EUROPEAN MATHEMATICAL SOCIETY

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NOTICE FOR MATHEMATICAL SOCIETIES

Labels for the next issue will be prepared during the second half of November 2000. Please send your updated lists before then to Ms Tuulikki Mäkeläinen, Department of Mathematics, P.O. Box 4, FIN-00014 University of Helsinki, Finland; e-mail: makelain@cc.helsinki.fi

INSTITUTIONAL SUBSCRIPTIONS FOR THE EMS NEWSLETTER

Institutes and libraries can order the EMS Newsletter by mail from the EMS Secretariat, Department of Mathematics, P. O. Box 4, FI-00014 University of Helsinki, Finland, or by e-mail: (makelain@cc.helsinki.fi). Please include the name and full address (with postal code), telephone and fax number (with country code) and e-mail address. The annual subscription fee (including mailing) is 60 euros; an invoice will be sent with a sample copy of the Newsletter.

EMS Committee

EMS Agenda

2000

22-27 September
EURESCO Conference at Obernai, near Strasbourg (France):
Number theory and Arithmetical Geometry: Motives and Arithmetic
Organiser: U. Jannsen, Regensburg (Germany), *e-mail:* euresco@esf.org
EURESCO Conference at San Feliu de Guixols (Spain):
Geometry, Analysis and Mathematical Physics: Analysis and Spectral Theory
Organiser: J. Sjöstrand, Palaiseau (France), *e-mail*: euresco@esf.org

30 September
Deadline for proposals for 2001 EMS Lectures
Contact: David Brannan, *e-mail*: d.a.brannan@open.ac.uk
Deadline for proposals for 2002 EMS Summer Schools
Contact: Renzo Piccinini, *e-mail:* renzo@matapp.unimib.it

11-12 November
Executive Committee Meeting in London (UK), at the invitation of the London Mathematical Society.

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

2001

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

10-11 March
Executive Committee Meeting in Kaiserslautern (Germany) at the invitation of the Fraunhofer-Institut für Techno- und Wirtschafts Mathematik.

9-20 July
EMS Summer School at St. Petersburg (Russia)
Asymptotic combinatorics with applications to mathematical physics
Organiser: Anatoly Vershik, *e-mail*: vershik@pdmi.ras.ru

19-31 August
EMS Summer School at Prague (Czech Republic)
Simulation of fluids and structures interactions
Organiser: Miloslav Feistauer, *email*: feist@ms.mff.cuni.cz

3-6 September
1st EMS-SIAM conference, Berlin (Germany)
Applied Mathematics in our Changing World
Organiser: Peter Deuflhard, *e-mail*: deuflhard@zib.de

Editorial

Olli Martio (Helsinki)

EMS Treasurer

How I came to this point …

I obtained my PhD at the University of Helsinki in 1967. My thesis adviser was O. Lehto, who later became the secretary of the IMU. The thesis dealt with quasi-conformal mappings and PDEs, a subject that became more important ten years later. The choice was a lucky one. At the end of 1970s I started to study quasi-regular mappings – non-homeomorphic quasi-conformal mappings, the counterparts of analytic functions in higher-dimensional Euclidean spaces. At that time Y. G. Reshetnyak in Novosibirsk had done pioneering work on these mappings, but our group at the University of Helsinki (J. Väisälä, S. Rickman and myself) gave new geometric insight to these mappings. Our studies continued the tradition of the function-theoretic school in Finland (E. Lindelöf, F. and R. Nevanlinna and L. Ahlfors).

In 1972 I became an associate professor at the University of Helsinki. In the same year I organised my first international meeting, a Nordic Summer School devoted to quasi-conformal mappings; among the speakers were L. Ahlfors, F. W. Gehring and A. Selberg. The meeting was one of the first new types of summer course organised in Scandinavia, but since then they have become commonplace. There were no proceedings, but later I did my share: I have now edited nine conference proceedings.

During the period 1969-90 I spent some years abroad. The most enjoyable visits were at the University of Michigan in 1974 and 1985. Other places include the Moscow State University, the Norwegian Institute of Technology and the Technion in Haifa, Israel. The latest visit was the fall term in 1999 at the Mittag-Leffler Institute, where I took care of the scientific activities.

