-2, -4, -6, ...$ are all situated on a line, namely are all of the form $z = \frac{1}{2} + \sqrt{-1}y$.

Unable to prove it, he assumes it as a hypothesis, leaving to others the task of proving it.

The "Riemann hypothesis", still unproven, is considered by many as the most important single open question in mathematics today.

Why is this obscure looking question about the zeros of a specific complicated function so important? From

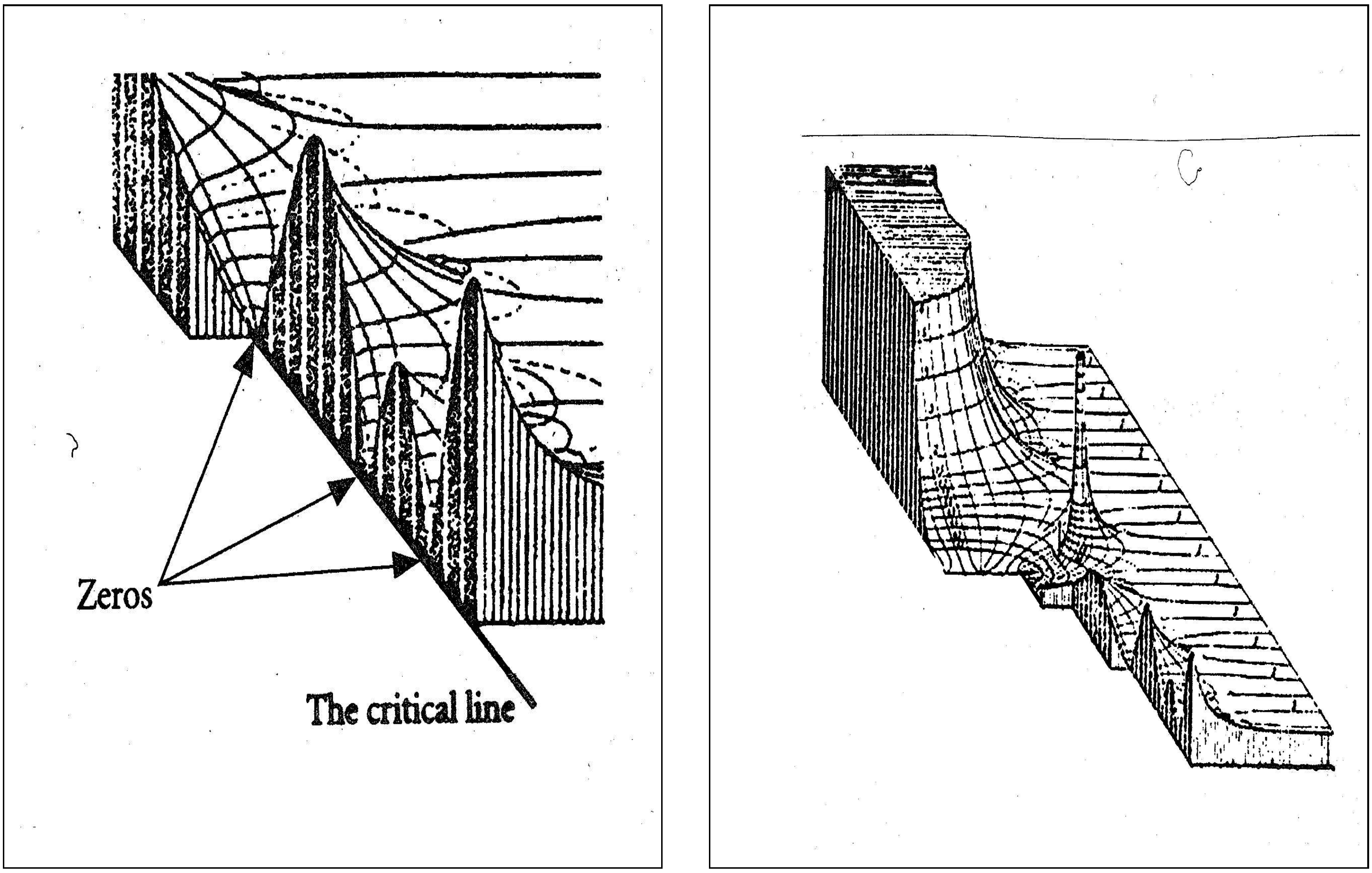


Figure 1: Graphs of the Riemann zeta function

the first formulas, we get a glimpse that it is related to questions of number theory. In fact, hundreds of theorems about prime numbers, or about theoretical computer science, have been proven under the assumption that Riemann's hypothesis is true, and were not proven otherwise. So when - or if - the hypothesis is proven, hundreds of other results will be proven at the same time.

In 1900, the great German mathematician David Hilbert drew a visionary list of 23 open problems that shaped part of the development of mathematics in the twentieth century.

Riemann's hypothesis is one of them, and the only specific question of the list unsolved after one century.

In 2000, the Clay foundation (established by philanthropist Landon Clay) announced a list of 7 Millennium problems and, times having changed, offered a reward of one million dollars for each. Riemann's hypothesis is - of course - one of them.

The main effect of trying to solve such a difficult problem is to relate it to new results and theories - a very positive result even when it does not solve the problem. Today, the obscure question of Riemann appears to be at the centre of a spider web of mathematical fields and theories.

Physics has also joined the web: Michael Berry related the zeros of zeta to quantum chaos, and Alain Connes to the eigenvalues of an operator, similar to the absorption spectrum of a star.

But is all this confined to the realm of "pure" or fundamental mathematics, highly amusing to mathematicians but unrelated to real life?

G. H. Hardy, who contributed to the Riemann hypothesis in 1914, claimed that number theory's beauty was related to its uselessness, so that it was not related to dull realities or applications.

Well, Hardy was wrong, and all of you use prime numbers regularly, but without knowing it.

Indeed, whenever you use a bank machine, or order anything through the internet, your bank data is of course encrypted. And the only totally safe encrypting code today is based on prime numbers.

Basically, it works as follows:

Anybody who wants to receive encoded messages will choose two very large prime numbers - say of one hundred digits. He will not reveal to anyone the two chosen numbers, the "secret key".

But he will compute the product of the two numbers, obtaining a two hundred digit number that he will advertise freely (the public key).

Using some clever mathematics (available as a software), anybody who wants to send him a message will encrypt it using the 200 digit numbers and can send it without much care. Indeed, the only possibility to decode it is to know the two prime numbers, known only to one person.

This is the principle of RSA cryptography, created in 1977 by Rivest, Shamir and Adleman (and slightly earlier by Ellis, Cocks and Williamson of the British secret service, but they kept it secret).

But, you might say, the two hundred digit number is decomposable in a unique way as the product of the two original prime numbers, and it would be sufficient to find that factorisation to decode all messages that use this number.

The point is that it would take centuries for the larger computer to find the decomposition, because of the size of the numbers.

Could one maybe find by chance one of the prime numbers, hence the other? The odds would be no better than trying to pick up at random a specific particle of the known universe.

So we get two more conclusions about mathematics

4) Old notions still give rise to the most pressing open problems of today and tomorrow.

5)"Pure" mathematics, studied only for the sake of elegance and beauty, suddenly finds crucial applications to science or economic development. To quote the physicist Eugene Wiegner, this is the "unreasonable effectiveness of mathematics applied to natural sciences".

Nobel prizes, Fields medals, Abel prizes and economic development

There are no Nobel prizes in mathematics. The mathematicians managed to keep alive for decades the legend that Alfred Nobel's girlfriend eloped with the Swedish mathematician Gosta Mittag-Leffler, so that Nobel would not create a prize that might go to his rival. However, Nobel's sex life is not so well documented, and the fun went out of the story when geologists and others tried to spread similar stories about their science.

The point is much more probably that Nobel - as an industrialist - was interested in "inventions and discoveries" and didn't see mathematics fitting there.

Anyway, the mathematicians created a prize recognised today as the "Nobel of Mathematics": the Fields medal, first awarded in 1936.

There are three main differences between Nobel prizes and Fields medals.

Compared to Nobel prizes, the medal comes only with a minimal financial prize.

Every four years, 2, 3 or 4 medals are awarded and they are never shared between mathematicians for a joint discovery.

The major difference is an upper age limit of 40 for the award of a medal, illustrating the fact that in most cases mathematical genius can be detected at a young age.

For example, Jean-Pierre Serre was awarded the medal in 1954 at the age of 27 - because he was already an acknowledged master with impressive discoveries.

On the other hand, Andrew Wiles, who achieved eternal (and even newspaper) fame by proving Fermat's last theorem (a question open since 1637), did not get a Fields medal because he was 41 when his proof was completed.

Now, many political and economical studies comparing the effectiveness of scientific research in various continents refer to Nobel prizes as an indicator and draw a negative conclusion about Europe.

Indeed, between 1980 and 2003, the Nobel prizes in biology and medicine, physics and chemistry give :

68 for Europe

154 for the USA

with the gap growing with time.

For mathematics, the Fields medals give a much better picture for Europe.

In the same period, Fields medals were awarded to :

9 Europeans (one working in the USA)

5 U.S. citizens

4 Russians (one working in Paris, two in the US)

1 Japanese

1 New Zealander (working in the US)

All together, including Russia in Europe where it should be, we get

10 working in Europe

9 working in the USA

a success story for Europe.

Fields medals are awarded for recent developments, so we see no growing gap at all in mathematics.

More recently, to celebrate the two hundredth anniversary of the birth of Niels Henrik Abel, the Norwegian government created a prize for mathematics similar to the Nobel prize, fittingly called the Abel Prize.

After two awards, the laureates are Jean-Pierre Serre (49 years after his Fields medal), Michael Atiyah and Isadore Singer - two Europeans and one US citizen.

To sum up, mathematics in Europe is at top level, quite cheap to run and extremely efficient.

It must be acknowledged that the usefulness of fundamental mathematics will not always appear quickly (even if 24 centuries from Euclid to internet is an extreme example).

But as stated by Timothy Gowers in his millennium address at the Clay foundation: "If you were to work out what mathematical research has cost the world in the last hundred years, then work out what the world has gained in crude economic terms, you will discover that the world has received an extraordinary return on a very small investment".

Since return is not immediate, it falls outside the scope of an industrial company that needs to meet its objectives within a few years. Needless to say, it is outside the aims of a financial group buying a company with the sole aim to sell it after five years, after raising its stock exchange value and nothing else.

Thus, funding for fundamental curiosity driven mathematics must come from public money, for everybody's long term interest.

This should be managed by programmes better suited for mathematics at the level of the European Commission and the national policies.

To include this better in the overall scientific planning of the E.U., a minimum step would be to include a mathematician in EURAB, the 45 member advisory committee of the European Commission on science (so far, 67 people have been members of EURAB - none of them mathematicians).

It is sometimes said that mathematicians work by themselves in their office, with a pen and a piece of paper. First one should not forget the waste paper basket, much used in mathematical research.

And then there are the serious needs for mathematical work.

First, of course, we need positions, either in universities or research institutes. Mathematics is done by people - and this is the priority.

In Europe, we face the same paradox as in other sciences. Indeed, we educate high level mathematicians up to the doctoral level, then have some post-doctoral positions, but usually do not provide the bridge between these positions and the tenured ones. At that stage, the USA step in and offer tenure-track jobs to scientists fully educated in Europe.

We should strongly promote the creation of timely tenure-track positions in our universities.

In this respect, I believe the European Commission is making a mistake in putting the accent on "training" of doctoral students (up to four years research experience) and not more experienced ones (up to 10 years) in all its Marie Curie activities. Doesn't this simply educate more scientists to be swallowed by the American system ?

A special consideration should be given to Central and Eastern Europe. The extremely high level of the mathematical tradition there explains why for instance we have four Russian Fields medallists out of twenty. But the dramatic economic situation explains that only one remained in Russia.

A smallish investment to preserve that tradition would be in everyone's interest.

Secondly, mathematicians need regular contacts with other researchers, the world over. This happens during conferences, and by short or long term visits.

These provide an immense acceleration of research. In one or two hours, a specialist can explain the basics and recent trends in his field, whereas it would take months to get that information from the literature. Also mathematicians are not working together in very large centres, so they regularly need to see specialists in their domain, often rather thinly spread.

Thirdly, easy access to the literature is necessary. We have seen that older articles keep all their value, and access is needed to all good level literature present and past.

No university library today can keep up with the rising cost of journals, but electronic access offers new unprecedented opportunities.

Most new papers are typed in the software TEX, and can be made accessible to all.

Another objective is to digitise the whole literature - an operation estimated at around 50 million euros. Good co-ordination is needed, so that all digitised papers are accessible with the same standard. Also, the ownership of the database should not be left to purely profit-making organisations, and this again requires public funding now.

Note that this database could be made available at minimal cost in less developed countries, where high level mathematics is present but faces major economic difficulties.

Finally, note that mathematical research is accomplished both in universities and in a string of high level research centres, with regular movement of researchers from one to the other, so that all are necessary.

Differential equations

Since the invention of calculus by Newton and Leibnitz, differential and partial differential equations have been the central tool in mathematics applicable to science - first astronomy and physics, then chemistry, biology and now economy and finance.

It is a huge subject, both in fundamental mathematics and its applications.

To take but a specific example, I'll consider the Navier-Stokes equations. They are a system of partial differential equations that model the movements in fluid dynamics. They were written by Navier in 1822, then justified more precisely by Stokes a few years later.

They are both extremely useful in applications and extremely hard to study with mathematical rigour.

After almost two centuries, we have no formula giving the solutions (this is usual for partial differential equations), and we don't even have decent results on their existence and properties.

In fact, their mathematical study is the object of one of the seven Millennium problems of the Clay foundation.

But still they are used in applications like shaping cars and planes, modelling the flow of blood in the cardiovascular system and many others.

I shall briefly describe an application developed at the Fraunhofer Institute of Applied Mathematics in Kaiserlautern, Germany: the conception of airbags for cars.

For many years, it was an inaccessible idea. Indeed, in case of an accident, the bag has to be inflated fully in 1/20 of a second or it is too late.

Everything will count: the way the gas is injected, the shape of the bag, the way it is folded.

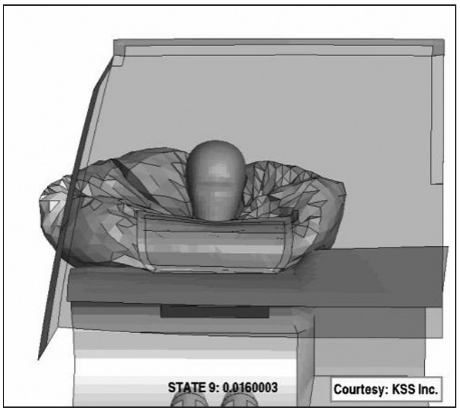


Figure 2. Airbag simulation

The most efficient (and cost efficient) way to find the best shape is by computer modelling. The researchers in Kaiserslautern developed a computer software that allows them to model any shape and gas speed, and look for an efficient one. They can vary the shape and folding many times and observe the blowing up of the bag.

Comparing the "films" of their mathematical bags with the film of concrete realisation of the bags built afterwards shows that they obtain a remarkable precision.

But this achievement required the development of new mathematics.

The standard way to model partial differential equations on a computer is to choose a mesh on the domain of the equation, then approximate derivatives by differences of the values at the different vertices.

Here the domain (the airbag) varies quickly, because of the varying gas pressure. Therefore, "mesh free" methods have to be developed.

We see here the same scheme appearing in an endless series of examples. There is first a mathematical theory, maybe fairly old. It is still the object of difficult theoretical questions. It also gives rise to unexpected applications which in turn give rise to new mathematical questions. Their study will provide new theories which again will motivate new problems and give rise to new unexpected applications.

Talking in Stockholm on partial differential equations, I should mention a grand master of the subject: Lars Hörmander.

His early work was so exceptional that he was appointed full professor in Stockholm at the age of 25.

At the age of 31 he got a Fields medal, but moved to the Institute for

Advanced Study in Princeton.

This brain drain provoked a strong reaction in Sweden, and the parliament voted the "Lex Hörmander", a law allowing the creation of personal chairs in exceptional case.

Hörmander came back to Lund and the law also allowed them to attract back Lennard Carlesson, another major figure.

Together, they had 36 PhD students in Sweden, who in turn had PhD students, so that the total number of their mathematical descendants in Sweden is now over 180.

Thus, their presence in Sweden helped not only the general reputation of the country, but more concretely the local development of science and industry.

Let us have a Lex Hörmander at the European level!

Pour l'honneur de l'esprit humain

So far, this lecture has concentrated on the far reaching economic benefits following the development of fundamental mathematics. I described only two examples, for lack of space, but could go on endlessly in most if not all fields of human activity. Fast developing examples include medical imaging, image compression for storage or transmission, epidemiology, biostatistic, mathematical genomics, finance, control theory for plane safety or energy saving ...

In this presentation, I followed the present day trend of having to prove the economic value of all activities, including art, mathematics, and culture.

But this is a sad evolution of our society, and mathematics should also be pursued "for the honour of the human mind", to coin the phrase of Carl Gustav Jacobi.

So I want to point out now that mathematics, like art, philosophy and science, are essential parts of civilisation.

The obvious example is the Greek civilisation, which left us as heritage (with contributions of the Arabic civilisation) art, mathematics, philosophy and the beginnings of science. It is these four aspects, and not the value of their stock exchange or whatever they had, that founded the rebirth of our civilisation after the Renaissance.

Civilisation as we live it is not defined in economic terms, and is our most precious asset.

The princes of Medicis, wealthy as they were, will be remembered forever for triggering that Renaissance.

Likewise, how should we remember Carl Wilhelm Ferdinant, Duke of Brunswick?

In my dictionary, he is described as a duke soldier who was beaten by the French in Valmy, then again in Iena.

But I must say I looked only in a French dictionary. Still, an uninspiring notice.

But one day, he got a report from a school teacher that a young boy seemed remarkably gifted in mathematics. The boy was the son of a poor gardener and bricklayer, so his future should have been rather bleak.

But the Duke liked mathematics, saw the boy and was convinced by his obvious talent (if not by his good manners). Thus he supported his studies and career throughout his life.

The boy's name was Carl Friedrich Gauss, and we owe to him (and the Duke) the Gauss law of prime numbers, the Gauss distribution in probability, the Gauss laws of electromagnetism, most of non-Euclidean geometry, and the Gauss approximation in optics.

Obviously, we need more Dukes of Brunswick in our governments.

More to the point, we need a European Research Council to cater for fundamental research.

Going back to the idea of civilisation, it seems that abstract mathematics - disjoint from practical applications - appears early in the development of the human mind.

The first mathematical ideas were practical: counting objects (like cattle), computing the area of a field, the volume of a pyramid.

But then why did Euclid care about prime numbers, or abstract proofs of geometric theorems? Why did the Babylonians, 1000 years before Pythagoras, engrave his theorem on their clay tablets? Why did the Egyptians develop a sophisticated and quite useless system of fractions?

On a bone, found by anthropologist Jean de Heinzelin in Ishango, Africa, a series of scratches provides the beginning of a multiplication table and a short list of prime numbers. The bone is dated between 7000 and 20000 years BC and the scratches could be a coincidence - or one of the first appearances of abstract mathematics.

I believe that the human mind, early in its evolution, has the need to think in abstract terms, and that mathematics unavoidably appears at this stage.

Finally, why do mathematicians do mathematics?

Why did Michelangelo paint and sculpt, why did Beethoven compose?

All for the same reason: because they must. As David Hilbert put it in 1930: Wir müssen wissen, wir werden wissen (we must know, we shall know).

Asked why he insisted in trying to climb Mount Everest, the famous mountaineer George Mallory answered: "Because it is there".

Likewise, mathematicians attack their own Everest (like Riemann's hypothesis) because it is there.

But when they reach the top, they have changed the scenery by their achievement.

Looking backward, they see the hard path that they have followed, but also some much easier and simplified paths now open to others.

Looking forward, they see higher mountains which were invisible or maybe did not exist before. Mountains that must now be climbed.

Because they are there.

Luc Lemaire [llemaire@ulb.ac.be] received a Doctorate from the Université Libre de Bruxelles in 1975 and a Ph.D. from the University of Warwick in 1977. From 1971 to 1982 he held a research position at the Belgian F.N.R.S., and has been a professor at the Université Libre de Bruxelles since then. His research interests lie in differential geometry and the calculus of variations, with a particular interest in the theory of harmonic maps.