In the late 1970s I again began to study non-linear PDEs. They originated from the theory of quasi-regular mappings, but the potential-theoretic aspects turned out to be more useful than I expected. In 1980 I became a professor of mathematics at the University of Jyväskylä in central Finland, where I stayed for 13 years. In Jyväskylä I had a number of good students who later became professors in Finland and abroad. This year I was given an honorary PhD degree (my third) at the University of Jyväskylä.

In 1993 I moved from Jyväskylä to Helsinki. I was looking forward to less administrative duties in Helsinki than in Jyväskylä. This was not going to be so. In Jyvaskyla I had served as Head of the Department for ten years and short periods as a Dean of the Faculty. After a couple of years I became Head of the Department in Helsinki and other administrative duties started to pile up: I was a member of the Scientific Council of the Academy of Finland as well as the President of the Scientific Academy of Finland. These were not the only headaches. Recent years have been difficult in the Finnish universities: the new financial system, based on the annual 'production' of MSc and PhD, has changed and increased the duties of heads of departments. The 'output' is supposed to increase and the budget to decrease each year. The theory is that people are more productive under stress. The theory is effectively applied to heads of departments.

Treasurer of the EMS …

Aatos Lahtinen proposed that the office of the EMS be established in Helsinki and this happened in due course. After serving full terms as treasurer of the EMS he retired in 1998 and it was necessary to find a replacement. There is no requirement that the treasurer must be from Finland. However, the office is in Helsinki and for a good reason: the Finnish State pays the salary of the office secretary and so this heavy financial burden has been removed from the EMS budget. Tuulikki Mäkeläinen has taken excellent care of the office from the very beginning. Thus I thought that since I can enjoy the benefits of a professional secretary, the treasurer's job would not take much of my time. Even so, it took some time before Aatos Lahtinen was able to persuade me to take the job.

I have now served as the EMS treasurer for a couple of years. My expectations have been correct, in the sense that routine financial matters (fees etc.) do not take much of my time. The EMS budget has reached a certain stationary level. Since the number of countries in Europe has increased, the same has happened to the number of mathematical societies and so there are new potential corporate members for EMS. Also, the number of individual members has increased steadily, although the number could grow much faster. This seems to depend on the efforts of the national mathematical societies. The membership fee for an individual member is low, 15 euros, and he or she receives the *Newsletter*, worth 11 euros. There are other benefits as well; for example, the conference fee for the 3ecm in Barcelona was less for EMS members than for other participants.

On the other hand, the treasurer is involved in many other duties of the Executive Committee and the EMS in general. The activities have enlarged considerably and so has the committee work. I am a member of the Support of East European Mathematicians Committee, the Publishing House Committee, the Working Team for the Reference Levels in School Mathematics Education in Europe, etc. I feel that I get nothing done properly. I hate meetings but have come to the conclusion that life is not intended to be enjoyable.

and beyond ...

I am looking forward to the EMS taking a central role in mathematics education in Europe. New initiatives and bold steps are needed. The Chairman of the EMS Education Committee, V. Villani, has just stepped down and Tony Gardiner has replaced him.

The project 'Reference Levels in School Mathematics Education in Europe', sponsored by the EMS and the EU Science Programme, is chaired by Antoine Bodin

and the final report will be ready at the end of 2000. The report will consist of national reports describing the school system in European countries, focusing on the 16-year-old age group; this age coincides, roughly speaking, with the end of compulsory education in most EU countries. The project has collected information in mathematics curriculum from a plurality of resources, such as official bodies, textbooks, teacher education, working conditions, etc. I hope to see an up-to-date description of mathematics education in Europe.

In Europe a great variety of mathematics education is offered at the elementary level. This is of great benefit compared, for example, to the USA where the compulsory school curriculum is quite uniform; it would be an error to try to create strict standards in Europe. On the other hand, there should be an information system that provides the opportunity to learn from the best experiences in teaching mathematics in Europe. This is badly lacking. The system should also include the mobility of mathematics teachers and students inside EU countries. I think that it is the time to create such a system; the money could be very well spent.