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

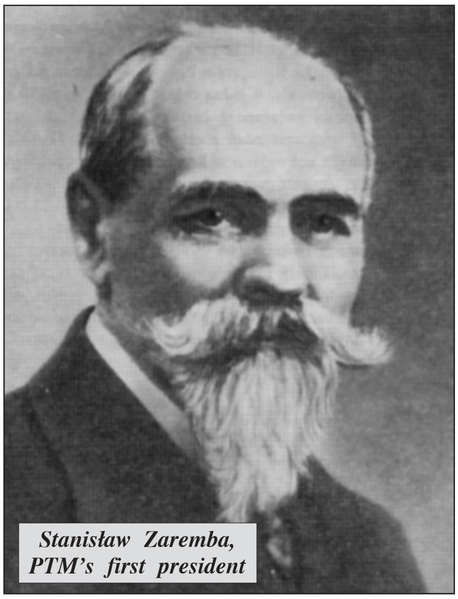
The Polish Mathematical Society (PTM)

Janusz Kowalski (Warsaw)

PTM in the early years

The Polish Mathematical Society was established in 1919. The Reader can find information regarding the circumstances of its rise, as well as a description of its activity during the first year of its existence, in an article by Józef Piórek in the *European Mathematical Society Newsletter* ([4]). Stefan Banach, Franciszek Leja, Otto Nikodym, Stanisław Zaremba and Kazimierz Żorawski were among its founder members, and Stanisław Zaremba was elected as the President of the Society. In 1921, the Mathematical Society in Cracow (*Towarzystwo Matematyczne w Krakowie*) was transformed into a national Polish Mathematical Society (*Polskie Towarzystwo Matematyczne*; PTM) with its headquarters in Kraków (Cracow).

According to its first statute, the Society's aim was "a comprehensive cultivation of pure and applied mathematics by means of scientific sessions combined with lectures". The first change to the statute - still in 1921 - resulted in the following insertion: "publication of a periodical and maintenance of contacts with the mathematical scientific movement".



Stanisław Zaremba, PTM's first president

Members not residing in Cracow were admitted to PTM through local sections. Within the period 1921-1939, the following sections existed: one in Lwów (Lvov), since 1921, and three others since 1923 in Warszawa (Warsaw), Poznań and Wilno (Vilnius). Since 1937, mathematicians from Cracow have constituted part of the Cracow section (after the Society's headquarters had been moved to Warsaw and its statute changed).

The number of members of the Polish Mathematical Society equaled 49 persons in 1921 and 155 persons in 1939. The Society was of a scientific character, as stated in the statute, where active and passive voting powers were given exclusively to authors of mathematical publications. A new statute, resolved in Lvov in 1936, established a federal organization of five sections with its headquarters in Warsaw. The General Meeting of PTM, which included delegates from all sections and the President of PTM, elected a president, a secretary and a treasurer - all of them constituting the General Management - as well as a Board of Control. The General Management also automatically included the presidents of the sections, who held titles of "vice-presidents of PTM". Sections held local meetings, where local General Management members were elected as well as those of local boards of control and delegates to the General Meeting of PTM. The aforementioned statute of 1936 substantially extended the aims of PTM. Apart from those adopted before, new ones were added, among others to organize competitions, to gather collections of publications, to improve work conditions for mathematicians, to maintain contacts with scientific institutions both within the country and abroad and to invite mathematicians from abroad to give lectures. The basic rules under this statute have been in force until present times.

Stefan Banach, elected president in 1939

Until 1936, when a Council for Exact and Applied Science (Rada Nauk Ścisłych i Stosowanych) and its organ called the Mathematical Committee were called into being by the government, the Polish Mathematical Society had been the only central institution representing Polish mathematics at home and abroad. Apart from assemblies of Polish mathematicians organized by this right, PTM was in contact with public institutions, voiced opinions on subjects related to science and education and issued its own periodical - "Annales de la Société Polonaise de Mathématique" - distributed nationally and internationally.

The post war years

In the years 1919-39, the time when the famous Polish mathematical school was established, Polish mathematics was a great success and met with a high esteem on the international forum. During the Second World War, when Poland fell under occupation, all official activity of the Polish Mathematical Society came to a standstill; only clandestine scientific sessions were held in Cracow and in Warsaw.

The second period of PTM's activity involves the years 1945-53, when Kazimierz Kuratowski acted as President. In 1945 the Cracow section was reactivated and in 1946 sections in Poznań and Warsaw started to operate again. Within the period 1946-53, six new sections were established. The number of members of PTM grew from 144 persons in 1946 to 339 in 1953.

During the first years of the post-war period, the Polish Mathematical Society was, similarly to the situation before 1936, the only institution actively covering the whole range of issues related to Polish mathematics. As such, it cooperated with Polish authorities on the reconstruction of the 3rd level education system (among others, it prepared a reform regarding mathematical studies and M.Sc. degrees in mathematics). PTM also cooperated on a regular basis with the Ministry of Education as well as other educational authorities, being a founding body of the first Olympic Games for secondary school students in the country, i.e. the Mathematical Olympic Games. The Society was also an initiator of research work and systematically convened scientific sessions. Within the years 1946-49, four assemblies of Polish mathematicians took place, the last one together with Czechoslovak counterparts. At the same time, annual competitions for the best works within the field of mathematics were organized. Editorial activities were launched by PTM as early as in 1945, when the 18th volume of "Annales de la Société Polonaise de Mathématique" was published.

Kazimierz Kuratowski

In 1948, the National Mathematical Institute (Państwowy Instytut Matematyczny) was established. That meant that PTM ceased to be the only central mathematical institution; therefore its activity started to be gradually limited to the profit of the Institute. After the Polish Academy of Sciences (Polska Akademia Nauk) had been called into being in 1952 (the National Mathematical Institute becoming a part of it after being renamed to: Mathematical Institute of the Polish Academy of Sciences - Instytut Matematyczny PAN), a third national mathematical institution came into being: the National Mathematical Committee of the Polish Academy of Sciences (Komitet Nauk Matematycznych PAN). Statutory tasks of the Mathematical Institute covered many fields, previously being within the scope of activity of the Polish Mathematical Society. In bigger scientific centres, numerous specialist seminars were established and, as a consequence, scientific sessions of PTM lost much of their appeal.

However, there still existed important scientific and social projects, which could only be carried out within the frame of a national scientific society that would assemble all scientific and didactic employees from within one field. A clear indication of this was a spontaneous establishment of PTM's new sections in cities and towns where new scientific and academic centres emerged. These were the sections in Toruń, Katowice and Szczecin - established in the years 1952-55 - and those in Białystok, Rzeszów, Słupsk, Częstochowa, Kielce, Olsztyn, Opole, Nowy Sącz and Zielona Góra - established in the years 1970-75. The saturation of big national scientific centres with specialist seminars made it necessary to do research work within a much wider scope that might be of interest to all mathematicians. There was also a need to hold a council dedicated to social and organizational issues. This type of activity was conducted by successive sections, as well as by the General Management of PTM, during section meetings, councils, conferences and assemblies of Polish mathematicians. The Polish Mathematical Society also fulfilled important tasks within the scope of cooperation with the educational authorities, and introduced new forms of teaching young people with a talent for mathematics. It also cooperated with foreign mathematical centers and initiated new publications. An aspect of significant value was PTM's help to newly established sections, effectuated mainly through delegating lecturers.

At the end of the 1960s, the Polish Mathematical Society got involved in a campaign to establish a new profession for mathematicians working within various branches of science, economy and state administration. This problem was the focus subject for the 10th Assembly of Polish Mathematicians - organized in Katowice in 1970, together with the National Mathematical Committee of the Polish Academy of Sciences. This Assembly, being the largest one in PTM's history as far as the number of participants is concerned (547), formulated new assignments for the Polish Mathematical Society and desiderata addressed to other institutions as well as a definite activity program. In this way, PTM managed to be a focal point for the majority of mathematicians working in various branches of economy. Members of the Polish Mathematical Society are employees of institutes of the Polish Academy of Sciences as well as educational centers such as various types of 3rd level education schools (including technical, pedagogic, economic, medical and agricultural ones), various teaching colleges and secondary schools.

Financial resources are derived from membership fees, subsidies granted by the Ministry of Scientific Research and Information Technology and by the Ministry of National Education and Sport.

According to the provisions of the first statute, PTM was supposed to "comprehensively cultivate pure and applied mathematics", but in practice was confined to "scientific sessions combined with lectures". A change in PTM's profile to a Society involved in large-scale scientific and social activity, became reflected in the development of various organizational structures, created within the Society's frame to fulfill defined assignments. By the end of 1975, six committees operated under the supervision of PTM's General Management: the Committee for Popularization of Mathematics and Higher Education, the Committee for Mathematics at Universities, the Committee for School Handbooks, the Committee for Application of Mathematics, the Committee for Publication and the Committee for an Information and Service Centre. Apart from these, there was a Main Committee for Mathematical Olympiads, which operated together with its local committees, seven editorial committees, one editorial board and four competition jury boards. Analogous teams operated under the supervision of local General Managements.

Roman Sikorski, who in the years 1953-75 impacted PTM's activity and development the most, was the Society's President between 1965 and 1977. Another important character in those years was Tadeusz Iwiński, Secretary in the years 1960-1981.

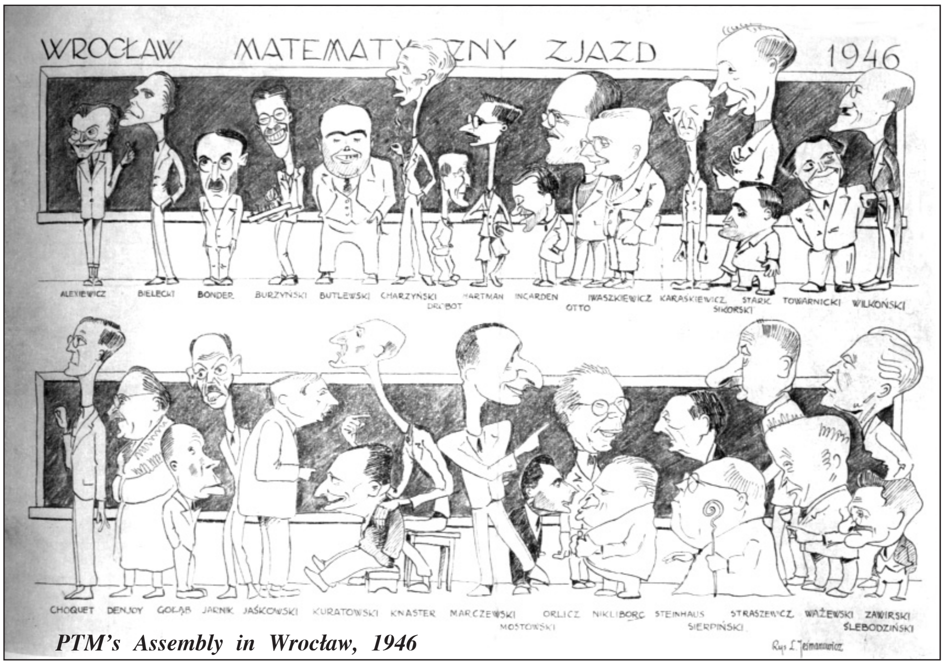
Conferences and Assemblies

Since the very beginning of PTM's existence, scientific lectures and discussions during local meetings, conferences and assemblies have been the basic form of activity. In the years 1919-39, as many as 1143 lectures were given, while in the period of 1949-75, the corresponding number was 5998 (there are no data covering the period of 1945-48). During the period between 1976 and 2003, as many as 3860 lectures were given. It is worth mentioning that members of other sec-

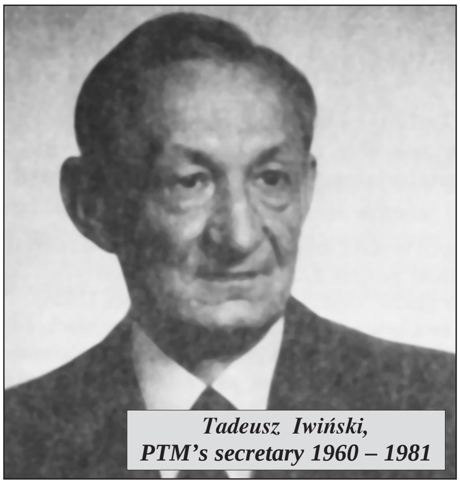

Roman Sikorski,
PTM's president 1965 – 1977

tions and mathematicians from abroad constituted a significant part of all lecturers. Foreign lecturers represented over 40 countries from all over the world.

The Polish Mathematical Society has so far organized 15 assemblies of Polish mathematicians (including 3 in the inter-war period), which usually take place every 5 years; in the remaining years, regular PTM meetings have been held. In 1929, PTM organized the First Congress of Mathematicians of the Slavic Countries. The assemblies are of scientific character. Their programmes involve lectures and reports of mathematical substance: cross-thematically during plenary meetings and those of a more specialized character during meetings in sections.



PTM's Assembly in Wrocław, 1946


Tadeusz Iwiński, PTM's secretary 1960 – 1981

These assemblies create an opportunity to ponder on more general issues regarding science, the system of education and social matters. These issues could even be a motive to convene a meeting (e.g. in the years 1969, 1970 and 1972).

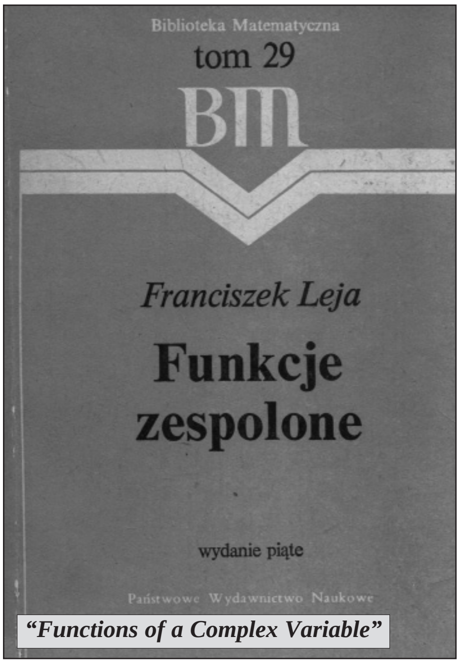
Since 1962 the Polish Mathematical Society has been organizing 2- to 4-day-long scientific sessions that, together with debates of the General Meeting of PTM, constitute the key elements of PTM's assembly. Forty sessions were held before 2004, which were dedicated to a general overview of selected issues related to contemporary mathematics, being of interest to all mathematicians. The thematic content of scientific sessions held in the years 1999-2002 embraced an overview of the most significant achievements in mathematics throughout the 20th century.

Publications

The publication of periodicals has been the second basic form of activity of the Polish Mathematical Society. In 1921, an organ of PTM entitled "Dissertations of the Polish Mathematical Society" was called into being, and one year later it was changed into a periodical named "Annales de la Société Polonaise de Mathematique". 25 volumes of this periodical were issued during the period 1922-52. In the years 1948-53, PTM started publishing other periodicals: a bimonthly for teachers entitled "Mathematics" ("Matematyka"), launched by PTM in 1948 but taken over by the Ministry of Education in 1953, and a series called "Mathematical Library" ("Biblioteka Matematyczna"), 1953. Apart from the ones mentioned above, the following titles were also published: "Fundamenta Mathematicae", "Studia Mathematicae", "Colloquium Mathematicum", "Mathematical Monographs" and "Mathematical Dissertations" (since 1952). In the years 1948-53, PTM supervised - by the order of the Ministry of Education - all Polish mathematical publications.

In 1953 the Mathematical Institute of the Polish Academy of Sciences took over all these publications, including PTM's official organ "Annales de la Société Polonaise de Mathematique", which was then renamed to "Annales Polonici Mathematici".

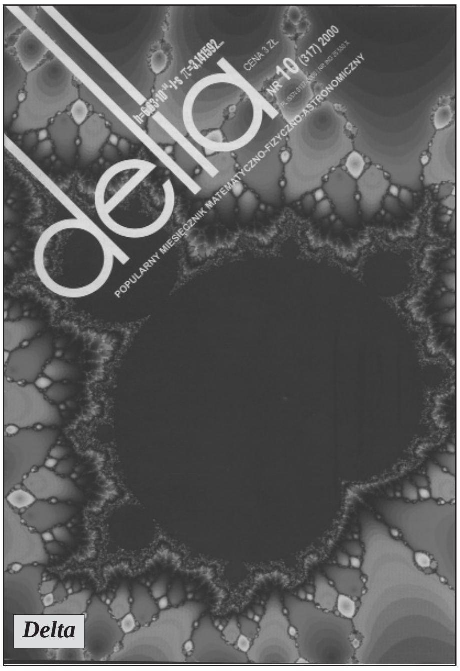
The Polish Mathematical Society started a new phase of publishing activity in 1955, when the first of each of two series of "PTM's Annals" were issued. Series 1: "Mathematical Papers" ("Prace Matematyczne"), which became "Commentationes Mathematicae" in 1967, published 43 volumes up to the year 2003. Series 2: "Mathematical News" ("Wiadomości Matematyczne") published 39 volumes up to the year 2003. In 1973, Series 3 was launched entitled "Applied Mathematics", which became "Applied Mathematics. Mathematics for the Society" in 2000, with 45 volumes published up to the year 2003. In 1977, Series 4 was launched, "Fundamenta



"Functions of a Complex Variable"

Wiadomości Matematyczne

Informaticae", publishing 56 volumes up to the year 2003. Finally, in 1982 Series 5 was launched, "Didactics of Mathematics" ("Dydaktyka Matematyki"); 25 volumes were published up to the



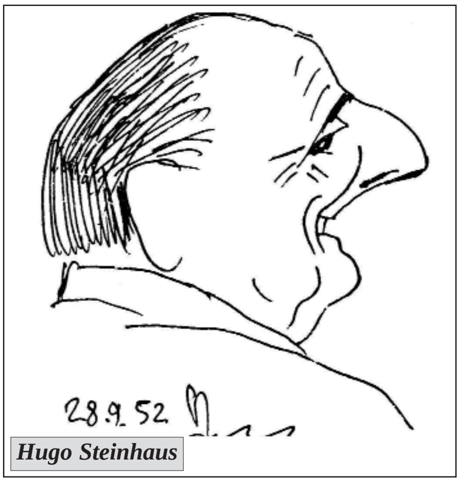
Delta

year 2003.

Since 1971, PTM has been distributing among its members an "Information Bulletin of the Polish Mathematical Society", which includes current news regarding scientific and organizational issues. At first it was published several times per year, but later this frequency diminished. After a two-year break (2000-2001) its publication was relaunched and continued on a more regular basis. Since 1974, further to an initiative of the Polish Mathematical and Physical Societies, a popular mathematical/physical monthly, entitled "Delta", has been published. The thematic scope of this publication was extended in 1979 by issues regarding astronomy. For more information about "Delta", see [4]. Two other periodicals are published with PTM's cooperation: "Mathematics" (a periodical for teachers) and "Gradient" (a periodical for teachers, pupils and their parents).

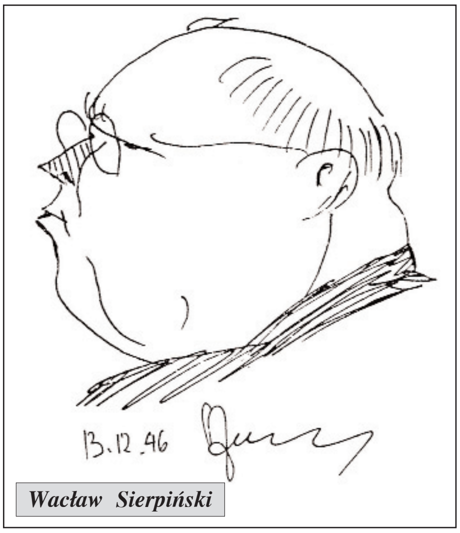
Competitions and prizes

The Polish Mathematical Society is also busy with organizing competitions and awarding prizes. There are two competitions open for entry to all Polish mathematicians, one for young mathematicians under 28 years of age and three for university students. Special PTM prizes have been set up, named after outstanding Polish mathematicians: Grand Prizes for scientific achievements (named after Stefan Banach, Stefan Mazurkiewicz, Stanisław Zaremba, Wacław Sierpiński, Tadeusz Ważewski, and Zygmunt Janiszewski); for achievements in the field of applied mathematics and practical elaborations (named after Hugo Steinhaus and Wacław Pogorzelski); final-



Hugo Steinhaus

ly, for achievements for the benefit of mathematical culture (named after Samuel Dickstein). PTM Prizes for young mathematicians have also been set up. The Toruń Section organizes the "Józef Marcinkiewicz Competition" for the best



Wacław Sierpiński

student's paper, the Wrocław Section does similarly for the best student's paper in the field of probability theory and mathematical applications, and the editorial board of "Didactics of Mathematics" organizes the "Anna Zofia Krygowska Competition" for the best student's paper in the field of didactics of mathematics. The Polish Mathematical Society is also involved in organizing and supervising competitions for prizes named after Kazimierz Kuratowski, Stanisław Mazur and Władysław Orlicz. It also takes part in carrying into effect the idea of lectures which are awarded with the "Wacław Sierpiński medal". On the whole, 836 prizes and 25 medals have been awarded so far.

The Polish Mathematical Society is a patron of activity aimed at bringing to light pupils with a talent in mathematics. This activity takes the form of a competition for schoolchildren's mathematical papers, organized by the editorial board of "Delta" monthly. This competition's finals take place during the annual Scientific Session of the Polish Mathematical Society. In the period 1976-2004, nearly one hundred schoolchildren were awarded with prizes and distinctions. First of all, they were from comprehensive secondary schools in big cities; however, among them there were also some pupils from secondary vocational schools in smaller towns.

Committees

In order to carry out its statutory tasks, PTM brings into being specialized committees. In 1953 a Committee for Popularization of Mathematics and in 1958 a Committee for Secondary Education were called into being by the General Management of the Polish Mathematical Society. In the period 1959-61, a subcommittee for a reform of programmes and teaching methods worked out projects and drafts regarding some school handbooks. This programme was introduced to schools with minor amendments and PTM cooperated with the Ministry of Education in its being carried out. In 1968 a Committee for School Handbooks was called into being to organize debates in working teams (in the period 1968-71), publish articles, deliver relevant materials to authors, and prepare reviews of handbooks (including organized debates over them). The Committees for Secondary and Primary Education and for Popularization of Mathematics worked within three spheres: scientific activity (focusing on the most recent results of scientific research related to didactics of mathematics), analysis of documents and cooperation in their being elaborated (legal acts and instructions concerning educational policy), and working out methods of modernizing the process of teaching mathematics as well as preparing the mathematics teachers for new tasks.

The Committees for Secondary and Primary Education and for Popularization of Mathematics, in cooperation with the Association of Teachers of Mathematics, organized, among others, a national scientific seminar devoted to didactics of mathematics. During this seminar, some proposals of methodical and didactic solutions were put forward which concerned various levels of education in relation to mathematics. Special attention was paid by the Committee to the role of mathematics at the "matura" examination (i.e. the final high school examination). This was exemplified by the "Open letter by the Polish Mathematical Society", accepted by PTM's General Meeting in Lublin in 1992 (published in numerous dailies and weeklies).

In 1962 the Polish Mathematical Society called into being a Committee for University Education which worked in two teams: one dedicated to non-universitary schools and one dedicated to universities and pedagogic schools. These teams embraced among other activities: a reform of the course and the programmes of studies (1964-67), educating mathematicians at technical schools (1962-65), the inter-school exchange of students and candidates for a doctor's degree, methods of educating future mathematicians, assessment of experimental programs, modernization of teaching methods, and education by the media. In the following years, smaller specialised committees emerged from this Committee.

In 1993, the Committee of Mathematics at Universities, Pedagogical Academies and Teaching Colleges, together with its counterparts in the Polish Physical, Chemical and Biological Societies, handed to the Ministry of Education a "Memorial regarding education within the scope of non-major basic subjects at tertiary-level schools". The Committee analyzed the phenomenon of intensified diversification of programmes related to teaching mathematical subjects in mathematical faculties at individual universities.

On the initiative of the Committee of Mathematics at Technical Universities, tests were conducted in 1995 to verify the level of mathematical knowledge of 1st year students at several technical tertiary schools. The results, which turned out to be somewhat alarming, were passed on to educational authorities and made public. Following this, the Committee insisted that an entry examination in mathematics be compulsory at all technical tertiary schools until a compulsory "matura" examination in mathematics was introduced.

The Committee for Mathematics in Economic Studies was busy with problems related to "the New Matura" examination in mathematics and a "programme base" for mathematics in economic studies.

Since 1987, the Committee for the History of Mathematics, under the auspices of PTM's General Management and in cooperation with mathematical institutes of schools of higher education, has been organizing annual Schools of History of Mathematics. 18 such schools were organized until the year 2004.

During the PTM's assembly in 1970, a Committee for Application of Mathematics was established in response to the fact that many "non-academic" (working in various branches of economy) mathematicians had joined the Polish Mathematical Society. This obliged the Committee to organize (in cooperation with other institutions) annual Conferences of Application of Mathematics, where mathematical models applicable to specified practical issues were acquired and presented. 32 such conferences took place until the year 2003.

In 1972, an Information and Service Centre was set up. Up until the end of the 1980s, it was responsible for solving problems submitted by various scientific and economic institutions, acting as advisor and conducting training for groups of employees in their workplace. During PTM's scientific sessions, assemblies and conferences, problems from applied mathematics have been the subject of a much more detailed scrutiny now than in the past.

Popularization

The Polish Mathematical Society undertakes various types of actions to commemorate Polish mathematicians. Many streets in Cracow, Warsaw and Wrocław have been named, on PTM's initiative, after outstanding mathematicians: Stanisław Gołąb, Bronisław Knaster, Mirosław Krzyżański, Kazimierz Kuratowski, Franciszek Leja, Edward Marczewski, Zdzisław Opial, Witold Pogorzelski, Marian Rejewski, Wacław Sierpiński, Stefan Straszewicz, Jacek Szarski, Tadeusz Ważewski and Stanisław Zaremba.

Further to PTM's application, on 23rd November 1982 the Polish Post-Office issued four stamps in a "Polish mathematicians" series with portraits of Stefan Banach, Zygmunt Janiszewski, Wacław Sierpiński and Stanisław Zaremba. On the initiative of PTM's Cracow Section, a monument dedicated to Stefan Banach was erected, to be unveiled with due ceremony on 30th August 1999 during the XV Assembly of Polish Mathematicians.

The Polish Mathematical Society carries on its activities in the school environment. It organizes lectures for teachers and schoolchildren, as well as the general public. 3637 such lectures were given in the years 1952-2003. Since 1954, PTM has been managing inter-school mathematical circles and competitions for talented pupils. 1100 such forms of work have been recorded so far.

Occasionally, other forms of popularization of mathematical knowledge are used: scientific camps for young people, distance learning studies (delivery of source materials and assignments to students and sending back corrected assignments), and guidance units for schools' mathematical circles.

The Mathematical Olympic Games have been operating under the auspices of the Polish Mathematical Society. 55 Olympiads were held in the years 1949-2004: 81972 pupils took part in 1st degree competitions, 20718 in 2nd degree competitions and 3846 in 3rd degree competitions. The total number of laureates amounted to 817, and of those awarded with a distinction title, to 444. Since 1959, a 6-8 person delegation has been chosen to participate in international mathematical Olympiads. Three of such Olympiads were organized in Poland in 1963, 1972 and 1986. Since 1977, there has also been a 6-person delegation chosen to participate in the Polish-Austrian mathematical competitions, organized each year alternately in Poland and in Austria. Since 1992, a 5-person delegation has been chosen to participate in mathematical competitions of the Baltic States, organized by Poland in 1998.

Stefan Straszewicz, organiser of Mathematical Olympic Games

Several mathematicians have been working on the organization of the Olympic Games. The first Chairman of the Main Committee was Stefan Straszewicz, one of the creators of the Mathematical Olympic Games, who held this position for 20 years (1949-1969).

The Toruń, Wrocław and Nowy Sącz sections, popularized among pupils and students, as well as among adults, the idea of participation in three international mathematical competitions: "Kangaroo", "International French Championship in Mathematical and Logical Games" and "Mathématiques sans Frontičres".

International Cooperation

The Polish Mathematical Society has been actively cooperating with the mathematical community abroad. Since the first years of PTM's existence, lectures have been organized to be given by foreign mathematicians at various occasions or at a special invitation to give a lecture in Poland. These lectures are given during scientific sessions in PTM's local sections, during PTM's conferences or assemblies. Nearly 2000 such lectures were held in the years 1949-2003. The Polish Mathematical Society made agreements for an exchange with the following societies: Czechoslovak (1962), Bulgarian (1968), Hungarian (1973) and Greek (1980). Within this framework, in the years 1976-1990, 390 persons profited from the exchange program on both sides, spending both in Poland and in the other above mentioned countries a total of 2641 so-called "exchange days". In the case of Greece, such cooperation took place in the years 1980-1982.

Stanisław Zaremba, the President of the Mathematical Society with its seat in Cracow, represented Polish mathematics during the International Mathematical Congress, held in 1920 in Strasbourg. The International Mathematical Union (IMU) was established there by representatives from 11 countries: Belgium, Czechoslovakia, France, Greece, Japan, Poland, Portugal, Serbia, United States of America, Great Britain and Italy. Among the members of the Executive Committee of the International Mathematical Union were Kazimierz Kuratowski (1959-1962), a patron of one of PTM's prizes, and Czesław Olech (1979-1982, 1983-1986). In the years 1963-66, K. Kuratowski acted as Vice-President of the Union.

The Polish Mathematical Society sent its own delegations to 4 international congresses organized by the International Mathematical Union (Stockholm in 1962, Moscow in 1966, Nice in 1970 and Helsinki in 1978), as well as to 16 scientific conferences in the years 1950-75. In 1983, Poland was the organizer of the International Mathematical Congress in Warsaw. Due to the Martial Law imposed in 1981, the Congress, initially planned to take place in 1982, could only take place as late as 1983. The Organizing Committee was presided by Czesław Olech, who was also elected President of the Congress.

The Polish Mathematical Society has also been cooperating with the American Mathematical Society (AMS) and the Canadian Mathematical Society (CMS) on the basis of a reciprocity agreement.

The Polish Mathematical Society is also one of the founder members of the European Mathematical Society (EMS), called into being in December 1990 during a meeting held in the Polish Academy of Sciences conference centre in Mądralin near Warsaw. EMS was established thanks to the initiative of about 30 mathematical societies representing nearly all European countries.

During the founding meeting, the Polish Mathematical Society was represented by Bogdan Bojarski (then director of the Mathematical Institute of the Polish Academy of Sciences) and Andrzej Pelczar, PTM's President in the years 1987-1991. One of EMS's first Vice-Presidents, elected for the term ending in 1992, was Czesław Olech. During the term 1992-96, Andrzej Pelczar acted as a member of the Executive Committee of EMS and later, in the years 1997-2000, as EMS's Vice-President. Another organ of EMS's authority is the Society's Council, where the Polish Mathematical Society holds a two-person representation. During the term 1999-2002, its representatives were Julian Musielak and Andrzej Pelczar. Kazimierz Goebel and Zbigniew Palka have been elected for the term 2002-2006.

This elaboration has been written on the basis of an article by Tadeusz Iwiński *[2]*

Honorary Members

In recognition for contributions to the development of mathematics, its being taught, applied and popularized, as well as in acknowledgement of devoted participation in PTM's activities, the Polish Mathematical Society confers the dignity of Honorary Member of PTM. The following mathematicians have been given this dignity so far: Paweł S. Aleksandrow, Donald W. Bushaw, Karol Borsuk, Zygmunt Butlewski, Zbigniew Ciesielski, Mieczysław Czyżykowski, Samuel Eilenberg, Pŕl Erdős, Eugeniusz Fidelis, Stanisław Gołąb, Tadeusz W. Iwiński, Wiktor Jankowski, Leon Jeśmanowicz, Bronisław Knaster, Andriej N. Kołmogorow, Jan Kozicki, Anna Krygowska, Włodzimierz Krysicki, Kazimierz Kuratowski, Andrzej Lasota, Jean Leray, Franciszek Leja, Stanisław Łojasiewicz, Edward Marczewski, Stanisław Mazur, Jan Mikusiński, Julian Musielak, Jerzy Spława-Neyman, Witold Nowacki, Władysław Orlicz, Franciszek Otto, Aleksander Pełczyński, Helena Rasiowa, Marian Rejewski, Edward Sąsiada, Wacław Sierpiński, Hugo Steinhaus, Roman Sikorski, Stefan Straszewicz, Władysław Ślebodziński, Andrzej Turowicz, Eustachy Tarnawski, Kazimierz Urbanik, Antoni Wakulicz, Tadeusz Ważewski, Lech Włodarski, Zygmunt Zahorski, Antoni Zygmund.

PTM's presidents (1946 – 1977)

Presidents

The function of President of the Polish Mathematical Society was performed by: Stanisław Zaremba (1919-21, 1936-37), Wiktor Staniewicz (1921-23), Samuel Dickstein (1923-26), Zdzisław Krygowski (1926-28), Wacław Sierpiński (1928-30), Kazimierz Bartel (1930-32), Stefan Mazurkiewicz (1932-36, 1937-39), Stefan Banach (1939-45), Karol Borsuk (1946), Kazimierz Kuratowski (1946-53), Stefan Straszewicz (1953-57), Edward Marczewski (1957-59), Tadeusz Ważewski (1959-61), Władysław Ślebodziński (1961-63), Franciszek Leja (1963-65), Roman Sikorski (1965-77), Władysław Orlicz (1977-79), Jacek Szarski (1979-81), Zbigniew Ciesielski (1981-83), Wiesław Żelazko (1983-85), Stanisław Balcerzyk (1985-87), Andrzej Pelczar (1987-91), Julian Musielak (1991-93), Kazimierz Goebel (1993-99), Bolesław Szafirski (1999-2003), Zbigniew Palka (2003-).

References

[1] *K.Ciesielski, Z.Pogoda,* Interview with Marek Kordos, *Newsletter of the European Mathematical Society* **41** (2001).

[2] *T.Iwiński,* Polskie Towarzystwo Matematyczne [The Polish Mathematical Society] *in:* Słownik polskich towarzystw naukowych [Dictionary of Polish scientific societies], *Warszawa 1975.*

[3] *T.Iwiński,* Ponad pół wieku działalności matematyków polskich [More than 50 years of activities of Polish Mathematicians], Państwowe Wydawnictwo Naukowe [Polish Scientific Publishers], *Warszawa 1975.*

[4] *J. Piórek*, From the minutes of the Mathematical Society in Cracow, *Newsletter of the European Mathematical Society* **32** (1999).

Janusz Kowalski [Z.G.PTM@impan.gov.pl] graduated in mathematics at Warsaw University in 1969. He currently works at the Łazarski Law and Trade University in Warsaw. For many years he taught at secondary schools in Warsaw. Since 1988 he has been the Vice-Secretary of the Polish Mathematical Society. He is also a member of the Polish Mathematical Society Commission of Teaching and Popularization.

INTERNATIONAL CENTRE FOR MATHEMATICAL SCIENCES

http://www.icms.org.uk

ERCOM: ICMS Edinburgh

The inaugural event of Edinburgh's International Centre for Mathematical Sciences (ICMS) was a meeting on Geometry and Physics held at Newbattle Abbey near Edinburgh in March 1991. Alain Connes, Roger Penrose and Simon Donaldson were among the speakers and Jacques-Louis Lions (Collège de France) was chair of the ICMS Programme Committee.

ICMS had been founded by a partnership that involved Edinburgh and Heriot-Watt universities, Edinburgh City Council, and the *International Centre for Theoretical Physics* in Trieste, with support from some of Edinburgh's financial institutions. An important figure during those early days of ***ICMS*** was John Ball, currently president of the *International Mathematical Union***.** The Nobel Prize winner Abdus Salam also took a keen interest in its development.

In 1994 ***ICMS*** moved to its current premises, 14 India Street, which is the house in Edinburgh's New Town where the celebrated physicist James Clerk Maxwell was born on 13 June 1831.

Purpose of ICMS

From the outset the purpose of ***ICMS*** was to

- Create an environment in which the mathematical sciences will develop in new directions
- Encourage and exploit those areas of mathematics that are relevant to other sciences , industry and commerce
- Promote international cooperation with particular reference to mathematicians working in developing countries

As a joint venture of its two founding universities, ***ICMS*** has, under the leadership of Angus MacIntyre, its first Scientific Director, established a strong reputation for running high quality international workshops across the full range of mathematical sciences and for bringing the best mathematicians in the world to Edinburgh and the UK. This record is all the more remarkable because it has, until now, been achieved in the absence of systematic core funding from government agencies, using only funds raised through the initiative of organisers who brought their projects to Edinburgh.

Editorial services, workshops and meetings

To compensate for the lack of core funding for its activities, ***ICMS*** has been developing a modest commercial arm by offering editorial services to journals and management services to research agencies. Currently, editorial work for the *Proceedings of the Royal Society of Edinburgh* and *Proceedings of the Edinburgh Mathematical Society* are done at ***ICMS*** headquarters, and ***ICMS*** manages the *Environmental Mathematics and Statistics Workshops* on behalf of the

Natural and Environmental, and the Engineering and Physical Sciences, Research Councils.

Determined that ***ICMS*** should succeed with its mission despite limited means, over the past decade a small but highly committed and resourceful staff has produced a range of meetings of outstanding quality across the entire range of the Mathematical Sciences, from *New Mathematical Developments in Fluid Mechanics* (1995) organised by Constantin, P-L Lions and Majda to the recent celebration of the *Centenary of Sir William Hodge* who was born in Edinburgh in 1903. This meeting, which was organised by Atiyah, Bloch, Donaldson, Griffiths and Witten, with members of Hodge's immediate family attending the historical lectures and the banquet, was described as 'stellar' by one distinguished participant. Details of meetings held since 1995 are available at http://www.icms.org.uk/previous/index.html.

In addition to research workshop activity ***ICMS*** has played a full part in the mathematical life of Scotland and of the UK. On the one hand it had a pivotal role in the organisation of *ICIAM* which brought over 2000 delegates to

Delegates at Geometry and Physics, Newbattle Abbey, 1991

New Mathematical Developments in Fluid Mechanics, Edinburgh, 1995 - part of the UNESCO 50th anniversary celebrations.

Edinburgh in 1999 and, on a totally different scale, it runs workshops and support meetings for research students in Scottish universities. It also encourages workshops on industrial problems from the local region. Most recently, in 2004 ICMS joined with the Faculty of Actuaries to set up a major meeting for senior professional actuaries on the problems currently facing the pensions industry in the UK and worldwide.

The Future

With its strong record of past achievement on a limited budget, in November 2004 ***ICMS*** and its two founding universities entered a partnership with the *Scottish Higher Education Funding Council* (*SHEFC*) and the UK's *Engineering and Physical Sciences Research Council* (*EPSRC*) with the aim of having guaranteed funds for workshops from now until 2008/9. During that period the ***ICMS*** Programme Committee, under the chairmanship of Jerry Bona (University of Illinois at Chicago), will have at its disposal funds for about eight international workshops per year, each with about 40 participants, and at the same time will continue to solicit proposals for workshops of various sizes from organisers who can make other funding arrangements. The new arrangement will enable ***ICMS*** to improve its facilities and very soon past visitors to India Street will see changes, with new decoration, modernisation of the lecture-room facilities and the introduction of new break-out rooms and computer equipment. Workshop organisers and participants will still benefit from the experience of the Centre Manager, Tracey Dart, who will now be able to designate one of the ***ICMS*** staff as a Conference Coordinator to each workshop. ***ICMS*** will continue to offer editorial and managerial services to the academic community.

With the new arrangements in place the ***ICMS*** Scientific Director, John Toland (University of Bath), and the Programme Committee are now soliciting high quality adventurous proposals in all branches of the mathematical sciences and scientific areas with significant mathematical content and, to be fair to inter-disciplinary proposals, will find ways to counter the inherent conservatism of the peer review process. They will also continue to look for ways to support participants from developing countries, an important part of the ***ICMS*** mission since it was founded, but still difficult because of a lack of available funding.

Within the United Kingdom the role of ***ICMS*** in promoting and supporting short workshop activity in Edinburgh complements that of the *Isaac Newton Institute* in Cambridge where support for researchers in residence in Cambridge is the key to the success of its long-term research programmes. In fact the two institutes are developing a good understanding and a close working relationship.

Institutional Structure

ICMS is a joint venture of Heriot-Watt and Edinburgh universities, is an institutional member of the *European Mathematical Society* and is represented on *European Research Centres on Mathematics* (*ERCOM*). The scientific programme is controlled by the Programme Committee with membership drawn from across the UK and abroad. Resources from *EPSRC, SHEFC*, Heriot-Watt and Edinburgh Universities, and elsewhere are allocated to individual workshops by a Management Committee of the two universities, following advice

Distinguished participants at the Hodge Centenary Conference, Edinburgh, 2003, including past and current scientific directors Angus MacIntyre (bottom row, second left) and John Toland (middle row, third left).