Good teachers produce good mathematicians and other users of mathematics. For 30 years I have been working on gymnasium and high-school teacher education in Finland. I must admit that the standard has not improved; the following is a short description of the situation in Finland.

Although the teacher salaries are not bad in Finland, the profession seems to lack those attributes that make it desirable for young people. There are so many other professions today for those interested in mathematics in Finland that a career of teaching mathematics is not fashionable. For young people, future career prospects for teachers are not very good – once a teacher, always a teacher.

The Finnish Ministry of Education has computed the number of mathematics teachers needed to replace retired teachers, and the Finnish universities almost produce this number. However, it has turned out that this number is totally inadequate. There are two underlying facts. First, schoolteachers retire at a younger age than expected. A retirement peak is just now taking place, as a high percentage of the teachers lie in the age range of 60 to 65. The second reason is that a considerable number of young teachers in mathematics take teaching jobs outside conventional schools. The most important task of information technology firms is now to teach people to use their systems, and teachers who can understand the basics are needed. The majority of new mathematics teachers now have computer science as their second subject. Ordinary schools also expect this, instead of physics and chemistry, the traditional second subjects. This, together with high-technology industry, consumes the best of the new mathematics teachers.

The Ministry of Education in Finland has not been able to provide any countermeasures to these developments. In general, the job market for mathematicians is good in Finland: a recent survey showed zero unemployment, which is strange since there are always some mathematicians who seem to have difficulty in finding their place in society. Most mathematics students find at least temporary employment before finishing their studies. For teacher students this has been very easy. Naturally the average study time has increased, and the Ministry of Education blames the universities for this.

Finland is not alone with this problem, although the problems vary from one European country to another. I have found that those who are responsible for future development are often poorly informed on solutions and methods used elsewhere. They do not listen enough to mathematicians.

Maths Quiz 2000

Jaume Aguade

Every mathematician in the world is invited to take part in a unique mathematical contest in which competitors will answer as many challenging mathematical questions as possible. We call it the *Maths Quiz 2000*, and it is a contribution of the CRM (Barcelona) to the celebrations of World Mathematical Year.

We are talking about a question-and-answer global and live competition. All the competitors (individuals or small teams) will compete in real time through the Internet. The contest will start at 12 midday Greenwich Mean Time on the 17 October 2000 and will last exactly 24 hours, without interruption.

Beyond the thrill of the challenge, the winners will be rewarded with two sorts of prizes. The five highest scoring competitors will each receive workstations courtesy of SUN Microsystems, the main sponsor of the competition. On the other hand, to spur on all the players, even those far behind the leaders, we will be giving away throughout the competition a considerable number of book tokens valued at 100 Euros which have been offered by Birkhäuser Verlag to be used in the purchase of books from this publisher.

So mark the 17th of October in your diaries, find a small group of colleagues, and visit the site of the Maths quiz 2000: http://www.mq2000.org

More World Mathematical Year Stamps

Slovakia

Czech Republic

Spain

Croatia

In EMS *Newsletters* 35 and 36 we featured three stamps issued to commemorate World Mathematical Year 2000. Further stamps have now been issued by Slovakia, the Czech Republic, Spain and Croatia.

The Slovakian stamp features the Slovak mathematicians Juraj Hronec and Stefan Schwarz with a lattice diagram. The Czech stamp features a statement of Fermat's last theorem, with the equation $x^n + y^n = z^n$ cancelled by 'Andrew Wiles 1995' across the equals sign. The Spanish stamp features Julio Rey Pastor, a dominant figure in Spain and later in Argentina. The Croatian stamp features the Blanusa graph, the smallest 3-regular graph (other than the Petersen graph) with chromatic index 4, discovered by D. Blanuša in 1946.