Call for Proposals

Proposals are invited for workshops to be held at ICMS in Edinburgh in 2005/6.

The International Centre for Mathematical Sciences (***ICMS***) is based in central Edinburgh, in the birthplace of James Clerk Maxwell. Following new funding arrangements with EPSRC for the period 2005 to 2008 ***ICMS*** is able to offer support to run workshops and symposia on all aspects of the mathematical sciences in new or traditional subjects and interdisciplinary areas with significant mathematical content.

The core of ***ICMS*** activity will be the rapid-reaction research workshop programme (R3WP). ***ICMS*** therefore particularly welcomes proposals for workshops in rapidly-developing and newly-emerging areas where there is a need to evaluate new developments quickly. ***ICMS*** will respond quickly to such proposals. Organisers can expect preliminary comments from reviewers in 8 weeks. Decisions will be made by the Programme Committee four times a year (December, March, May and September). Small meetings can be organised in 6-8 months from acceptance.

Potential organisers should contact ***ICMS*** as early as possible to discuss ideas, before submitting a firm proposal. The proposal document should not normally exceed five pages and should be submitted electronically (PDF, PS, Word or DVI). Proposals may be submitted at any time.

Full instructions on how to submit a proposal, together with details of the refereeing process and criteria for selection can be found on the webpages:

http://www.icms.org.uk/call/index.html

Anyone unable to read these pages or download documents can order print versions from ***ICMS***.

If your application is successful, you will be offered a funding package to contribute to the travel and subsistence of a proportion of the participants. ***ICMS*** staff will undertake all non-scientific administration connected with the workshop (such as issuing invitations, processing registrations, organising accommodation, preparing material, financial administration). One of the Scientific Organisers (often an author of the initial proposal) will be appointed Principal Organiser and be the main point of contact.

For all enquiries about ***ICMS*** or the procedures for submitting a proposal, please contact Tracey Dart, Centre Manager, ***ICMS***, E-mail Tracey.Dart@icms.org.uk (14 India Street, Edinburgh EH3 6EZ, Tel +44 (0)131 220 1777; Fax +44 (0)131 220 1053).

from the Programme Committee. ***ICMS*** is advised by the ***ICMS*** *Board*, whose membership is drawn from organisations with an interest in ***ICMS***, such as the Edinburgh and London Mathematical Societies, the Royal Society of Edinburgh, ICTP, and the City of Edinburgh.

International Centre for Mathematical Sciences
14 India Street, Edinburgh EH3 6EZ

Scientific Director & Chair of the Management Committee:
John Toland (University of Bath)

Programme Committee Chair:
Jerry Bona (University of Illinois at Chicago)

Management Committee Deputy Chairs:
Chris Eilbeck (Heriot-Watt University)
Tony Carbery (Edinburgh University)

Centre Manager:
Tracey Dart (ICMS)

The classical Georgian house in central Edinburgh that is the headquarters of ***ICMS*** has proved an attractive venue for workshops and with the new funding arrangements will, it is hoped, continue to be so far in the future.

Ramanujan Prize for Young Mathematicians from Developing Countries

The Abdus Salam International Centre for Theoretical Physics (ICTP) is pleased to announce the creation of the Ramanujan Prize for young mathematicians from developing countries. The Prize is funded by the Niels Henrik Abel Memorial Fund.

The Prize will be awarded annually to a researcher from a developing country less than 45 years of age at the time of the award, who has conducted outstanding research in a developing country. Researchers working in any branch of the mathematical sciences are eligible. The Prize carries a $10,000 cash award and travel and subsistence allowance to visit ICTP for a meeting where the Prize winner will be required to deliver a lecture. The Prize will usually be awarded to one person, but may be shared equally among recipients who have contributed to the same body of work.

The Prize will be awarded by ICTP through a selection committee of five eminent mathematicians appointed in conjunction with the International Mathematical Union (IMU). The first winner will be announced in 2005. The deadline for receipt of nominations is July 31, 2005.

Please send nominations to director@ictp.it describing the work of the nominee in adequate detail. Two supporting letters should also be arranged.

Problem Corner
Contests from Bulgaria Part IV
Paul Jainta

Unquestionably, the peak of most sports events culminates in a grand finale. And it's often been this way with intellectual challenges, say, maths contests. Finalists in these meetings have to clear the hurdles of divers selection criteria and/or come through several qualifyings, i.e. local and regional qualifying rounds bearing particularly exotic names, and observe specific rules on the whole. For example, in Bulgaria they are trading under unusual names such as the 'Virgil Krumov' contest or the 'Chernorizets Hrabar Tournament' and so on .

The last three issues of Problem Corner have dealt with the wealth of different competitions. Here, all roads lead to the national highlight for mathematically able youngsters, the National Mathematics Olympiad (NMO). But it would go beyond the scope of this Corner to enumerate the whole plethora of contests that Bulgaria offers to its adolescents in this field. For, in spite of this diversity, the separate maths trials are distinguishing from one another only by nuances. The National Bulgarian Mathematics Olympiad represents a country-wide showdown for native pupils to decorate themselves with the unofficial title of champion of maths, as reported by **Prof. Sava Grozdev**, Institute of Mechanics, Bulgarian Academy of Sciences, Sofia. Here comes his final part of a long story that describes the efforts made in his country towards getting young people really interested in mathematics.

The National Mathematics Olympiad

The Bulgarian National Mathematics Olympiad (BNMO) originates in 1949 and was actually the first competition organized in Bulgaria. Because of a two year interruption during the period 1957-59, the 53rd National Olympiad took place in May, 2004. Initially, only students from grades 8 to 11 were permitted to participate in the Olympiad. At present the contest is open to grades 4 to 12. The BNMO is run in 3 rounds. Naturally, the first round, better known as 'school' round, is conquered by participants. About ten years ago, the number of starters evened out at 150 000 individuals, almost 10 per cent of all participating students. Currently, the initial number is reduced to about 20 000. One of the reasons for this decrease is a reduction in the total number of students due to a strongly abating birth-rate.

During the first round students have to solve three questions within four hours. All problems are compiled and worked out by the Regional Inspectorates of Education while the present teachers are asked to correct the examination papers of their own charges. About 30 per cent of all participants in this round will pass to the second stage, the regional round. Students of different grades are gathered in regional centres and have to solve three problems within four hours again. This time, the responsibility for the set of questions lies in the hands of the National Olympiad Commission and the examination papers are marked under the supervision of regional inspectors. The third round, or the National round, is reserved for students from grades 8 to 12. In former times there was an additional round for 7-graders, and these results were partially used as a permit to enter a Mathematics-, Foreign Language-, or Technical School. Alas, this tradition does not exist any more because of a complete restructuring of the veteran educational system, which is still going on. The third round is a two-day event like the International Olympiad. Students are asked to solve three problems each day within 4 or 5 hours. The National Commission in Mathematics creates the problems and is also responsible for marking the examination papers. The coordination of the results is carried out in the presence of both teachers and students. This procedure is a fully objective, fair and thus democratic element of the construct, called BNMO. Usually, the number of participants in the third round is about 100, with a growing tendency to drop further. For instance, in May 2002 the total number of students in the third round of the National Olympiad reached a minimum of 38 'survivors'. The champions of the final round are awarded the possibility to study Mathematics at a Bulgarian University of their choice, without passing entrance examinations. The universities in Bulgaria (about 40) follow an autonomous policy, which includes such individual tests, but they respect the results achieved at the National Olympiad, and thus are acknowledging high level talents. Besides this, the 12 students with the highest scores in the third round are invited for further selection each year. The selection includes two two-day tests consisting of six problems in all. When the six constituents of the National team have finally been identified, they have to undergo a fortnight preparation for the International Olympiad afterwards.

Bulgaria is one of the founder countries of the International Mathematics Olympiad (IMO) and has participated in all its 42 editions. Only two other countries can look back to a similar constance: Romania and the Czech Republic. Bulgarian students have won 32 gold, 73 silver and 81 bronze medals altogether. During the last 10 years, Bulgaria has ranked among the top ten countries with best performance, and regarding the last 4 years, Bulgaria has even moved into the best five. France, Germany, England, Italy and other countries that are world centres of Mathematics, have much lower rankings. In 1998 in Taiwan, Bulgaria was second, in 1999 and in 2000 - fifth, in 2001 with the participation of exactly 83 countries - third. The International Jury awards exceptional prizes to students with extraordinary achievements. Since 1987, only two prizes have been awarded. Both of these were addressed to Bulgarians: in Australia in 1988 and in Canada in 1985. The recent winner of a special prize was Nikolay Valeriev, who represents a real phenomenon of the IMO: from four participations he has won three gold and one silver medal. During the long history of the IMO, the mother of all maths contests worldwide, there have been only five other participants with comparable achievements. Four of them were before 1974, when the number of participating countries was limited. The fifth was Ride Burton from the USA team, who obtained four gold medals out of four and maintains a world record in this branch until today. Nowadays, the Bulgarian student Alexander Lishkov has the possibility to improve this mark, since he has one silver medal and four more participations to come through.

What is expected from those who have worked their way from a large field of starters up to the finale can best be learnt by an examination of the problems posed in my recent Corner. The new set is a bundle of questions which were used while preparing the Bulgarian team for participating in the International Mathematical Olympiad, held in Glasgow, Scotland, July 17 - 30, 2002. All problems are original and are worked out by members of the Team for Extra Curricula Research in cooperation with the Union of Bulgarian mathematicians.

164 Strange animals live in a building with $n \geq 3$ floors. The roof is considered the (n+1)st floor. Exactly one animal is living on the first floor, while one animal at most is living on each of the other floors. Within a month curious things will happen: Exactly once a month each animal gives birth to a new animal. Immediately after his birth the new animal moves to the nearest upper floor and remains there if the floor is unoccupied by another animal. If not, the newborn animal eats the previous inhabitant and walks on to the next upper floor repeating the same procedure. But a giant is dwelling on the roof and if an animal enters the roof, it will be eaten by the giant. The same things will happen the next month and so on. It is known that all the animals give birth to new animals simultaneously. What is the smallest number of months, after which the building will be settled the same way as it was at the beginning?

165 Consider a regular polygon with 2002 vertices and all its sides and diagonals. How many different ways can you choose some of them, such that they form the longest continuous (= connected) route?

166 Given the sequence: $x_1 = \frac{a}{2}, x_{n+1} = x_n^2 + x_n + 1, \quad (n \geq 1)$, where a is a positive integer. Prove that $\sqrt{x_n}$ is irrational for every $n \geq 3$.

167 All points on the sides of an acute triangle *ABC* are coloured white, green or red. Prove that there exists 3 points of the same colour, which form the vertices of a right triangle, or rather there exists 3 points of different colours, which are vertices of a triangle similar to the given one.

168 Given is a sequence of polynomials: $P_1(x) = x$, $P_2(x) = 4x^3+3x$, …, $P_{n+2}(x)= (4x^2+2)\cdot P_{n+1}(x) - P_n(x)$, $n \geq 1$. Prove that there are no positive integers *k*, *l* and *m*, such that $P_k(m) = P_l(m+4)$.

169 Find all continuous functions *f*: **R→R,** such that f satisfies the functional equation: $f(x + f(x)) = f(x)$ for all real x.

It remains for me to present solutions to questions 152 to 157, published in Issue 49 of the Corner. All problems come from Hungarian sources, which stand for high quality of course.

152 The first four terms of an arithmetic progression of integers are a_1, a_2, a_3, a_4.
Show that $1\cdot a_1^2 + 2\cdot a_2^2 + 3\cdot a_3^2 + 4\cdot a_4^2$ can be expressed as the sum of two perfect squares.

Solution by ***J.N. Lillington, Wareham, UK*** .

Let $a_1 = a$, $a_2 = a+d$, $a_3 = a+2d$, $a_4 = a+3d$, where a,d are integers. Then $1\cdot a_1^2 + 2\cdot(a+d)^2 + 3\cdot(a+2d)^2 + 4\cdot(a+3d)^2 = a^2 + 2a^2 + 4ad + 2d^2 + 3a^2 + 12ad + 12d^2 + 4a^2 + 24ad + 36d^2 = 10a^2 + 40ad + 50d^2 = a^2 + (3a)^2 + 40ad + d^2 + (7d)^2 = (3a+7d)^2 + (a-d)^2$.
Also solved by Niels Bejlegaard, Copenhagen, Denmark; Pierre Bornsztein, Maisons-Laffitte, France; Erich N. Gulliver, Schwäbisch-Hall, Germany; Gerald A. Heuer, Concordia College, Moorhead, MN, USA, and Dr Z Reut, London, UK.

153 Is it possible to get equal results if $\sqrt{10^{2n} - 10^n}$ and $\sqrt{10^{2n} - 10^n + 1}$ are rounded to the nearest interger? (n is a positive interger).

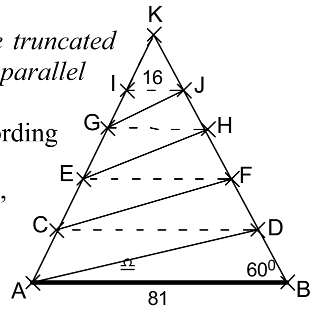
Solution by ***Gerald A. Heuer*, *Concordia College, Moorhead, MN, USA .***

No. From the fact that $10^{2n} - 10^n < 10^{2n} - 10^n + \frac{1}{4} < 10^{2n} - 10^n + 1$ it follows that

$\sqrt{10^{2n} - 10^n} < 10^n - \frac{1}{2} < \sqrt{10^{2n} - 10^n + 1}$. Therefore the nearest integer to $\sqrt{10^{2n} - 10^n}$ is at most 10^n-1, while the nearest integer to $\sqrt{10^{2n} - 10^n + 1}$ is 10^n.
Also solved by Niels Bejlegaard, Pierre Bornsztein, E.N. Gulliver, J.N. Lillington, and Dr Z Reut, London.

154 An Aztec pyramid is a square-based right truncated pyramid. The length of the base edges is 81 m, the top edges are 16 m and the lateral edges 65 m long. A tourist access is designed to start at a base vertex and to rise at a uniform rate along all four lateral faces, ending at a corner of the top square. At what points should the path cross the lateral edges?

Solution by ***J.N.Lillington.***



(*Ed. We refer to the opposite figure. It can easily be seen that the lateral faces of the truncated pyramid form trapezoids with 60^0 base angles. Line segments CD, EF, GH, IJ are drawn parallel to base AB.)*

First, we show that triangle ABK is equilateral. Triangles ABK and IJK are similar according to the preface, thus $\frac{KJ}{16} = \frac{KJ+65}{81}$ (because the lateral edges measure 65 m) or KJ = 16, which gives the result.

Let the tourist walk be the path ADCFEHGJI crossing the right lateral edge at D,F,H.

Applying the sine rule on triangles ABD, and ACD gives: $\frac{81}{\sin\left(120^0 - \delta\right)} = \frac{AD}{\sin 60^0}$ and

$\frac{AD}{\sin 120^0} = \frac{CD}{\sin(60^0 - \delta)}$ or (because of $\sin 120^0 = \sin 60^0$ and $\sin(120^0 - \delta) = \sin[180^0 - (120^0 - \delta)] = \sin(60^0 + \delta)$)

this leads to $\frac{81}{\sin\left(60^0 + \delta\right)} = \frac{CD}{\sin\left(60^0 - \delta\right)}$ or $81 = CD \cdot \frac{\sin\left(60^0 + \delta\right)}{\sin\left(60^0 - \delta\right)}$.

Then applying successively to triangles CDF, CEF, EFH, EGH, GHJ and GIJ we get $81 = 16 \cdot \left(\frac{\sin\left(60^0 + \delta\right)}{\sin\left(60^0 - \delta\right)}\right)^4$

or $\frac{3}{2} = \frac{\sqrt{3} + \tan\delta}{\sqrt{3} - \tan\delta}$ which finally simplifies to $5 \cdot \tan\delta = \sqrt{3}$.

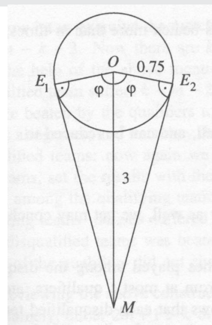
Applying the sine rule on triangle ABD gives $\frac{DB}{\sin\delta} = \frac{81}{\sin\left(60^0 + \delta\right)}$ or $DB = \frac{81}{\frac{\sqrt{3}}{2} \cdot \cot\delta + \frac{1}{2}}$. Hence DB = 27

and applying successively we yield DF = 18, FH = 12, and HJ = 8.

Also solved by Niels Bejlegaard.

155 The billposters of the Mathematician's Party observed that people read the posters standing 3 meters away from the centres of the cylindrical advertising pillars that have a 1.5 m diameter. The Party wants to achieve that, after sticking the posters around a pillar, a whole poster will be visible from any direction. How wide should the posters be?

Solution by ***Niels Bejlegaard***, ***Copenhagen***, slightly revised by the editor.



(Ed. A person standing at M, a distance of 3 meters away from the centre, is able to see the part of the cylindrical advertising pillar that is bounded by two tangent planes drawn to it. Clearly, it will be sufficient to view a circle as a cross-section of the pillar). According to the figure a simple calculation shows:

$\tan\varphi = \frac{\sqrt{3^2 - .75^2}}{.75} = \sqrt{15}$ or $\varphi \approx 75.52^o$. The length of a bill along the cylinder is s = arctan $\sqrt{15}$ ≈ 1.98 m (*or* $s \approx .75 \cdot 2\pi \cdot \frac{2 \cdot 75.52^o}{360^0}$*).*

Obviously two equal bills are not sufficient to be viewed completely because the visual angle would be 0^o then.

If we denote the width of the posters by w, then we must have $w \le \frac{s}{2}$. Since we are looking for the maximal width, we may assume the posters to tile the pillar, i.e. the circumference of the pillar is an integer multiple of the poster width. If we have, say, n posters, then $\frac{.75 \cdot 2\pi}{5} \le \frac{s}{2}$ must hold, from which we get n > 4.767 … . So the smallest possible value of n is 5, and the poster width must be $w = \frac{.75 \cdot 2\pi}{5} \approx .942$ m.

Also solved by J.N. Lillington.

156 Find a simpler expression for the sum $S = 3 + 2\cdot 3^2 + 3\cdot 3^3 + \ldots + 100\cdot 3^{100}$.

*Solution by **Dr Z Reut, London**.*

The sum can be written as $S=\sum_{n=1}^{100} n\cdot 3^n=\sum_{n=1}^{100}(n-1+1)\cdot 3^n=\sum_{n=1}^{100}(n-1)\cdot 3^n+\sum_{n=1}^{100}3^n$. The first term can now be written as follows: $\sum_{n=1}^{100}(n-1)\cdot 3^n=3\cdot\sum_{n=1}^{100}(n-1)\cdot 3^{n-1}=3\cdot\sum_{n=1}^{99}n\cdot 3^n=3\cdot(\sum_{n=1}^{100}n\cdot 3^n-100\cdot 3^{100})$ $= 3\cdot(S - 100\cdot 3^{100})$. The second term is a geometric series, which is reduced as follows: $\sum_{n=1}^{100}3^n=3\cdot\frac{3^{100}-1}{3-1}=\frac{3}{2}\cdot\left(3^{100}-1\right)$. The first equation becomes $S=3\cdot\left(S-100\cdot 3^{100}\right)+\frac{3}{2}\cdot\left(3^{100}-1\right)$. Solving for S gives the result $S=\left(150-\frac{3}{4}\right)\cdot 3^{100}+\frac{3}{4}=\frac{3}{4}\cdot\left(199\cdot 3^{100}+1\right)$.

Also solved by Pierre Bornsztein, Niels Bejlegaard, Erich N. Gulliver, Gerald A. Heuer, and J.N. Lillington.

157 Given are two non-negative numbers x,y, that satisfy the inequality $x^3 + y^4 \le x^2 + y^3$. Prove that $x^3 + y^3 \le 2$.

*Solution by **Pierre Bornsztein**.*
First, the result is trivially true for $x = y = 0$. Thus, we assume $(x,y) \ne (0,0)$.
Suppose, for a contradiction, that $x^3 + y^3 > 2$.

The inequality between means of order 2 and order 3 gives $\sqrt{\frac{x^2+y^2}{2}}\le\sqrt[3]{\frac{x^3+y^3}{2}}$.

Thus, $x^2+y^2\le\left(x^3+y^3\right)^{\frac{2}{3}}\cdot 2^{1-\frac{2}{3}}=\left(x^3+y^3\right)^{\frac{2}{3}}\cdot 2^{\frac{1}{3}}<\left(x^3+y^3\right)^{\frac{2}{3}}\cdot\left(x^3+y^3\right)^{\frac{1}{3}}=x^3+y^3$.
It follows that $x^2 - x^3 < y^3 - y^2$.
On the other hand we have $y^3-y^2 \le y^4-y^3 \Leftrightarrow 0 \le y^2\cdot(y-1)^2$, and this inequality is generally true.
It follows that $x^2-x^3 < y^3-y^2 \le y^4-y^3$, which contradicts the statement of the problem.
Thus, $x^3 + y^3 \le 2$, as desired.
Also solved by Niels Bejlegaard and J.N. Lillington.

(*Ed. **Marcel G. de Bruin**, Faculty of Electrical Engineering, Mathematics and Computer Science, Department of Applied Mathematics, Delft, The Netherlands, has proposed an improvement of the outcome of problem 147, given in the NewsletterNo. 51. The question reads as follows:*
Given 100 positive integers $x_1, x_2, \ldots, x_{100}$, such that $\frac{1}{\sqrt{x_1}}+\frac{1}{\sqrt{x_2}}+\ldots+\frac{1}{\sqrt{x_{100}}}=20$, prove that at least two of the integers must be equal.
A simple sharpening of the integral-test allows one to establish a better estimation, for the following inequality can be easily shown: $\frac{1}{\sqrt{n}}<\int_{n-\frac{1}{2}}^{n+\frac{1}{2}}\frac{dx}{\sqrt{x}}$, $n\in\mathbb{N}\setminus\{0\}$. *Assuming $x_1, \ldots, x_m$ to be distinct positive integers, we find* $\sum_{n=1}^{m}\frac{1}{\sqrt{x_n}}\le\sum_{k=1}^{m}\frac{1}{\sqrt{n}}<\int_{\frac{1}{2}}^{m+\frac{1}{2}}\frac{dx}{\sqrt{x}}=2\sqrt{m+\frac{1}{2}}-\sqrt{2}$. *The 'best' integer m follows easily from* $2\sqrt{m+\frac{1}{2}}-\sqrt{2}\le 20$, *i.e. m = 114.)*

That completes this issue of the Corner. Send me your nice solutions and generalizations.

Personal column

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

Awards

Alain Connes (IHES) was awarded the *Gold Medal 2004* of the French CNRS for the creation of non-commutative geometry, revolutionizing the theory of operator algebras, and for his contributions to the mathematical problems arising from quantum physics and relativity theory.

Pierre Deligne (Princeton) has been awarded the 2004 *Balzan Prize in Mathematics* for major contributions to several important domains of mathematics.

Mikhael L. Gromov (IHES) and **Jay Gould** (Courant NYU) received the 2003-2004 *Frederic Essers Nemmers Prize* in Mathematics.

Gérard Laumont and **Bao-Châu Ngô** (Paris-Sud) were presented a 2004 *Clay Research Award* in recognition of their work on the Fundamental Lemma for unitary groups.

Guy David (Paris-Sud) received the *Ferran Sunyer i Balaguer Prize* of the Institut d' Estudis Catalans, in recognition of his monograph *Singular Sets of Minimizers for the Mumford-Shah Functional*. He was also awarded the *Prix Servant* of the French Academy of Sciences.

Henri Berestycki (Paris) was awarded the *Grand Prix Sophie Germain* of the French Academy of Sciences for his fundamental contributions to the analysis of nonlinear partial differential equations.

Colette Moeglin received the *Prix Jaffé* of the French Academy of Sciences.

Laurent Stolovitch was awarded the *Prix Paul Doistau-Emile Bluter* of the French Academy of Sciences.

Paul Biran (Tel Aviv) has received the 2003 *Oberwolfach Prize* for outstanding research in geometry and topology, particularly symplectic and algebraic geometry.

Gabriele Veneziano (CERN) has been awarded the *Dannie Heineman Prize for Mathematical Physics* for his pioneering work in dual resonance models.

Frank Allgöwer (Stuttgart) has been awarded a *2004 Leibniz Prize* by the Deutsche Forschungsgemeinschaft for his work in nonlinear systems and control theory.

Jerzy Jezierski (Warsaw) and **Wacław Marzantowicz** (Poznań) were awarded the *Banach Great Prize* of the Polish Mathematical Society for their research papers on topology and nonlinear analysis.

Witold Więsław (Wrocław) was awarded the *Dickstein Great Prize* of the Polish Mathematical Society for his achievements in the history of mathematics and popularization.

Dariusz Buraczewski (Wrocław) was awarded the *Kuratowski Prize*.

Jakub Onufry Wojtaszczyk (Warsaw) was awarded the first *Marcinkiewicz Prize* of the Polish Mathematical Society for students' research papers.

Sir Roger Penrose OM FRS (Oxford) was awarded the *De Morgan Medal* of the London Mathematical Society for his wide and original contributions to mathematical physics.

Boris Zilber (Oxford) was awarded the *Senior Berrick Prize* for his paper "Exponential sums equations and the Schanuel conjecture", J. London Math. Soc. (2), **65,** (2002).

Richard Jozsa (Bristol) was awarded the *Naylor Prize* of the LMS for his fundamental contributions to quantum information science.

Ian Grojnowski (Cambridge) is the first recipient of the LMS *Fröhlich Prize* for his work on problems in representation theory and algebraic geometry.

The *Whitehead Prizes* of the LMS were awarded to **Mark Ainsworth** (Strathclyde), **Vladimir Markovic** (Warwick), **Richard Thomas** (London) and **Ulrike Tillmann** (Oxford).

Amongst those elected to *Fellowship of the Royal Society* in May 2004 were: **Samson Abramsky** (Oxford), **Julian Besag** (Seattle), **David Epstein** (Warwick) and **David Preiss** (London).

Björn Sandstede (Surrey) has been awarded a five-year *Royal Society Wolfson Research Merit Award* for research in coherent structures in science and biology: dynamics, stability and interaction.

David Acheson (Oxford) has been awarded a *National Teaching Fellowship*.

Ben Green (Cambridge) was presented a 2004 *Clay Research Award* in recognition of his work on arithmetic progressions of primes.

Jens Marklof (Bristol) has received one of the five 2004 *Marie Curie Excellence Awards* of the European Commission for his work in quantum chaos and number theory (Semi-Classical Correlations in Quantum Spectra).

Deaths

We regret to announce the deaths of:

John Chalk (28.6.2004)

Janusz Jerzy Charatonik (11.7.2004)

Klaus Doerk (2.7.2004)

Anatoolii Ya. Dorogovtsev (22.4.2004)

Günther Hellwig (17.6.2004)

Arno Jaeger (24.2.2004)

Olga Alexandrovna Ladyzhenskaya (12.1.2004)

Thomas Maxsein (10.5.2004)

Jerzy Norwa (14.6.2004)

Flemming Damhus Pedersen 23.2004)

Gert Kjćrgaard Pedersen (13.4.2004)

Helmut Pfeiffer (2.7.2004)

Forthcoming conferences

compiled by Vasile Berinde (Baia Mare, Romania)

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

January 2005

6–9: 24th Nordic and 1st Franco-Nordic Congress of Mathematicians, Reykjavik, Iceland
Information: e-mail:
FrancoNordicCongress@raunvis.hi.is
Web site: http://www.raunvis.hi.is/1FrancoNordicCongress/
[For details, see EMS Newsletter 53]

28–30: 4th Mediterranean Conference on Mathematics Education, Palermo-Italy
Information: e-mail:
spagnolo@math.unipa.it
Web sites: http://math.unipa.it/~grim/ mediterranean_05.htm;
www.cms.org.cy
[For details, see EMS Newsletter 53]

February 2005

5–13: Applications of braid groups and braid monodromy, EMS Summer School, Eilat, Israel
Information:
Web site: www.emis.de/etc/ems-summer-schools.html

14-19: Topology, analysis and applications to mathematical physics, Moscow, Russia
Dedicated to the memory of Prof. Yu.P. Solovyov (8.10.1944-11.9.2003)
Topics: Geometry and topology, analysis, applications to mathematical physics including the following topics of particular interest of Yu.P. Solovyov: algebraic and differential topology, noncommutative geometry, elliptic theory, operator algebras, path integration
Format: Plenary lectures (1.5 hour) and session lectures (45 min)
Organizing and Programme Committee: V.A. Sadovnichij (chairman), A. Bak, P. Baum, V.V. Belokurov (vice-chairman), V.M. Buchstaber, D. Burghelea, S.M. Gussein-Zade, A.A. Egorov, J. Eichhorn, A.T. Fomenko (vice-chairman), M. Karoubi, G.G. Kasparov, R. Krasauskas, A. Lipkovski, A.S. Mishchenko (vice-chairman), Th.Yu. Popelensky, V.V. Sharko, V.M. Tikhomirov, E.V. Troitsky, V. Zoller
Information:
e-mail: soloconf@mech.math.msu.su, soloconf@yandex.ru
Web site: dgfm.math.msu/conf/

17-21: CERME 4 (Fourth Congress of the European Society for Research in Mathematics Education), Sant Feliu de Guíxols, Spain
Aim: CERME is a congress designed to foster a communicative spirit. It deliberately and distinctively moves away from research presentations by individuals towards collaborative group work. Its main feature is a number of thematic groups whose members will work together in a common research area. Researchers wishing to present a paper at the congress should submit the paper to one of these groups. In addition to the thematic working groups, there will be plenary sessions, including plenary speakers and debates, poster sessions, and ERME policy sessions.
Programme Committee: A. Arcavi (IL); C. Bergsten (S); R. Borromeo Ferri (G); M. Bosch (E); J.-L. Dorier (F); N. Gorgorió (E); B. Jaworski (UK-N); J. Pedro Ponte (P); H. Steinbring (G); N. Stehlikova (CH); E. Swoboda (PL); R. Zan (G)
Speakers: Y. Chevallard (F); M. Brown (UK); J.D. Godino (E); M. Artigue (F); P. Ernest (UK); F. Furinghetti (I); J. Matos (P); C. Tzanakis (GR)
Working Groups: The congress is organised around some thematic groups working in parallel. Over 4 days, groups will have at least 12 hours to meet and progress their work. Participants are encouraged to attend and contribute to the work of just one group.
Information:
Web site: http://cerme4.crm.es

March 2005

9–April 1: 14th INTERNATIONAL WORKSHOP ON MATRICES AND STATISTICS (IWMS-2005), Massey University, Albany Campus, Auckland, New Zealand
Information:
Web site: http://iwms2005.massey.ac.nz/
[For details, see EMS Newsletter 53]

April 2005

4-8: International conference on Selected Problems of Modern Mathematics, dedicated to the 200th anniversary of K.G. Jacobi, and the 750th anniversary of the Koenigsberg foundation
Aim: Kaliningrad State University hosts an international conference, organised under the aegis of the Russian Academy of Sciences (RAS). Leading mathematicians from Russia and other countries are expected to participate.
Topics: Algebra and Geometry; Mathematical Physics; Applied Mathematics, Mathematical Modelling and IT; Theoretical Mechanics; History of Mathematics
International Programme Committee: L.D. Faddeev, chair; A.B. Zhizhchenko, deputy chair; S.K. Godunov; V.V. Kozlov; A.P. Klemeshev; S.P. Novikov; V.A. Sadovnichii; V.M. Buchstaber (Russia); O. Pironneau (France); F. Hirzebruch; W. Jäger; C. Zenger (Germany); M. Atiyah (UK); L. Karleson (Sweden)
Organising Committee: A.P. Klemeshev, chair; S.A. Ishanov, deputy chair; B.N. Chetverushkin, deputy chair; G.M. Fedorov; L.V. Zinin; A.I. Maslov; S.I. Aleshnikov; K.S. Latyshev
Format: Plenary lectures and working groups. Apart from plenary sessions and working groups, the scholars are welcome to make presentations and give lectures for students and post-graduates at KSU departments.
Kaliningrad State University covers the lecturers' royalties, accommodation costs and per diem.
Abstracts: are to be published before the conference.
Conference fee: 200 €; for students and post-graduates: 100 €
Deadline: January 10, 2005
Information:
e-mail: cyber@mathd.albertina.ru

May 2005

9-20: The Third Annual Spring Institute on Noncommutative Geometry and Operator algebras & 20th Shanks Lecture, Vanderbilt University, Nashville, Tennessee, USA
Main speakers: A. Connes (College de France, IHES & Vanderbilt University), V. Jones (UC Berkeley), U. Haagerup (Univ. of Southern Denmark), S. Popa (UCLA) and D. Voiculescu (UC Berkeley).
Organisers: A. Connes (director), D. Bisch, B. Hughes, G. Kasparov and G. Yu.
Information:
e-mail: ncgoa05@math.vanderbilt.edu
Web site: http://www.math.vanderbilt.edu/~ncgoa05

16-18: Conference "Algorithmic Information Theory", University of Vaasa, Finland
Theme: Algorithmic Information Theory is an international meeting bringing together mathematicians, computer theorists, logicians, mathematical physicists and scientists in related fields to assess recent development in the Foundations of Mathematics and the limits to Computability and Computation and to stimulate further research in these and related fields.
Topics: Algorithmic Information Theory; Formal Systems; Symbolic Computation; Cellular and Quantum Automata; Operator and Spectral Theory
Main speakers: B. Buchberger (RISC Institute in Linz); G. Chaitin (IBM Thomas Watson Research Center, New York); G. Dasgupta (Columbia Univ., New York); J. Kari (Univ. of Turku); H. Langer (Technische Univ. Wien); H. de Snoo (Univ. of Groningen); K. Sutner (Carnegie-Mellon University)
Organising committee: M. Laaksonen (Univ. of Vaasa); M. Linna (Univ. of Vaasa); S. Mäkinen (Vaasa Polytechnic); Jari Töyli (Univ. of Vaasa); M. Wanne (Univ. of Vaasa), chairman
Program Committee: S. Hassi (Univ. of Vaasa); V. Keränen (Rovaniemi Polytechnic); C.-G. Källman (Vaasa Polytechnic); chairman, M. Linna (Univ. of Vaasa); H. Niemi (Vaasa Polytechnic); T. Vanhanen (Stadia)
Deadline: for extended abstracts January 31, 2005

Information: e-mail: ait05@uwasa.fi
Web site: http://www.uwasa.fi/ait05

31-June 3: 4th Kortrijk Conference on Discrete Groups and Geometric Structures, with Applidations, Oostende, Belgium
Topics: Recent developments concerning all interactions between group theory and geometry including geometric group theory, group actions on manifolds, crystallographic groups and all possible generalizations (affine, polynomial, projective crystallographic groups, almost-crystallographic groups), discrete subgroups of Lie groups, graphs of groups
Scientific Committee: Y. Félix (Univ. Catholique de Louvain), W. Goldman (Maryland, College Park), F. Grunewald (Univ. Düsseldorf), P. Igodt (K.U.Leuven/Kortrijk), K.B. Lee (Oklahoma)
Main Speakers: O. Baues (Univ. Karlsruhe), Y. Benoist (ENS, Paris), M. Bridson (Imperial College, London), B. Farb (Univ. of Chicago), O. Garcia-Prada (Univ. Autonoma de Madrid), E. Ghys (Ecole normale Supérieure, Lyon), D. Toledo (University of Utah)
Proceedings: will be published as a part of a special issue in Geometriae Dedicata
Location: Hotel Royal Astrid, Oostende
Conference fee: 145€
Deadline: with abstract: April 12, 2005; without: May 1, 2005
Information:
e-mail: workshop@kulak.ac.be
Web site: http://www.kulak.ac.be/workshop

June 2005

12–24: Foliations 2005, Łodz, Poland
Information:
e-mail: fol2005@math.uni.lodz.pl
Web site: http://fol2005.math.uni.lodz.pl
[For details, see EMS Newsletter 53]

13–17: Computational Methods and Function Theory CMFT 2005, Joensuu, Finland
Aim: The general theme of the meeting concerns various aspects of interaction of complex variables and scientific computation, including related topics from function theory, approximation theory and numerical analysis. Another important aspect is to promote the creation and maintenance of contacts with scientists from diverse cultures.
Format: Invited one-hour plenary lectures, invited and contributed session talks, and poster sessions.
Plenary speakers: L.A. Beardon (Oxford), P. Clarkson (Canterbury), H. Farkas (Jerusalem), A. Fokas (Cambridge), H. Hedenmalm (Stockholm), D. Khavinson (Fayetteville), A. Martinez-Finkelshtein (Almeria), M. Seppälä (Helsinki), N. Trefethen (Oxford) and R. Varga (Kent)
Scientific committee: St. Ruscheweyh (Würzburg), E. B. Saff (Nashville), O. Martio (Helsinki) and I. Laine (Joensuu)
Grants: Limited amount of support available for participants coming from developing countries.
Information: e-mail: cmft@joensuu.fi
Web site: http://www.joensuu.fi/cmft

20-22: Workshop on Mathematical Problems and Techniques in Cryptology, Centre de Recerca Matemàtica, Campus of the Universitat Autònoma de Barcelona
Speakers: A. Lenstra (Eindhoven Univ. of Technology); R. Cramer (Leiden Univ.); T. Okamoto (NTT Laboratories); H. Krawkzyc (Technion Univ.); S. Galbraith (Royal Holloway Univ. of London)
Program Co-chairs: R. Cramer; T. Okamoto
Coordinators: J.L. Villar and C. Padró (Univ. Politècnica de Catalunya)
Information:
e-mail: work-cryptology@crm.es
Web site: http://www.crm.es/jornadas_ criptologia

25–July 2 : Subdivision schemes in geometric modelling, theory and applications, EMS Summer School, Pontignano, Italy
Information:
Web site: www.emis.de/etc/ems-summer-schools.html
[For details, see EMS Newsletter 53]

28-July 2: Barcelona Conference on Geometric Group Theory, Centre de Recerca Matemàtica, Campus of the Universitat Autònoma de Barcelona
Speakers: M. Bestvina (Univ. of Utah); T. Delzant (Univ. de Strasbourg); G. Levitt (Univ. of Caen); K. Vogtmann (Cornell Univ.)
Programme Committee: N. Brady; J. Burillo; E. Ventura; J. Burillo, coordinator
Information:
e-mail: GeometricGroupTheory@crm.es
Web site: http://www.crm.es/Geometric GroupTheory

July 2005

5-15: Advanced Course on the Geometry of the Word Problem for finitely generated groups, Centre de Recerca Matemàtica, Campus of the Universitat Autònoma de Barcelona
Speakers: H. Short (Univ. d'Aix-Marseille I); N. Brady (Oklahoma Univ.); T. Riley (Yale Univ.)
Coordinator: Josep Burillo
Registration Fee: 160 EUR
Deadline: May 15, 2005
Grants: The CRM offers a limited number of grants for registration and accommodation addressed to young researchers. The deadline for application is April 5, 2005.
Information:
e-mail: WordProblem@crm.es
Web site: http://www.crm.es/Word Problem

17-August 14: Summer School of Atlantic Association for Research in the Mathematical Sciences, Campus of Dalhousie University in Halifax, Nova Scotia, Canada
Aim: The Summer School is intended for graduate students and promising undergraduate students in Mathematics from all parts of the world. Each participant is expected to register for two courses. The courses will be: 1. Convexity and Fixed Point Algorithms in Hilbert Space (H. Bauschke, Univ. of Guelph); 2. Integral Geometry of Convex Bodies and Polyhedra (D. Klain, Univ. of Massachusetts at Lowell); 3. The Mathematics of Finance (W. Runggaldier, Univ. di Padova); 4. Mathematical Statistics (B. Smith, Dalhousie Univ.)
Format: Each course consists of four sixty-minute lectures and two ninety-minute problem sessions each week, for four weeks;
Organizer: The Atlantic Association for Research in the Mathematical Sciences" (Canada)
Location: Campus of Dalhousie University in Halifax, Nova Scotia, Canada. Accommodation is available on Campus
Grants: Some financial support in Halifax is possible.
School Director: T. Thompson, Dalhousie Univ.
Information:
e-mail: tony@mathstat.dal.ca;
renzo@matapp.unimib.it;
renzo@mathstat.dal.ca

17-23: European young statisticians training camp, EMS summer school, Oslo Norway
associated with the European Meeting of Statistics (see below).
Information:
Web site: www.emis.de/etc/ems-summer-schools.html#2005

24-28: 25th European Meeting of Statistics, Oslo, Norway
Organizer: University of Oslo and the Norwegian Computing Center
Format: 8 invited lectures, 24 invited sessions and contributed sessions
Invited lecturers: D. Donoho (Stanford), Y. Peres (Berkeley), O. Aalen (Oslo), J. Bertoin (Paris), W. Kendall (Warwick), N. Shephard (Oxford), L. Davies (Essen), K. Worsley (Mc Gill)
Programme Committee: A. van der Vaart (chair, Amsterdam), Ø. Borgan (Oslo), U. Gather (Dortmund), S. Richardson (London), G. Roberts (Lancaster), T. Rolski (Wrocław), J. Steif (Göteborg)
Deadlines: for grant application: March 1, 2005; for submission of contributed papers and posters: March 31, 2005; for early registration: May 1, 2005; for registration: June 30, 2005.
Conference fee: 310€, 280€ (Bernoulli Society of ISI members), 200€ (students)
Information: e-mail: ems2005@nr.no
Web site: www.ems2005.no;

30-August 6: Groups St. Andrews 2005, University of St. Andrews, St. Andrews, Scotland
Aim: This conference, the seventh in the series of Groups St Andrews Conferences, will be organised along similar lines to previous events in this series.
Speakers: P.J. Cameron (Queen Mary, London); R.I. Grigorchuk (Texas A&M); J.C. Meakin (Nebraska-Lincoln); A. Seress (Ohio State)
Programme: The speakers above have kindly agreed to give short courses of lectures. In addition there will be a programme of one hour invited lectures and short research presentations.
Topics: The conference aims to cover all aspects of group theory. The short lecture courses are intended to be accessible to postgraduate students, postdoctoral fellows, and researchers in all areas of group theory.
Location: Mathematical Institute, St. Andrews.
Scientific Organising Committee: C. Campbell (St. Andrews); N. Gilbert (Heriot-Watt); S. Linton (St. Andrews); J. O'Connor (St. Andrews); E. Robertson (St. Andrews); N. Ruskuc (St. Andrews); G. Smith (Bath)
Information:
e-mail: gps2005@mcs.st-and.ac.uk
Web site: http://groupsstandrews.org

August 2005

21-26: SEMT '05 (International Symposium on Elementary Mathematics Teaching), Czech Republic, Charles University in Prague, Faculty of Education
Theme: Understanding the environment of the mathematics classroom.
Format: Plenary lectures, presentation of papers, workshops and discussion groups.