EMS Executive Committee meeting

Barcelona, 6 July 2000

Present were Rolf Jeltsch (President, in the Chair), Andrzej Pelczar (Vice-President), David Brannan (Secretary), Olli Martio (Treasurer), Bodil Branner, Doina Cioranescu, Renzo Piccinini, Marta Sanz-Solé and Anatoly Vershik, and (by invitation) Robin Wilson, Tuulikki Mäkeläinen, David Salinger and Carles Casacuberta. Apologies were received from Luc Lemaire (Vice-President).

Photos: David Salinger *Andrzej Pelczar, Marta Sanz-Solé and Robin Wilson*

The President thanked the Catalan Mathematical Society for organising the meeting and for its hospitality.

Officers' Reports

The President reported briefly on his past travels. He had visited Hanoi, where he had set up a 'Zentralblatt consortium', and the Clay Millennium Prizes Event in France, and was going to visit the Nigerian Mathematical Society at the end of July. The EMS was now a partner in DREAMS, a project for raising public awareness in mathematics with J.-F. Rodrigues as its main organiser.

The EMS Lectures in Zürich had been excellent in content and well attended.

Council 2000

The EMS auditors, H.-J. Munkholm and L. Reich were no longer delegates, so new EMS auditors had to be elected. The professional auditors could continue.

The Council meeting in 2002 was planned to be in connection with the Abel meeting (2-8 June 2002). The proposal should be to hold it on Friday 31 May and Saturday 1 June.

EMS Committees

The strategy paper prepared for the EU by the EMS Group on Relations with European Institutions had been well received. The new Commissioner, Philippe Busquin, had been very positive. There were three special points to be discussed: the ('large project') Grid, large computers (net) and modelling, and the Genome project.

Claude Lobry had prepared a basic working plan for the EMS Developing Countries Committee. The Committee was awarded funding of 2000 euros to cover the 12-month period from 1 July 2000.

An EMS Committeee on 'Raising Public Awareness of Mathematics' was established.

Projects

The EC was still looking into the question of establishing an EMS Publishing House, and would discuss this with interested parties at the Barcelona Congress.

Reciprocity Agreements

An EMS-AMS reciprocity agreement would probably be signed on 13 July. Further reciprocity agreements were in the pipeline.

Future Executive Committee meetings

The next meeting will be held in the London Mathematical Society office, De Morgan House, 57-58 Russell Square, London WC1B 4HS, on 10-12 November 2000. The following meeting will be held at ITWM in Kaiserslautern, on 9-11 March 2001.

EMS Newsletter

EC members reported that they thought highly of the June EMS *Newsletter*. Various articles were solicited by its Editor for future issues. EMS members are always encouraged to offer articles to the EMS *Newsletter* Editor, Robin Wilson [*r.j.wilson @open.ac.uk*].

David Brannan

Bodil Branner, Rolf Jeltsch and Tuulikki Mäkeläinen

EMS Council meeting

Barcelona, 7 - 8 July 2000

The 2000 meeting of the Society's Council was held in the Residence Hall for Researchers of the Institute for Catalan Studies in Barcelona, Spain. Around 60 delegates of members were present, together with members of the Executive Committee and some invited guests, including the Presidents of the American Mathematical Society and of the African Mathematical Union. The President expressed the thanks of the delegates to the local organisers of the meeting, Sebastià Xambó-Descamps, Marta Sanz-Solé and Javier Martínez de Albèniz.

Address of the President, Rolf Jeltsch

The President observed that the EMS is a highly active society with some 50 corporate members and approximately 1900 individual members. Unfortunately the number of individual members was much too small considering the more than 10000–20000 mathematicians in Europe.

The EMS was financially sound but still not strong enough to do the job it envisioned, namely:

– to be active in the EU and on the supranational level;
– to provide professional service to its members;
– to help less privileged colleagues, e.g. from Eastern Europe, developing countries, young mathematicians.

It often had problems caused by its rather limited funds – he gave two examples, the funding of EMS summer schools and the difficulty of finding volunteers to carry out some rather routine but vital tasks (e.g. maintaining the web sites).

He ended with the statement that EMS was now 10 years old. In his opinion it had gained a very high visibility and he was proud of what had been achieved.