Information:
e-mail: jarmila.novotna@pedf.cuni.cz
Web site: http://www.pedf.cuni.cz/kmdm/index.htm

September 2005

13-23: Advanced Course: Recent Trends on Combinatorics in the Mathematical Context; Centre de Recerca Matemática, Campus of the Universitat Autònoma de Barcelona
Speakers: B. Bollobas (Trinity College Cambridge and Univ. of Memphis); J. Nesetril (Charles Univ. and ITI, Prague)
Coordinator: O. Serra
Registration Fee: 160 EUR
Deadline: July 10, 2005
Grants: The CRM can offer a limited number of grants to young researchers covering the registration fee and/or accommodation. The deadline for application is June 1, 2005.
Information:
e-mail : RecentTrends@crm.es
Web site: http://www.crm.es/Recent Trends

October 2005

11-18: EMS Summer School and Séminaire Européen de Statistique, Statistics in Genetics and Molecular Biology, Warwick, UK
Grants: 40 Marie Curie Actions grants available
Local Organization: B. Finkenstadt (Warwick)
Information:
e-mail: b.f.finkenstade@warwick.ac.uk
Web site: http://www2.warwick.ac.uk/fac/ sci/statistics/news/semstat/

17-21: Nonlinear Parabolic Problems, Helsinki
Aim: An international program on nonlinear parabolic partial differential equations will be organized in Helsinki, Finland, during Sept-Nov 2005.
The program will run at the University of Helsinki and at the Helsinki University of Technology (HUT) and is sponsored by the governmental agency The Academy of Finland. Within the framework of this programme, a conference on nonlinear parabolic problems will be also held in Helsinki.
Organizers: H. Amann (amann@math. unizh.ch); J. Taskinen (jari.taskinen@ helsinki.fi); S.-O. Londen (stig-olof.londen@hut.fi)
Main topics: Qualitative theory of parabolic equations; Reaction-diffusion systems; Fully nonlinear problems; Free boundary problems; Navier-Stokes equations; Maximal regularity; Degenerate parabolic problems
Speakers: M. Chipot (Zurich); Ph. Clement (Delft); J. Escher (Hannover); M. Fila (Bratislava); M. Hieber (Darmstadt); G. Karch (Wroclaw); H. Kozono (Sendai); Ph. Laurencot (Toulouse); J. Lopez-Gomez (Madrid); S. Nazarov (St.Petersburg); W.-M. Ni (Minnesota); M. Pierre (Rennes); J. Pruess (Halle); P. Quittner (Bratislava); J. Rehberg (Berlin); G. Simonett (Nashville); H.Sohr (Paderborn); V. Solonnikov (St. Petersburg); Ph. Souplet (Versailles); J.L.Vazquez (Madrid); D. Wrzosek (Warszawa); L. Weis (Karlsruhe); E. Yanagida (Sendai)
Location: The conference will take place at HUT, located northwest of downtown Helsinki.
Information:
Web site: http://www.math.helsinki.fi/research/FMSvisitor0506

Recent books

edited by Ivan Netuka and Vladimír Souček (Prague)

M. Anderson, V. Katz, R. Wilson: ***Sherlock Holmes in Babylon and Other Tales of Mathematical History,*** *Spectrum, The Mathematical Association of America, Washington, 2003, 420 pp., $49,95, ISBN 0-88385-546-1*
This excellent book contains 44 articles on the history of mathematics, which were published in journals of the Mathematical Association of America (American Mathematical Monthly, College Mathematics Journal, Mathematics Magazine, National Mathematics Magazine) over the past 100 years. The articles were written by distinguished past historians of mathematics (e.g., F. Cajori, J. L. Coolidge, M. Dehn, D. E. Smith, C. Boyer) as well as some contemporary ones (including E. Robson, R. Creighton Buck, V. Katz). The articles are divided into four sections (Ancient mathematics, Medieval and renaissance mathematics, The seventeenth century, The eighteenth century) and they cover almost 4000 years (from the ancient Babylonians to the development of mathematics in the eighteenth century). The most interesting topics from Babylonian, Greek, Roman, Chinese, Indian as well as European mathematics are included. Each section is preceded by a Foreword, containing comments on historical context, and followed by an Afterword. In some cases, two articles on the same topic are included showing the progress in the history of mathematics. The comparison shows that although modern research brings new information and new interpretations, the older papers are neither dated nor obsolete. The book is not a classical textbook of the history of mathematics; the topics included do not cover the whole development of mathematics. The book can be recommended to everybody interested in the history of mathematics and to anybody who loves mathematics. (mnem)

R. Arratia, A.D. Barbour, S. Tavaré: ***Logarithmic Combinatorial Structures: A Probabilistic Approach,*** *EMS Monographs in Mathematics, vol. 1, European Mathematical Society, Zürich, 2003, 375 pp., €69, ISBN 3-03719-000-0*
Many combinatorial (and other) objects can be decomposed into connected components and one can be interested in numbers and sizes of components in a random object. In this monograph, strong results are derived for the component frequency spectrum in a rather general probabilistic situation, which is determined by two conditions (axioms): the conditioning relation and the logarithmic condition. In chapter 1, the decomposition of permutations to cycles and the decomposition of integers to primes are compared and in chapter 2, many more examples of combinatorial structures and their decompositions are presented. In the remaining eleven chapters, the authors build an abstract probabilistic approach to the problem of estimation of the component frequency spectrum. Techniques and notions used include the Wasserstein distance, the Stein method, the Ewens sampling formula, size biasing, the scale invariant Poisson process, the GEM distribution and the Poisson-Dirichlet distribution. In the final chapters, the treatise becomes technical but the reader is rewarded by strength and generality of obtained theorems. (mkl)

A. Arvanitoyeorgos: ***An Introduction to Lie Groups and the Geometry of Homogeneous Spaces,*** *Student Mathematical Library, vol. 22, American Mathematical Society, Providence, 2003, 141 pp., $29, ISBN 0-8218-2778-2*
The main topics treated in this small book are semisimple Lie groups, homogeneous spaces and their geometry, invariant metrics, symmetric spaces and generalized flag manifolds. The book starts with the definition of a Lie group and its associated Lie algebra, together with a simple version of Lie theorems. A study of the Killing form leads to the notion of a semisimple Lie algebra. To equip Lie groups with a structure of a Riemannian manifold, bi-invariant metrics are introduced, together with the associated connections and expressions for their curvature. Homogeneous spaces are introduced and their Riemannian structure is defined by means of G-invariant metrics. Two basic classes of examples - symmetric spaces and generalized flag manifolds - are classified. The last chapter contains some applications to physics (homogeneous Einstein and Kähler-Einstein metrics, Hamiltonian systems on generalized flag manifolds and homogeneous geodesics). Notions introduced in the book are nicely illustrated by a lot of examples. The size of the book is very small but it contains a wealth of interesting material. (vs)

M. Audin, A.C. da Silva, E. Lerman*:* ***Symplectic Geometry of Integrable Hamiltonian Systems,*** *Advanced Courses in Mathematics CRM Barcelona, Birkhäuser, Basel, 2003, 225 pp., €28, ISBN 3-7643-2167-9*
The three contributions contained in the book are based on lectures given by the authors at the Euro Summer School "Symplectic geometry of integrable Hamitonian systems", held in Barcelona in July 2001. The first paper (by M. Audin) contains a discussion of special Lagrangian submanifolds. This notion was studied very intensively during recent years in connection with integrable systems and, in particular, with string theory and the mirror symmetry. Special Lagrangian submanifolds are rare beings, hard to construct, and their moduli space is finite dimensional. In the paper, explicit examples of special Lagrangian submanifolds are constructed and the moduli space of special Lagrangian submanifolds of a Calabi-Yau manifold is discussed. The second paper (by A. C. da Silva) contains an introduction to toric manifolds using the moment map and the moment polytope as the main tools. The text has two parts. The first part uses a classification of equivalence classes of symplectic toric manifolds, using their moment polytopes, and a computation of homology of symplectic toric manifolds using the Morse theory. The second part considers toric manifolds in algebraic geometry and it has a structure parallel to the first part. The third contribution (by E. Lerman) is devoted to the following problem: Let M be the cotangent bundle of an *n*-dimensional torus without the zero section. Suppose that there is an effective action of the group $G=R^n/Z^n$ on M, preserving the standard symplectic structure on M and commuting with dilations. Is the action of G necessarily free? To answer the question, contact toric manifolds are introduced, and contact moment maps are used together with the Morse theory on orbifolds. The three sets of lectures complement each other nicely and the book offers a very useful and systematic introduction to a modern and interdisciplinary field. (vs)

C. Bardaro, J. Musielak, G. Vinti: ***Nonlinear Integral Operators and Applications,*** *de Gruyter Series in Nonlinear Analysis and Applications 9, Walter de Gruyter, Berlin, 2003, 201 pp., €88, ISBN 3-11-017551-7*
The book is devoted to quite general approximation methods based on convolution operators (both linear and nonlinear) and to the study of such operators. In order to develop the right setting for this investigation, the first two chapters contain preliminary results on modular spaces, which are a suitable generalization of the Orlicz spaces as well as of spaces with bounded φ-variation. The following two chapters present some error estimates of approximations in terms of moduli of continuity. Classical linear convolution operators are generalized here to nonlinear convolutions with kernels, which either satisfy Lipschitz-type conditions or are homogeneous in the generalised sense. Applications to the summability problem of a family of functions are given in Chapter 5. The convergence of approximations in φ-variation is possible only in certain subspaces of functions of bounded φ-variation. These subspaces are studied in Chapter 6. Two basic fixed-point theorems are used in Chapter 7 to obtain solutions of nonlinear convolution equations. There is an important application of interpolations to the so-called sampling theorem in signal analysis. The classical linear interpolation methods can be replaced by nonlinear ones. Results in this direction for several classes of signals are shown in the last two chapters. The book, based mainly on results from the authors, can be considered as a nonlinear continuation of the classical book of P. L. Butzer and R. J. Nickel (Fourier Analysis and Approximation, Academic Press, 1971). The presentation is clear and self-contained so that the book can be recommended not only to researchers in approximation theory but to graduate students as well. (jmil)

H.-J. Baues: ***The Homotopy Category of Simply Connected 4-Manifolds,*** *London Mathematical Society Lecture Note Series 297, Cambridge University Press, Cambridge, 2003, 184 pp., £24,95, ISBN 0-521-53103-9*
The main aim of this book is to understand the category of simply connected closed topological 4-manifolds and the homotopy classes of mappings between them. It is necessary to mention that the problem consisted especially in the description of the homotopy classes of maps. As an important tool the author uses the category **CW**(2,4). Its objects are CW-complexes X with one 0-cell, and then with cells only in dimension 2 and 4, and its morphisms are homotopy classes of mappings. Within this category we find the above-mentioned manifolds in the sense that every simply connected 4-manifold is homotopy equivalent with such a CW-complex X with only one 4-cell. The main achievement of the book is a construction of a purely algebraic category, which is equivalent to the category **CW**(2,4). This, of course, enables the transform from various topological considerations into an algebraic setting. The advantage of such a transformation is obvious. The subject of the book is relatively special, and this naturally brings the necessity of special procedures and special computations. Therefore the reader may have an impression that the text is rather technical. This is not at all true. On the contrary, the reader will obtain very deep information on the structure of relevant categories. The text is very clearly written but the author substantially uses many previous results of his own as well as many other results. This means that the reading is not very easy. Nevertheless, the results are so excellent that they deserve some patience and effort. (jiva)

M. A. Bennet, B. C. Berndt, N. Boston, H. G. Diamond, A. J. Hildebrand, W. Philips, (Eds.): ***Number Theory for the Millennium,*** *I, A. K. Peters, Natick, 2002, 461 pp., $50, ISBN 1-56881-126-8*
M. A. Bennet, B. C. Berndt, N. Boston, H. G. Diamond, A. J. Hildebrand, W. Philips, (Eds.): ***Number Theory for the Millennium, II,*** *A. K. Peters, Natick, 2002, 447 pp., $50, ISBN 1-56881-146-2*
M. A. Bennet, B. C. Berndt, N. Boston, H. G. Diamond, A. J. Hildebrand, W. Philips, (Eds.): ***Number Theory for the Millennium, III,*** *A. K. Peters, Natick, 2002, 450 pp., $50, ISBN 1-56881-152-7*
This three volume collection of papers contains more than 1300 pages with 72 talks given at the Millennial Conference on Number Theory, which was held at the campus of the University of Illinois at Urbana-Champaign in May 2000. The papers cover the wide range of contemporary number theory. The conference was one of the most important international meetings devoted to number theory, framed by 175 talks. Consequently the interested reader finds here not only surveys on the most important contributions to number theory and its applications, but also surveys on methods and techniques used in this important branch of mathematics. The collection offers a respectable view on contemporary number theory given by prominent number theorists, and therefore could be recommended not only to number theorists but generally to all mathematicians interested in various aspects of number theory. (špo)

S. Bezugly, S. Kolyada, Eds.: ***Topics in Dynamics and Ergodic Theory,*** *London Mathematical Society Lecture Note Series 310, Cambridge University Press, Cambridge, 2003, 270 pp., £30, ISBN 0-521-53365-1*
The volume collects some of the mini-courses presented at the International Conference and US-Ukrainian Workshop "Dynamical Systems and Ergodic Theory", held in Katsiveli (Crimea, Ukraine) in August 2000. The introductory contribution by A. M. Stepin is devoted to the memory of V. M. Alexeyev, one of the best lecturers of the Katsiveli's school, who died in 1980 at the age of 48. The paper "Minimal idempotents and ergodic Ramsey theorems", by V. Bergelson, reviews the construction of the Stone-Čech compactification β N of N as the Ellis enveloping semigroup of the map σ = x+1 on N. Using minimal idempotents, the celebrated van der Waerden theorem on arithmetic progressions is proved. In "Symbolic dynamics and topological models in dimensions 1 and 2", A. de Carvalho and T. Hall present the classical kneading theory of unimodal systems and extend it to two-dimensional systems like the horseshoe. In "Markov odometers", A. H. Dooley proves that every ergodic non-singular transformation is orbit equivalent to a Markov odometer on a Bratteli-

Vershik system. In "Geometric proofs of Mather's connecting and accelerating theorems", V. Kaloshin treats the wandering trajectories of exact area preserving twist maps. In "Structural stability in 1D dynamics", O. Kozlovski treats the structural stability in spaces of smooth and analytic maps. In "Periodic points of nonexpansive maps: a survey", B. Lemmas shows that trajectories of nonexpansive maps converge to periodic orbits. In "Arithmetic dynamics", N. Sidorov deals with explicit arithmetic expansions of reals and vectors that have a dynamical sense. In "Actions of amenable groups", B. Weiss generalizes much of the classical ergodic theory to general amenable groups like Z^n; in particular he proves the Shannon-McMillan theorem. (pku)

N. Bourbaki: *Elements of Mathematics. Integration I. Chapters 1-6,* *Springer, Berlin, 2004, 472 pp., €99,95, ISBN 3-540-41129-1*

Bourbaki, a collective author in the sixties, wrote the series of books 'Elements of Mathematics'. This is an English translation of the well-known original French edition. It contains the first six chapters (of nine) from the part devoted to integration. As in all books in the series, presentation of material is abstract, proceeding from general to particular. Therefore a good knowledge of an undergraduate course seems to be almost necessary. The approach to the integration theory here is functional, based on the notion of a measure as a continuous linear functional on the space of real, or complex, continuous functions with compact support in a locally compact topological space. The six chapters cover a detailed exposition of results on extension of measures. The chapter on integration of measures includes the Lebesgue-Fubini theorem, the Lebesgue-Nikodým theorem, and results on disintegration of measures. An essential part of the theory of L^p spaces is also covered. The presentation of vector-valued integration is based on the weak integral. The text contains full proofs of the stated results, many exercises, and worthwhile historical notes. It is written very carefully to prevent misunderstandings and to make orientation in the text easy. (ph)

D. Cerveau, E. Ghys, N. Sibony, J.-Ch. Yoccoz: *Complex Dynamics and Geometry,* *SMF/AMS Texts and Monographs, vol. 10, American Mathematical Society, Société Mathématique de France, Providence, 2003, 197 pp., $59, ISBN 0-8218-3228-X*

The book contains four survey papers on different but closely related topics in the theory of holomorphic dynamical systems. The first paper (by D. Cerveau) is devoted to a study of codimension 1-holomorphic foliations. The main tool used here is a reduction of singularities. Particular attention is devoted to foliations in dimensions two and three. The paper ends with applications to the singular Frobenius theorem and a discussion of invariant hypersurfaces. The second paper (by E. Ghys) contains a discussion of Riemann surface laminations, arising in the theory of holomorphic dynamical systems. The Riemann surface laminations are more general objects than ordinary foliations, the ambient space need not have a structure of a manifold. Their leaves are (not necessarily compact) Riemann surfaces. Classical questions for Riemann surfaces (uniformization, existence of meromorphic functions) are studied in this more general setting. The paper by N. Sibony describes an analogue of the Fatou-Julia theory for a rational map f from $P^k(C)$ to itself. The dynamics of f are described using properties of a suitable closed positive current of bidegree (1,1). The second part is devoted to a study of regular polynomial biholomorphisms of C^k, and the last part to holomorpic endomorphisms of $P^k(C)$. For the convenience of the reader, properties of currents and plurisubharmonic functions are summarized at the end of the paper. The fourth contribution (by J.-C. Yoccoz, written by M. Flexor) describes properties of the simplest nontrivial case of holomorphic dynamics, given by a quadratic polynomial in one complex variable. The discussion is centred around hyperbolic aspects, the Jacobsen theorem and quasiperiodic properties, related to problems of small divisors. The whole book starts with an introductory paper on holomorphic dynamics (written by E. Ghys). It contains many interesting comments on the historical evolution of the discussed topics and their mutual relations. (vs)

J. W. Cogdell, H. H. Kim, M. R. Murty: *Lectures on Automorphic L-functions,* *Fields Institute Monographs, American Mathematical Society, Providence, 2004, 283 pp., $63, ISBN 0-8218-3516-5*

This book consists of lecture notes from three graduate courses given at the special program on authomorphic forms at the Fields Institute in the spring of 2003. The course by Cogdell is an introduction to standard L-functions of automorphic forms on GL(n) and the Rankin-Selberg L-functions on GL(m) x GL(n). It covers the following topics: Whittaker models, local and global functional equations, converse theorems and functorial lifts for classical groups. The course by Kim is a survey of the Langlands–Shahidi approach to L-functions via constant terms of Eisenstein series. It culminates in the recent proofs of functoriality of the symmetric cube and fourth for GL(2). The course by Ram Murty centers on analytic properties of automorphic L-functions and their applications to estimates for Hecke (and Laplace) eigenvalues. This book is a wonderful introduction to the Langlands program. It is heartily recommended to students (and researchers) specializing in number theory and related areas. (jnek)

J. K. Davidson, K. H. Hunt: *Robots and Screw Theory. Application of Kinematics and Statistics to Robotics,* *Oxford University Press, Oxford, 2004, 476 pp., £85, ISBN 0-19-856245-4*

This monograph can be regarded as a comprehensive textbook on applications of screw theory in a variety of situations in mechanics and robotics. Special attention is paid to modern applications of screws in the robotics of both serial and parallel manipulators. A screw is defined either as a pair of a force and a couple (a wrench) or as an infinitesimal space motion (twist). Later on, the connection to the vector field of velocities of a spatial motion and to the instantaneous motion is described. The basic properties of screws are described in chapter 3, including screw (Plücker) coordinates. The next three chapters deal with coordinate transformations, screw systems and reciprocity (duality) of twists and wrenches. Properties of serial robot manipulators are studied in chapters 6 and 7, including many examples of commercially used robots. Chapters 7 and 8 are devoted to parallel robot-manipulators and their basic geometric properties, including the Jacobian and its computation. Special attention is given to the 3-3 parallel manipulator - the octahedral structure. The rest of the book concentrates on more advanced topics, for instance on manipulators combining serial and parallel structures, redundant robotic systems and legged vehicles. Appendices give some useful formulas from line geometry and basic ideas of the projective representation of screws in connection with the projective line geometry. The Study representation is mentioned at the very end. The book contains useful historical remarks on the origins of screw theory and related topics, references contain not only historical sources on the subject but also recent publications relevant to considered problems. The main point of the book lies in applications of screws and not much space is devoted to the theory. This means that no proofs are given, the algebraic structure of the screw space is not emphasized and the style of the book is traditional. It can be recommended to all engineers and postgraduate students doing research in complicated mechanical systems, in particular in the mechanics of serial and parallel robot manipulators. (ak)

M. Emerton, M. Kisin: *The Riemann-Hilbert Correspondence for Unit F-Crystals,* *Astérisque 293, Société Mathématique de France, Paris, 2004, 257 pp., €57, ISBN 2-85629-154-6*

If k is a perfect field of characteristic p > 0 and X a smooth $W_n(k)$-scheme, a well known generalization of the Artin–Schreier theory (due to N. Katz) establishes an equivalent of categories between locally free étale sheaves of Z/p_nZ –modules on X and vector bundles E on X satisfying F*R $\cong$ E (where F is a lift of the Frobenius to X). The main goal of the book is to generalize this result to a Riemann-Hilbert type correspondence between the derived category D^b_{ctf} (X_{et}, Z/p_nZ) and a certain triangulated category of arithmetic D–modules equipped with an action of Frobenius. In fact, the case n=1 is treated separately, as it does not require any differential operators (nor the perfectness of k). (jnek)

L. Fargues, E. Mantovan: *Variétés de Shimura espaces de Rapoport-Zink et correspondances de Langlands locales,* *Astérisque 291, Société Mathématique de France, Paris, 2004, 331 pp., €66, ISBN 2-85629-150-3*

This volume contains two articles that generalize some aspects of the recent work of M. Harris and R. Taylor on cohomology of certain unitary Shimura varieties and associated moduli space of p-divisible groups. As the authors consider unitary groups of more general signature, they have to get around the fact that one can no longer use Drinfeld bases to define nice integral models of the relevant moduli spaces. Instead, the authors work with the corresponding rigid analytic spaces defined by M. Rapoport and T. Zink. In the first article, L Fargues shows that one can realize the local Langlands correspondence (in the supercuspidal case) in the étale cohomology of certain Rapoport–Zink spaces. In the second article, E. Mantovan series uses the Newton–polygon stratification of the special fibre of the Shimura variety to relate its cohomology to the cohomology of the associated Rapoport–Zink spaces and generalized Igusa varieties. (jnek)

G. N. Frederickson: *Dissections: Plane and Fancy,* *Cambridge University Press, Cambridge, 2003, 310 pp., £16,95, ISBN 0-521-57197-9, ISBN 0-521-52582-9*

The book by Frederickson on recreational mathematics is devoted to the problem of how to cut a square (or triangle or hexagon) into the smallest number of pieces and how to rearrange them into two squares (or triangles or hexagons). The book also deals with others figures, e.g. stars, Maltese Crosses, and with solids (polyhedra). Martin Gardner, a well-known expert in recreational mathematics, can be considered the unofficial godfather of the book. Even great mathematicians were interested in dissections. In 1900, David Hilbert presented the famous wide-ranging list of twenty-three problems and a third of them dealt with dissections of polyhedra (the negative result proposed by him was proven by M. Dehn within a few months). The reader will find solutions to all problems contained at the end of the book. The bibliography is very comprehensive. A basic knowledge of high school geometry is sufficient for reading the book. Every puzzle fan will like this interesting and amusing book. (lboc)

F. Gesztesy, H. Holden: *Soliton Equations and Their Algebro-Geometric Solutions, vol. I: (1+1)-Dimensional Continuous Models,* *Cambridge Studies in Advanced Mathematics 79, Cambridge University Press, Cambridge, 2003, 505 pp., £65, ISBN 0-521-75307-4*

The field of completely integrable systems has developed enormously in the last decades. The book under review covers a part of this broad landscape. Its aim is to discuss in detail algebro-geometric solutions of five hierarchies of integrable nonlinear equations. The presented class of solutions form a natural extension of the classes of soliton and rational solutions, and can be used to approximate more general solutions (e.g. almost periodic ones). Basic tools in the description are spectral analysis and basic theory of compact Riemann surfaces and their theta functions. The basic KdV hierarchy is the most famous case, it contains the equation for solitary waves on channels, which were discovered by Scott Russell in 1834. The solutions of the KdV hierarchy are discussed in the first chapter. The discussion is presented in more detail for this first case than in the other four cases. The second hierarchy treated in Chapter 2 is a combined sine-Gordon and modified Korteweg-de Vries hierarchy. The third chapter contains a discussion of solutions of the AKNS (Ablowitz, Kaup, Newell, Segur) system and related classical Boussinesq hierarchies. The classical massive Thirring system is treated in Chapter 4. The last chapter describes solutions of the Camassa-Holm hierarchy. Individual chapters are organized in such a way that they can be read independently. To reach this goal, similar arguments in constructions are repeated in individual cases. Each chapter ends with detailed notes (e.g. notes for the first chapter have 17 pages) with references to literature, comments and additional results. In the Appendix (140 pages), it is possible to find a summary of many fields (e.g. algebraic curves, theta functions, the Lagrange interpolation, symmetric functions, trace formulae, elliptic functions, spectral measures), which are used in the main chapters. At the end, the reader can find an extensive bibliography (30 pages of references). The book is very well organized and carefully written. It could be particularly useful for analysts wanting to learn new methods coming from algebraic geometry. (vs)

V. I. Gromak, I. Laine, S. Shimomura: *Painlevé Differential Equations in the Complex Plane,* *de Gruyter Studies in Mathematics 28, Walter de Gruyter, Berlin, 2002, 299 pp., €88, ISBN 3-11-017379-4*

At the beginning of the 20th century, Painlevé studied properties of second order differential equations in the complex plane and isolated a certain number of equations with distinguished behaviour. Their solutions have the property that there are no movable singularities other than poles. Later on, attention has concentrated to six equations $P_1, \ldots, P_6$ of Painlevé type with the most interesting properties. The book is devoted to them. In the first chapter, the authors show that the equations P_1, P_2, P_4 and modifications of equations P_3 and P_5 have meromorphic solutions only (with proofs in the first three cases). The growth properties of solutions of these 5 types of equations together with the value distribution theory for them are studied in the next two chapters. The next six chapters are devoted to a study of the properties of solutions of six Painlevé equations. Behaviour of solutions in a neighbourhood of a singularity is studied. Integrable (systems of) equations usually come in whole hierarchies. Higher order analogues of the Painlevé equations of the first two types are discussed in the book. For specific values of parameters of the equations, solutions can be constructed using the Bäcklund transformations. For these values of parameters, solutions can be expressed in terms of rational functions or classical transcendental functions. Relations of the Painlevé equations to hierarchies of integrable systems (KdV, Boussinesq, sine-Gordon, nonlinear Schrödinger, Einstein and Toda type equations) are discussed in the last chapter. The two appendices offer a summary of basic facts needed about solutions of ordinary differential equations in the complex plane and on the Nevanlinna theory. Interest in properties of solutions of Painlevé equations is steadily growing and they appear in many questions in mathematics and mathematical physics. Hence, the careful treatment of them in the presented monograph is a valuable addition to the existing literature. (vs)

A. Grothendieck, Ed.: *Revêtements étales et groupe fondamental (SGA 1),* *Documents Mathématiques 3, Société Mathématique de France, Paris, 2003, 325 pp., ISBN 2-85629-141-4*
This is a new edition of the first volume of A. Grothendieck's SGA (Séminaire de géométrie algébrique), which is devoted to the theory of the algebraic fundamental group. The book incorporates a few minor corrections and several updating remarks by M. Raynaud. A TEX file of this text (as well as of the uncorrected version), typeset by a team of volunteers headed by S. Edixhoven, is available from the arXiv.org e-print server. This book is indispensable to any serious student of algebraic geometry. (jnek)

B. Hasselblatt, A. Katok: *A First Course in Dynamics: with a Panorama of Recent Developments,* *Cambridge University Press, Cambridge, 2003, 424 pp., £25,95, ISBN 0-521-58750-6, ISBN 0-521-58304-7*
The book has two parts. The first one (A Course in Dynamics: From Simple to Complicated Dynamics) can serve as a textbook for a beginner course in dynamical systems for senior undergraduate students of mathematics, physics and engineering. The explanation is slightly unusual, since it is based on a number of simple examples that present basic behaviour of dynamical systems. The outset of theory, including topological and probabilistic methods, begins from the detailed study of these examples. The exposition is accompanied by many valuable comments and exercises of different complexity. The first part ends with complicated orbit structures like recurrence and mixing for systems on a torus. Chaotic behaviour is presented and applications to coding are also given.

The second part (Panorama of Dynamical Systems) is more advanced and is intended as an introduction to modern achievements of the theory. Hyperbolic dynamics is studied, and results like the closing and shadowing lemma are proved. A lot of attention is paid to the classical example of the quadratic map. A mechanism that produces horseshoes and thus gives rise to chaotic dynamics is shown. The famous Lorentz attractor, as a prototype of a strange attractor, is examined in details. Variational approach does not belong to usual tools in dynamical systems. The authors present how this approach can be applied to the study of twist maps and afterwards to Riemann manifolds. The existence of infinitely many closed geodesics on the two-dimensional sphere equipped with a Riemannian metric is proved. The second part ends with the chapter devoted to relations between number theory and dynamical systems. The book is written in a precise and very readable style, there are many useful remarks and figures throughout. It can be highly recommended to anybody who is interested in dynamical systems and who has a basic knowledge of calculus. The book is also an excellent introduction to the more advanced monograph written by the same authors (Introduction to the Modern Theory of Dynamical Systems, Encyclopaedia of mathematics and its applications, vol. 54, Cambridge University Press, 1995). (jmil)

R. M. Heiberger, B. Holland: *Statistical Analysis and Data Display,* *Springer Texts in Statistics, Springer, New York, 2004, 729 pp., 200 fig., €79,95, ISBN 0-387-40270-5*
The book is written as a text for a yearlong course in statistics. The importance of such a textbook follows from the fact that today there are more than 15,000 statisticians in the United States only, over 100 U.S. universities offer graduate degrees in statistics and a shortage of qualified statisticians is expected to persist for some time. The students should learn not only purely mathematical tools but also the use of computers for obtaining numerical results and their graphical presentation. The book describes statistical analysis of data and shows how to communicate the results. The topics included in the book are standard ones: an introduction to statistical inference, one-way and two-way analysis of variance, multiple comparisons, simple and multiple linear regression, design of experiments, contingency tables, nonparametrics, logistic regression, and time series analysis in time domain. An "invisible" but extremely important part of the book is a web page (or CD) with the data for all examples and exercises, which also contains codes in S (i.e., S-PLUS and R) and in SAS. In online files, the reader also finds the code and the PostScript file for every figure in the text.

The statistical analysis in the book is taught on interesting real examples. Sometimes (e.g. in logistic regression) the analysis is quite deep. An extraordinary care is devoted to graphical presentation of results. Many of the graphical formats are novel. Finally, appendices to the book contain useful remarks on statistical software, typography, and a review of fundamental mathematical concepts. A reader who studies the book and repeats the authors' calculations gains basic statistical skills and knowledge of software for solving similar problems in applications. The book contains no theorems and no proofs. The methods are only explained and then demonstrated. However, if a statistical course contains a theoretical part, then the book can serve as a source of interesting examples and problems. By the way, the authors' web page also contains errata, which is quite comfortable for the readers. It is surely not a final list of misprints. For example, the median of the binomial distribution with n=2 and p=0.5 is h=1 which does not satisfy condition (3.10) on p. 28. (ja)

T. A. Ivey, J. M. Landsberg: *Cartan for Beginners: Differential Geometry via Moving Frames and Exterior Differential Systems,* *Graduate Studies in Mathematics, vol. 61, American Mathematical Society, Providence, 2003,378 pp., $59, ISBN 0-8218-3375-8*
Moving frames and exterior differential systems belong to classical methods for studying geometry and partial differential equations. These ideas emerged at the beginning of the 20th century, being introduced and developed by several mathematicians, in particular, by Élie Cartan. Over the years these techniques have been refined and extended. The book is a nice introduction into classical and recent geometric applications of the techniques. It covers classical geometry of surfaces and basic Riemannian geometry in the language of the method of moving frames; it also includes results from projective differential geometry. There is an elementary introduction to exterior differential systems, basic facts from *G*-structures and general theory of connections. Every section begins with geometric examples and problems. There are four appendices devoted to linear algebra and representation theory, differential forms, complex structures and complex manifolds and initial value problems. Interesting exercises are included, together with hints and answers to some of them. The authors presented it as a textbook for a graduate level course. It can be strongly recommended to anybody interested in classical and modern differential geometry. (jbu)

W. Keller: *Wavelets in Geodesy and Geodynamics,* *Walter de Gruyter, Berlin, 2004, 279 pp., 130 fig., €84, ISBN 3-11-017546-0*
This excellent textbook gives an introduction to wavelet theory both in the continuous and the discrete case. After developing the theoretical fundament, typical examples of wavelet analysis in geosciences are presented. The book consists of three main chapters. Fourier and filter theory are shortly sketched in the first chapter. The second chapter is devoted to the basics of wavelet theory. It includes the continuous as well as the discrete wavelet transform both in one- and in two-dimensional cases. A special emphasis is paid to orthogonal wavelets with finite support, because they play an important role in many applications. In the last chapter, some applications of wavelets in geosciences are reviewed. The book has developed from a graduate course held at the University of Calgary and is directed to graduate students interested in digital signal processing. The reader is assumed to have a mathematical background on the graduate level. (knaj)

B. M. Landman, A. Robertson: *Ramsey Theory on the Integers,* *Student Mathematical Library, vol. 24, American Mathematical Society, Providence, 2003, 317 pp., $49, ISBN 0-8218-3199-2*
The topic of this book is Ramsey theory on sets of integers. Chapter 1 introduces notation and basic results of the field, van der Waerden's theorem, Schur's theorem and Rado's theorem. The largest portion of the book, chapters 2-7, is devoted to the first result. In Chapter 2, a proof of van der Waerden's theorem is given and bounds on van der Waerden's numbers are discussed, including the breakthrough by W. Gowers. Chapters 3-7 deal with various modifications and variations on the theme of arithmetical progressions (subsets and supersets of arithmetical progressions, homothetic copies of sequences, and modular arithmetical progressions). Chapter 8 is devoted to Schur's theorem, Chapter 9 to Rado's theorem and Chapter 10 to other topics (Folkman's theorem, Brown's lemma and others). Each chapter is followed by exercises, a list of research problems, and commentary. The book concludes with a list of notation and an extensive bibliography with 275 items. (mkl)

J.-L. Lions: *Oeuvres choisies de Jacques-Louis Lions, vol. I,* *EDP Sciences, Paris, 2003, 722 pp., €70, ISBN 2-86883-661-5*

J.-L. Lions: *Oeuvres choisies de Jacques-Louis Lions, vol. II,* *EDP Sciences, Paris, 2003, 864 pp., €70, ISBN 2-86883-662-3*

J.-L. Lions: *Oeuvres choisies de Jacques-Louis Lions, vol. III,* *EDP Sciences, Paris, 2003, 813 pp., €70, ISBN 2-86883-663-1*
Jacques-Louis Lions, outstanding scientist and leading personality in partial differential equations and many related fields, published more than 20 monographs and more than 600 research papers. The presented three volumes represent a high level and representative sample of papers and parts of monographs carefully chosen by the scientific committee (A. Bensoussan, P. G. Sciarlet, R. Glowinski and R. Temam, with the collaboration of coordinators F. Murat and J.-P.Puel).

The first volume starts with an introduction (written by R. Temam) and a commentary by E. Magenes about his joint work with J.-L. Lions. The volume is devoted to partial differential equations and interpolation theory. It covers, roughly speaking, results published in the period between 1950 and 1960 and it contains almost 30 papers. Let us quote at least a few of the most interesting points. J.-L. Lions and E. Magenes developed a theoretical framework for solving non-homogeneous boundary value problems in a series of joint papers "Problèmes des limites non homogénes I - VII", whose first five parts are reproduced here. The Hilbert part of the theory in $H^s(\Omega)$ spaces is contained in the three volume monograph of J.-L. Lions and E. Magenes. The $W^{k,p}(\Omega)$ theory is very well described in the (fully reproduced) course by J.-L. Lions at the University of Montreal. The interpolation between Sobolev spaces plays a very important role here and thus these results are closely connected with J.-L. Lions' contributions to interpolation theory both within Hilbert spaces and Banach spaces. Significant achievements were obtained also in nonlinear partial differential equations. J.-L. Lions together with J. Leray used monotonocity methods and generalized the results of F. Browder and G. Minty to functionals of the calculus of variations that are convex in the highest derivatives only. They also presented a new and elegant proof to the results of M. Vishik. An important part of nonlinear PDEs is the classical Navier-Stokes system and its generalizations. J.-L. Lions also contributed to the modern theory of the Navier-Stokes system. He presented a new and simpler variant of Hopf's proof of the existence of weak solutions in three space dimensions - the most interesting from the point of view of physics - and in a joint paper with G. Prodi, they proved uniqueness of weak solutions in two space dimensions. Together with Q.

Stampacchia, he introduced the concept of a variational inequality, which proved to be very useful in many applications.

The second volume of the series with subtitles "Controle" and "Homogenization", is introduced by A. Bensoussan and contains results published from the end of the sixties up to the end of the nineties. J.-L. Lions' interest in optimal control theory started soon after the pioneering books of L. S. Pontryagin and R. Bellman, which appeared in 1957. Already 11 years later, Lions' book "Controle optimal des systèmes ..." was published, and it became soon a standard reference book. It was well known that the problem of optimal control for distributed systems can lead to problems with free boundary of Stefan type. J.-L. Lions used variational inequalities to make this relation straightforward. In the seventies, he generalized the notion of variational inequalities so that it was well suited to describe the problems of optimal stopping time and together with A. Bensoussan, they studied the stochastic control and variational inequalities and impulse control and quasi-variational inequalities. Later he returned to optimal control theory from a new point of view - namely the possibility of using control theory for stabilization of unstable or ill posed problems. New aspects of control theory appear also in J.-L. Lions later papers, especially his famous HUM - Hilbert uniqueness method. Together with R. Glowinsky, he introduced numerical methods suitable for solving these questions. In the second half of the seventies, J.-L. Lions was interested in the homogenisation theory for a large scale of equations with periodically oscillating coefficients. The method he used was far-reaching and applicable also to problems with an oscillating boundary or problems posed on perforated domains. Thus it made it possible in fluid mechanics to deduce Darcy's equation from Stokes' system, or to study the homogenisation of Bingham fluids. At the same time it allowed the study of mechanical properties of composite materials.