Reports from Executive Committee members

The *President*, *Rolf Jeltsch* (ETH, Switzerland), reported that he had tried to keep contact with the member societies and the individual members at least on a yearly basis by writing an annual letter at the change of the year.

His main aims had been:

– *to enlarge the membership base of EMS* by various approaches, such as reaching out for applied mathematicians, attracting more corporate members in applied mathematics like ESMTB, cooperating with SIAM in a major conference in Berlin on 2-6 September 2001, instituting the Felix Klein Prize, changing the name of the 'Committee on Applications of Mathematics' to 'Applied Mathematics Committee', having more articles on applied mathematics in the *Newsletter*, and making it possible for Europeans living outside Europe to join (via reciprocity agreements with the American Mathematical Society, the Australian Mathematical Society and perhaps the Canadian Mathematical Society).

– *to make the EMS more visible* by increasing relations with other societies, EMS joining IMU and ICIAM as an Associate Member, contacts with AMS, SIAM and the Clay Mathematical Institute, involvement in raising public awareness of mathematics (via the EMS WMY2000 Committee and a new EMS committee on RPA), influencing the European Commission for example, by influencing the definition of the 5th and 6th Framework Programmes), and supporting the Zentralblatt MATH LIMES project and the EULER project.

He ended with the observation that he had been one and a half years in office and it had been satisfying to work together with a great team of devoted colleagues.

The *Secretary*, *David Brannan* (OU, England), reported on the discussions at the four Executive Committee meetings since the previous Council meeting in Berlin in 1998.

The *Treasurer*, *Olli Martio* (Helsinki, Finland), reported on various financial matters. He informed the Council that the income of the EMS still consisted mainly of membership fees, which showed only a small increase. Expenses connected to individual members were rather high, so that raising the number of individual members would not raise income considerably. He had no special concern for membership fees from corporate members. The positive financial outcome was partly due to many Executive Committee members being supported by local sources, though he had occasional concerns over the financing of various EMS Special Projects. A reserve fund of 70000 euro had been collected by the Society and could be used to allay unexpected costs.

The Financial Statements and Auditors' Reports for 1998 and 1999 were accepted. The budgets for the years 2001 and 2002 were approved, with no major changes compared to previous years and no changes for membership dues.

László Márki (Budapest, Hungary) and *John Hubbuck* (Aberdeen, Scotland) were elected as Auditors for the years 2001-2002. *P. Kaasalainen*, with *K. Soikkeli* as Deputy, was elected as the professional Auditor for the years 2001-2002.

photos: Peter Legisa

The recently-retired *Publicity Officer*, *Mireille Chaleyat-Maurel* (Paris, France), was warmly thanked for her long and devoted service to the EMS. Council noted that *David Salinger* (Leeds, England) had recently succeeded to the post.

3ecm 2000

The *Chair of the Organising Committee*, *Sebastià Xambó-Descamps*, reported briefly on the Barcelona Congress. It was expected to have an attendance of about 1600 persons from more than 80 countries. The budget of the congress was sound, though it had been raised from 90 million pesetas to 109.6, and it was balanced. The organisers had been able to give 10 million pesetas towards prizes and 195 million pesetas as grants to young researchers. The grants were more than 300 in number.

For a successful organisation the support of people and institutions had been needed and they had been secured. The Congress had dedicated Organising and Executive Committees.

The Catalan Mathematical Society wished the Council a pleasant stay in Barcelona, both during the Council and the Congress.

Membership of EMS

The *European Mathematical Trust* had cancelled its membership, because it had

ceased to exist. The *Royal Spanish Mathematical Society* expressed the wish to raise its Class from 1 to 2, and this was agreed. The *European Society for Mathematical and Theoretical Biology* had applied for membership in Class 1, and this was approved.

The Executive Committee had proposed a reciprocity agreement with the *American Mathematical Society*. The draft agreement included the sentence: "This exchange agreement shall in no way interfere with existing reciprocity agreements between the AMS and corporate members of the EMS." The reciprocity agreement was unanimously accepted.

The Executive Committee had proposed that the Council authorise the Executive Committee to negotiate reciprocity agreements in the spirit of the agreement reached with AMS, on the basis that these agreements should be enacted on a provisional basis until they were ratified at a Council meeting. This authorisation was unanimously given.

Executive Committee elections

Bodil Branner (DTU, Copenhagen, Denmark) was elected unanimously to be Vice-President for the years 2001-2004.

Four candidates had been nominated for election to three vacancies for Members-at-Large. Following statements by all the candidates, a secret ballot was held and *Victor Buchstaber* (Moscow, Russia), *Marta Sanz-Solé* (Barcelona, Spain) and *Mina Teicher* (Ramat Gan, Israel) were declared elected as Members at Large of the Executive Committee for the years 2001-2004.

Detailed review of the various Society activities

The following reports from Officers and Committees were received and accepted, in some cases after a short discussion:

- Publications: *Publications Officer*, *Carles Casacuberta*, (Barcelona, Spain) This covered the *Journal of the European Mathematical Society* and electronic publications.
- *Newsletter*: *Newsletter Editor-in-Chief, Robin Wilson* (OU, England) The Newsletter now contained more feature articles, more reports and more on local societies.
- Applied Mathematics Committee
- Developing Countries Committee
- Education Committee
- Electronic Publishing Committee
- ERCOM Committee
- European Database Committee
- Group on Relations with European Institutions
- Special Events Committee
- Summer Schools Committee
- Support of East European Mathematicians Committee
- Women and Mathematics Committee
- World Mathematical Year 2000 Committee

Council noted too that the Executive Committee had just created a new *Committee for Raising Public Awareness in Mathematics*, with Vagn Lundsgaard Hansen in the Chair.

European Congress of Mathematics: ECM4 in 2004

One bid had been received to host ECM4. However a number of problems had appeared, and Council decided to empower the Executive Committee to investigate matters further and to choose another venue for ECM4 if necessary.

A report on the finally agreed location will appear in a forthcoming *Newsletter*.

EMS Council Meeting in 2002

The Norwegian Mathematical Society invited EMS Council to Oslo in 2002, prior to the Abel conference of 2-8 June 2002. The invitation was accepted with pleasure, and the dates were preliminarily fixed at 31 May- 1 June 2002.

MATH-NET

Martin Groetschel presented a brief outline of the German project MATH-NET. Council encouraged collaboration between different electronic search systems – for instance, between EULER and MATH-NET.

ICIAM

Council was informed that the EMS had been accepted as a large associate member of ICIAM, the International Council/Congress of Industrial and Applied Mathematics.

Congress Fees

The delegates of the French Mathematical Society brought forward the following motion accepted by the French National Committee for Mathematics (CNFM) concerning high fees for congresses:

The CNFM observes that registration fees for international conferences in mathematics tend to rise steadily. The Committee is concerned by such a trend, which makes it every year more difficult to support the participation of mathematicians asking for its financial help.

Following some discussion and rewording, Council agreed on the following EMS Council resolution:

In relation to the CNFM statement, EMS Council expresses its concern over the high fees charged by some conferences. Scientific meetings are an essential component in the development of Science and Mathematics, and should therefore always be considered as scientific events and not as commercial activities. In particular, their organisers should always make special efforts to facilitate participation by younger mathematicians. It is also unacceptable that a scientist should be unable to attend a scientific conference solely because it has a high conference fee.

African Mathematical Union

The AMU President, *Jan Persens*, thanked the Council for the opportunity to have been able to attend and to learn about the EMS. He extended his thanks to EMS and to the London Mathematical Society, whose grants enabled him to attend. AMU had invited presidents of other organisations for its 2000 Congress and the President of EMS had participated.

He called for collaboration, mentioning summer-winter schools, workshops, specialised conferences in sub-regions, graduate students' courses, external examinations, sharing teaching materials, possibly lecture note series at post-graduate level, and researchers' visits. In 2004 the AMU congress would be held in Tunisia, where European mathematicians would be most welcome.

History of the EMC and of the EMS

It was agreed that EMS should take steps to ensure that at least a short *History of the European Mathematical Council* was written and published in a suitable place fairly soon, and that key persons were interviewed or persuaded to write their memoirs.