The third volume, with an introduction by P. G. Ciarlet, is devoted to numerical analysis and applications of PDEs in a wide scale of problems - the mechanics of fluids and solid bodies, Bingham fluids, viscoelastic or plastic materials, problems with friction, and plates described by linear as well as nonlinear elasticity theory. Since 1990, J.-L. Lions was attracted by very complex and complicated systems of PDEs, i.e., by climatology models. Even in this exceptional case, he, together with R. Temam and S. Wand, proved existence and uniqueness of solutions, their asymptotic behaviour and ways to their numerical solution. These two papers and more than 20 others dealing with highly interesting problems are contained in Volume III. The papers in the collection are, as well as all works by J.-L. Lions, written in a very clear and concise form and they are indispensable for researchers in PDEs and in numerical analysis. (jsta)

Y. Lu: ***Hyperbolic Conservation Laws and the Compensated Compactness Method,*** *Monographs and Surveys in Pure and Applied Mathematics 128, Chapman & Hall/CRC, Boca Raton, 2003, 241 pp., $84,95, ISBN 1-58488-238-7*

The book is devoted to the theory of the compensated compactness method, which is a principal tool for studying properties of systems of hyperbolic conservation laws. Quasilinear systems of hyperbolic conservation laws in one space dimension are considered. This setting (systems in one space dimension) is more or less the only case for which the existence and uniqueness results can be obtained also in a classical way, e.g. by the method of wave-front tracking. In this book a different approach is used, namely that of compensated compactness. The author introduces basic elements of the theory of compensated compactness, based on results of Tartar and Murat from the 80's. The notion of a Young measure is introduced and discussed. After these preliminaries, the author studies the Cauchy problem for a scalar equation with L^∞ and L^p data. It is to be noted that the simplified proof of the existence of the solution presented here does not need to use a concept of the Young measure. In the system case, the author works with all the usual concepts, such as the strict hyperbolicity, genuine non-linearity, linear degeneracy, Riemann invariants, entropy-entropy flux pair and theory of invariant regions to obtain uniform L-infinity estimates, symmetric and symmetrizable systems. The author then studies different important systems of hyperbolic equations, namely the system of Le Roux type, the system of the polytropic gas dynamic, Euler equations of one-dimensional compressible fluid flow, systems of elasticity and some applications of the compensated compactness to relaxation problems. The book is carefully written and will be appreciated both by PhD students and experts in the field as one of a few books gathering the knowledge until recently dispersed among research papers. (mro)

G. Mislin, A. Valette: ***Proper Group Actions and the Baum-Connes Conjecture,*** *Advanced Courses in Mathematics CRM Barcelona, Birkhäuser, Basel, 2003, 131 pp., €28, ISBN 3-7643-0408-1*

The book has two parts. The first contribution, by G. Mislin, contains a discussion of the equivariant *K*-homology *KG*(EG)* of the classifying space *EG* for proper actions of a group *G*. The Baum-Connes conjecture states that the *K* theory of the reduced *C** algebra of a group *G* can be computed by the equivariant K-homology *KG*(EG)*. The tools used in the exposition contain the Bredon homology for infinite groups. Relations of the Baum-Connes conjecture to many other famous conjectures in topology are described in the Appendix. The second part (written by A. Valette with Appendix by D. Kucerovsky) contains a discussion of the Baum-Connes conjecture for a countable discrete group Γ. Suitable index maps provide the link between both sides of the conjecture. The second part of the book contains a careful discussion of these maps. Both lecture notes clearly cover the area around a beautiful, interdisciplinary field and could be very useful to anybody interested in the subject. (vs)

V. Műller: ***Spectral Theory of Linear Operators and Spectral Systems in Banach Algebras,*** *Operator Theory Advances and Applications, vol. 139, Birkhäuser, Basel, 2003, 381 pp., €158, ISBN 3-7643-6912-4*

The monograph is written as an attempt to organize a huge amount of material on spectral theory, most of which was until now available only in research papers. The aim is to present a survey of results concerning various types of spectra in a unified, axiomatic way. The book is organized in to five chapters. At the beginning, the author presents spectral theory in Banach algebras, which forms a natural frame for spectral theory of operators. The second chapter is devoted to applications to operators. Of particular interest are regular functions: operator-valued functions whose ranges behave continuously. A suitable choice of a regular function gives rise to the important class of Kato operators and the corresponding Kato spectrum. The third chapter gives a survey of results concerning various types of essential spectra, Fredholm and Browder operators, etc. The fourth chapter contains an elementary presentation of the Taylor spectrum, which is by many experts considered to be the proper generalization of the ordinary spectrum of a single operator. The most important property of the Taylor spectrum is existence of a functional calculus for functions analytic on a neighbourhood of the Taylor spectrum. The last chapter is concentrated on the study of orbits and weak orbits of operators, which are notions closely related to the invariant subspace problem. All results are presented in an elementary way. Only a basic knowledge of functional analysis, topology and complex analysis is assumed. Moreover, basic notions and results from Banach spaces, analytic and smooth vector-valued functions and semi-continuous set-valued functions are given in the Appendix. The monograph should appeal both to students and to experts in the field. It can also serve as a reference book. (jsp)

M. C. Pedicchio, W. Tholen, Eds.: ***Categorical Foundations: Special Topics in Order, Topology, Algebra, and Sheaf Theory,*** *Encyclopaedia of Mathematics and Its Applications 97, Cambridge University Press, Cambridge, 2004, 440 pp., $90, ISBN 0-521-83414-7*

The book is a result of a collaborative research project of mathematicians from four European and three Canadian universities. During the years 1998 – 2001, small teams were formed to work on a variety of themes of current interest and to develop the categorical approach to them. This book presents the results of their work. The book contains 8 chapters devoted in turn to ordered set and adjunction (by R. J. Wood), locales (by J. Picado, A. Pultr and A. Tozzi), general topology (by M. M. Clementino, E. Giuli and W. Tholen), regular, protomodular and Abelian categories (by D. Bourn and M. Gran), monads (by M. C. Pedicchio and F. Rovatti), sheaf theory (by C. Centazzo and E. M. Vitale) and to effective descent morphisms (by G. Janelidze, M. Sobral and W. Tholen). Every chapter is self-contained with its own list of references. The book is very comprehensive and presents a lot of material on each of the themes. Moreover, it offers various ways of how to study "spaces" or "algebras", selecting and accentuating some of their features. The knowledge required for the reading of the book varies between the chapters, but only a modest knowledge of category theory is supposed at the beginning. The authors of each chapter develop the necessary categorical techniques themselves. The book will be very useful for graduate students and teachers, and inspiring for the researchers interested in the discussed topics as well as in category theory itself. (vtr)

G. Pisier: ***Introduction to Operator Space Theory,*** *London Mathematical Society Lecture Note Series 294, Cambridge University Press, Cambridge, 2003, 475 pp., £39,95, ISBN 0-521-81165-1*

The monograph is devoted to the study of operator space theory. The book has three parts. The first part contains a basic exposition of the theory and various illustrative examples. An operator space is just a (usually complex) Banach space *X,* equipped with a given embedding into the space B*(H)* of all bounded linear operators on a Hilbert space *H.* Natural morphisms in this category are completely bounded maps (a linear map is completely bounded if the naturally induced mappings between respective spaces of matrices have uniformly bounded norms). In view of this, we can have many operator space structures on a given Banach space. One of the basic tools for the theory is the Ruan theorem, which shows the correspondence between operator space structures on *X* and some kind of norms on the tensor product of *X* with the space $K(L_2)$ of compact operators on L_2. Basic operations on Banach spaces (dual space, quotient space, direct sum, complex interpolation, some tensor products, etc.) can be defined in the category of operator spaces. Some of these definitions are elementary, some make use of the Ruan theorem. It is also worth mentioning the existence (and uniqueness) of the "operator Hilbert space" - a canonical operator space structure on the Hilbert space. The second part is devoted to C*-algebras, which form a subclass of operator spaces (notice that the structure of a C*-algebra on a Banach space induces a unique operator space structure). The main themes in this part are C*-tensor products and various classes of C*-algebras and von Neumann algebras. Some properties of C*-algebras are extended to general operator spaces, and local theory of operator spaces is investigated. The third part deals with non-self-adjoint operator algebras, their tensor products and free products. The theory of operator spaces is also used to reformulate some classical similarity problems. (okal)

A. Polishchuk: ***Abelian Varieties, Theta Functions and the Fourier Transform,*** *Cambridge Tracts in Mathematics 153, Cambridge University Press, Cambridge, 2003, 292 pp., £47,50, ISBN 0-521-80804-9*

The book gives a modern introduction to theory of Abelian varieties and their theta functions. The text is based on lectures by the author delivered at Harvard University (1998) and Boston University (2001) and it provides an up-to-date introduction to the subject, oriented to the general mathematical community. One of the main goals is to give the first introduction to algebraic theory of Abelian varieties and theta functions, employing Mukai's approach to the Fourier transform in the context of Abelian varieties. This approach is also supported by recently discovered links to the mirror symmetry problem in algebraic geometry and quantum field theory. The exposition of material presented in the book was influenced by the category approach to problems under consideration. The book is divided into three main parts, then each of them into seven or eight chapters. Part I (Analytic Theory) discusses classical and recent aspects of transcendental theory of Abelian varieties. Part II (Algebraic Theory) is devoted to general Abelian varieties over an algebraically closed field of arbitrary characteristic. Part III (Jacobians) contains theory of Jacobian varieties of smooth irreducible projective curves over arbitrary fields. The chapters' text contains many exercises complementing the material covered. The bibliography is up-to-date and comprehensive, consisting of 138 titles. The book is primarily intended for anybody interested in modern algebraic geometry and mathematical physics, with a good background not only in complex and differential geometry, classical Fourier analysis, or representation theory, but also in modern algebraic geometry and categorical algebra. The book is written by a leading expert in the field and it will certainly be a valuable enhancement to the existing literature. (špor)

N. Saveliev: *Invariants for Homology 3-Spheres,* *Encyclopaedia of Mathematical Sciences, vol. 140, Springer, Berlin, 2002, 223 pp., €84,95, ISBN 3-540-43796-7*
The book can be considered as a fundamental monograph on invariants of homology 3-spheres. Let us mention that while the topic may seem rather specialised, these investigations have proved to be extremely useful in the manifold topology. The text covers almost all invariants from the classical Rokhlin invariant, through the Casson invariant and its various refinements and generalizations, to recent invariants of the gauge type. Quite naturally, it also contains many results on topology of 4-manifolds. Obviously, the book is designed for specialists in the field who will find there a practically complete survey of results and methods. On the other hand, it is written in such a clear style that I would like to recommend it strongly to postgraduate students starting to make themselves familiar with the field. The book will help them to learn basic notions and will gradually introduce them into contemporary research. The large number of references (311 items going up to 2001) will enable them the further orientation. (jiva)

L. Schneps, Ed.: *Galois Groups and Fundamental Groups,* *Mathematical Sciences Research Institute 41, Cambridge University Press, Cambridge, 2003, 467 pp., £50, ISBN 0-521-80831-6*
This volume is the outcome of the MSRI special semester on Galois groups and fundamental groups, held in the fall of 1999. The book contains scientific and survey articles from the most important extensions and ramifications of Galois theory - geometric Galois theory, Lie Galois theory and differential Galois theory, all in various characteristics. The main focus of the study of geometric Galois theory is the theory of curves and objects associated with them - curves with marked points, their fields of moduli and their fundamental group, covers of curves with their ramification information, finite quotients of the fundamental group that are Galois groups of the covers. The articles presented in the book include fundamental groups in positive characteristic, anabelian theory and Galois group action on fundamental groups. The subject of Lie Galois theory originates in the geometric situation, whose linearised version leads to graded Lie algebras associated with profinite fundamental groups. Special attention is paid to special loci in the moduli space with a particular group of automorphisms. Instead of considering finite groups as Galois groups of Galois extensions of arbitrary fields, differential Galois theory treats linear algebraic groups as Galois groups of so called Picard-Vessiot extensions of D-fields, which are fields equipped with derivation. (pso)

T. Sheil-Small: *Complex Polynomials,* *Cambridge Studies in Advanced Mathematics 75, Cambridge University Press, Cambridge, 2002, 428 pp., £65, ISBN 0-521-40068-6*
The book studies geometric properties of polynomials and rational functions in the complex plane. The book starts with a description of foundations of complex variable theory from the point of view of algebra as well as analysis. For example, the degree principle is studied in connection with the fundamental theorem of algebra, falling out into the mini-course of plane topology. To mention another example, the Rouché theorem is studied together with its topological analogues, including the Brouwer fixed-point theorem. After the preliminary chapter on the algebra of polynomials, the book is divided in to 11 chapters containing a study of the Jacobian problem, analytic and harmonic functions in the unit disc, trigonometric polynomials, critical points of rational functions, self-inversive polynomials and many other topics in connection with the central notion of a complex polynomial. Real polynomials are discussed in a separate chapter, including the Descartes rule of signs, distribution of critical points of real rational functions, and real entire and meromorphic functions. Blaschke products are also mentioned at the end of the book, with connection to harmonic mappings, convex curves and polygons. In general, the book offers a whole variety of concepts, oscillating among analysis, algebra and geometry. This is clearly one of the advantages of this nice publication. The book, with (or despite) its more than 400 pages, gives the reader a feeling that it is both a concise and a comprehensive monograph on the topic. It will surely be appreciated by graduate and PhD students, as well as by researchers working in the field. (mro)

J. F. Simonoff: *Analyzing Categorical Data,* *Springer Texts in Statistics, Springer, New York, 2003, 496 pp., 64 fig., €84,95, ISBN 0-387-00749-0*
The book can be divided into several parts. It starts with an introduction to regression models, including regression diagnostics and model selection. Then the author deals with discrete distributions and corresponding goodness-of-fit tests. The main topics here are binomial, multinomial, and Poisson distributions complemented by the zero-inflated Poisson model, the negative-binomial model, and the beta-binomial model. Then regression models for count data are presented. They are based mainly on generalized linear models. The part on contingency tables describes log-linear models, conditional analyses, structural zeros, outlier identification, models for tables with ordered categories, and models for square tables. The last part of the book introduces regression models for binary data and for multiple category response data. The chapters end with a section that provides references to books or articles related to the material in the chapters.

The author based this book on his notes for a class with a very diverse pool of students. The material is presented in such a way that a very heterogeneous group of students could grasp it. All methods are illustrated with analyses of real data examples. The author provides a detailed discussion of the context and background of the problem. For example, it is known that incorrect statistical analysis of data that were available at the time of the flight of Challenger on January 28, 1986, led to its explosion. It is less known that one of the recommendations of the commission was that a statistician must be part of the ground control team from that time on. All statistical modeling and figures in the text are based on S-PLUS. The author has set up a web site related to the book, where data sets and computer code are available as well as answers to selected exercises (there are more than 200 exercises in the book). On the other hand, there are no theorems and proofs in the book. Before using it as a textbook, the instructor should consult original papers and books to prepare theoretical background. At the same time, the style is not a "cookbook". The book is very interesting and it can be warmly recommended to people working with categorical data. (ja)

J. Stopple: *A Primer of Analytic Number Theory: From Pythagoras to Riemann,* *Cambridge University Press, Cambridge, 2003, 383 pp., £ 22,95, ISBN 0-521-81309-3, ISBN 0-521-01253-8*
The book constitutes an excellent undergraduate introduction to classical analytical number theory. The author develops the subject from the very beginning in an extremely good and readable style. Although a wide variety of topics are presented in the book, the author has successfully placed a rich historical background to each of the discussed themes, which makes the text very lively. The author covers topics with roots in ancient mathematics like polygonal numbers, perfect numbers, amicable pairs, basic properties of prime numbers and all central themes of the basic analytic number theory. Assuming almost no knowledge from complex analysis, he develops tools needed to show the significance of the Riemann hypothesis for the distribution of primes. Problems of additive number theory are not covered, as well as the prime number theorem. In the last three chapters of the book, the reader finds a couple of specific examples of L-functions attached to Diophantine equations. The material covered in these chapters includes solutions of the Pell equation, elliptic curves and analytic aspects of algebraic number theory. The text contains a rich supplement of exercises, brief sketches of more advanced ideas and extensive graphical support. The book can be recommended as a very good first introductory reading for all those who are seriously interested in analytical number theory. (špor)

W. Tutschke, H. L. Vasudeva: *An Introduction to Complex Analysis,* *Modern Analysis Series, Chapman & Hall/CRC, Boca Raton, 2004, 460 pp., $89,95, ISBN 1-584-88478-9*
The authors present two parallel approaches to complex function theory. One follows the idea that what can be used from the real analysis must be applied to lay the foundations of complex function theory, while the other one is "purely complex". The book starts with a review (86 p.) of basic methods and notions from real analysis such as metric spaces, liminf and limsup of a sequence of real numbers or the Gauss-Green formula, and basics on the field C of complex numbers and on elementary functions (in C). Then the theory is developed and this is quite often done on two levels. For example, the Cauchy theorem is first done in the version with sufficiently smooth positively oriented (firstly based on the intuition) curves bounding a bounded domain G and with function $f = u + iv$ holomorphic in G and u,v in C^1-class on the closure of G. Later on it is proved for a rectifiable boundary and f holomorphic in G and continuous on its closure. Many things, which are briefly described in other books, in remarks or exercises, are given in full details (at least 5 different proofs of the fundamental theorem of algebra are given). The book contains an exposition of analytic continuation, homotopy, conformal mappings, special functions and boundary value problems, to name the less frequently treated material. The authors will please readers interested mainly in applications as well as those who want to know how things really work and prefer deeper and more detailed treatment of the material. The book also contains more than 200 examples and 150 exercises. A certain drawback is that the fonts used in the typesetting of the book are rather small. Regardless of this fact the book is nice and I recommend it for courses in complex function theory (even on an advanced level) and also as a reference book. (jive)

C. Villani: *Topics in Optimal Transportation,* *Graduate Studies in Mathematics, vol. 58, American Mathematical Society, Providence, 2003, 370 pp., $59, ISBN 0-8218-3312-X*
The monograph is an exhaustive survey of the optimal mass transportation problem. It gives an overview of the recent knowledge of the subject and it introduces all tools convenient for its investigation. One of the principal tools used in the book is the Kantorovich duality on bounded continuous functions. Subsequent chapters introduce relevant geometric arguments needed to prove the duality theorem for the quadratic cost. Furthermore, Brenier's Polar factorisation theorem, the Monge-Ampère equation, displacement interpolation and the probabilistic metric theory, are all discussed. Relations to physical theories are also mentioned. The optimal mass transportation problem is reformulated in terms of fluid mechanics. Reformulation and explanation, by means of energy and entropy production optimisation under variational inequalities, are stated. The monograph grew from a graduate course taught by the author. The book is well organized and written in a clear and precise style. The text includes a list of illustrative problems helping to understand the theory. A certain level of mathematical skill is required from the reader. The monograph can be recommended to researchers and scientists working or interested in the field as well as an appropriate textbook for graduate and postgraduate courses on the subject. (pl)

C. Voisin: *Théorie de Hodge et géométrie algébrique complexe,* *Cours Spécialisés 10, Société Mathématique de France, Paris, 2002, 595 pp., €69, ISBN 2-85629-129-5*
Cambridge University Press published the English translation of the book in a two-volume version in 2002, 2003 resp. The review of both parts of the English translation appeared in the EMS Newsletter No. 53, p. 48. (pso)

List of reviewers for 2004

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

J. Anděl, R. Bashir, M. Bečvářová-Němcová, L. Beran, L. Bican, L. Boček, J. Bureš, J. Dolejší, P. Dostál, J. Drahoš, M. Ernestová, D. Hlubinka, Š. Holub, P. Holický, M. Hušková, O. John, O. Kalenda, A. Karger, T. Kepka, M. Klazar, J. Kopáček, V. Koubek, O. Kowalski, P. Kůrka, P. Lachout, J. Lukeš, J. Malý, P. Mandl, M. Markl, J. Milota, J. Mlček, E. Murtinová, K. Najzar, J. Nekovář, J. Nešetřil, I. Netuka, O. Odvárko, D. Pražák, Š. Porubský, J. Rataj, B. Riečan, M. Rokyta, T. Roubíček, P. Simon, P. Somberg, J. Souček, V. Souček, J. Spurný, J. Stará, Z. Šír, J. Štěpán, J. Trlifaj, V. Trnková, J. Tůma, J. Vanžura, J. Veselý, M. Zahradník, M. Zelený.

All of the above are on the staff of the Charles University, Faculty of Mathematics and Physics, Prague, except: M. Markl and J. Vanžura (Mathematical Institute, Czech Academy of Sciences), Š. Porubský (Technical University, Prague), B. Riečan (University of B. Bystrica, Slovakia), J. Nekovář (University Paris VI, France).