The President reported that the Executive Committee had received a manuscript of *The History of the EMS*, written by *David Wallace* (Strathclyde, Scotland), and had decided to store it in the EMS archives for the moment.

Closing remarks

Finally, the President expressed his thanks to all participants for attending. Special thanks were given to the Catalan hosts of the meeting, especially to Sebastià Xambó-Descamps, Marta Sanz-Solé and Javier Martínez de Albèniz.

David Brannan

3ecm in Barcelona

10-14 July 2000

David Brannan

The motto of the Third European Congress of Mathematics (*3ecm*) was *Shaping the 21st Century*. 3ecm was one of the main mathematical events of 2000, a year designated by the International Mathematical Union and UNESCO as World Mathematical Year (*WMY2000*).

The event was organised by the Societat Catalana de Matemàtiques (Catalan Mathematical Society, or SCM), of the Institut d'Estudis Catalans (IEC); particularly important roles were played by the President of the IEC, Manuel Castellet, and the President of the SCM, Sebastià Xambó-Descamps. The IEC comprised: Sebastià Xambó-Descamps (Chairman), Carles Casacuberta (in charge of information and publications), Julià Cufí (finances), Rosa M. Miró-Roig (programming and activities), Marta Sanz-Solé (organisational secretary), and Ferran Puerta and Marta València (infrastructure). They were assisted by their mathematical colleagues in all the universities in the Barcelona area, and over a hundred students assisted delegates in very many ways during 3ecm.

Rolf Jeltsch (EMS) & Felix Browder (AMS) signing the EMS-AMS Reciprocity Agreement, July 13th 2000

The Scientific Committee comprised: Sir Michael Atiyah (Chairman), Vladimir I. Arnold, Robert Azencott, Fabrizio Catanese, Ildefonso Díaz, Antti Kupiainen, Jack van Lint, Colette Moeglin, A. F. M. Smith, Johannes Sjöstrand, Domokos Szász, Stanislaw L. Woronowicz and Don Zagier. The Prize Committee comprised: Jacques-Louis Lions (Chairman), Noga Alon, Werner Ballmann, Jan Derezinski, Maxim Kontsevich, Eduard Looijenga, Angus Macintyre, David Nualart, A. N. Parshin, Ragni Piene, Itamar Procaccia, Mario Pulvirenti, Rolf Rannacher, Caroline Series, Vladimir Sverák and Dan Voiculescu. The Round Table Committee comprised: Miguel de Guzmán (Chairman), Andrey Bolibrukh, Heinz W. Engl, Juan José Manfredi, Carles Perelló, Tomás Recio, Zbigniew Semadeni and Vinicio Villani.

Around 1250 mathematicians assembled in Barcelona for the Opening Ceremony on 10 July. All the 3ecm activities took place in the Palau de Congressos of Barcelona, close to the Olympic Stadium. There was an Opening Reception in the *Galeria* of the Palau de Congressos and a wonderful Congress Dinner in the gardens of the Palau de Pedralbes. The weather was excellent throughout the congress, and the local organisation superb. It was an outstanding success, thoroughly enjoyed by everyone who participated. Lectures were given by those nine Prize-winners who were present in Barcelona.

There were nine Plenary Lectures:

Robbert Dijkgraaf – *The mathematics of M-theory*

Hans Föllmer – *Probabilistic applications of financial risk*

Hendrik W. Lenstra, Jr. – *Flags and lattice basis reduction*

Yuri I. Manin – *Moduli, motives, mirrors*

Yves Meyer – *The role of oscillations in some non-linear problems*

Carles Simó – *New families of solutions in N-body problems*

Marie-France Vignéras – *Local Langlands correspondence for GL(n, Q_p), modulo $l \neq p$*

Olerg Viro – *Dequantization of real algebraic geometry on a logarithmic paper*

Andrew Wiles – *Galois representations and automorphic forms*

There were also twenty-nine Invited Lectures, in parallel sessions:

Rudolf Ahlswede – *Advances on extremal problems in number theory and combinatorics*

François Baccelli – *Flow control in stochastic networks*

Volker Bach – *Mathematical theory of matter and radiation*

Vivianne Baladi – *Spectrum and statistical properties of chaotic dynamics*

Joaquim Bruna – *Sampling in complex and harmonic analysis*

Xavier Cabré – *A conjecture of De Giorgi on symmetry for elliptic equations in R^n*

Peter J. Cameron – *The random graph and its relations*

Zoé Chatzidakis – *Difference fields: model theory and applications to number theory*

Ciro Ciliberto – *Geometric aspects of polynomial interpolation in more variables and of Waring's problem*

Gianni Dal Maso – *The calibration method for free discontinuity problems*

Jan Denef – *Geometry of arc spaces of algebraic varieties*

Barbara Fantechi – *Stacks for everybody*

Alexander B. Givental – *Some aspects of symplectic field theory*

Alexander Goncharov – *Multiple ζ-values, Galois groups and geometry of modular varieties*

3ecm Round Table "Shaping the 21st Century", July 14th 2000

Alexander Grigor'yan – *Heat kernels on manifolds, graphs and fractals*
Michael Harris – *Local Langlands correspondence and vanishing cycles on Shimura varieties*
Kurt Johansson – *Random growth and random matrices*
Konstantin M. Khanin – *Burgers turbulence and dynamical systems*
Pekka Koskela – *Sobolev spaces and quasiconformal mappings on metric spaces*
Steffen L. Lauritzen – *Probabilistic networks and the mathematics of local computation*
Nicholas S. Manton – *Understanding skyrmions using rational maps*

Tuulikki Mäkeläinen at the EMS Booth at 3ecm

Ieke Moerdijk – *Models for the leaf space of a foliation*
Eric M. Opdam – *Recent developments in the theory of hypergeometric functions*
Thomas Peternell – *Contact manifolds in algebraic geometry*
Alexander Reznikov – *Analytic topology*
Henrik Schlichtkrull – *Harmonic analysis on reductive symmetric spaces*
Bernhard Schmidt – *Sums of roots of unity and finite geometry*
Klaus Schmidt – *Algebraic $\mathbf{Z}^d$-actions*
Bálint Tóth – *Self-interacting random motions*

Ten Mini-Symposia provided a wide range of talk on varied topics:

Computer algebra (Chair, Wolfram Decker): Manuel Bronstein, Gaston Gonnet, Gert-Martin Greuel, Erich Kaltofen, Hendrik W. Lenstra Jr. and Tomás Recio

Curves over finite fields and codes (Chair, Gerard van der Geer): Noam Elkies, Arnaldo Garcia, Gerard van der Geer, Andrew Kresch, Christian Maire, Henning Stichtenoth and Chaoping Xing

Free boundary problems (Chair, José Francisco Rodrigues): Giovanni Belletini, Klaus Deckelnick, Irina V. Denisova, Gonzalo Galiano, Harald Garcke, Josephus Hulshof, Régis Monneau, Henrik Shahgholian and José Miguel Urbano

Mathematical Finance: Theory and Practice (Chair, Hélyette Geman): Tomas Bjork, M. A. H. Dempster, Ernst Eberlein, Dilip Madan, Ezra Nahum, Stanley Pliska, Rainer Schobel and Ton Vorst

Mathematical finance: theory and practice (Chair, Hélyette Geman): Tomas Björk, Ernst Eberlein, Dilip B. Madan, Stanley R. Pliska and Rainer Schöbel

Mathematics in modern genetics (Chair, Peter Donnelly): David J. Balding, Peter Donnelly, Alison Etheridge, Warren Ewens and Augustine Kong

Quantum chaology (Chair, Sir Michael Berry): Sir Michael Berry, Eugene Bogomolny, Monique Combescure, Christopher Howls, Jonathan Keating, Jens Marklof, Zeév Rudnick and André Voros

Quantum computing (Chair, Sandu Popescu): Charles H. Bennett, Richard Cleve, Nicolas Gisin, Sandu Popescu, Rolf Tarrach and Umesh Vazirani

String theory and M-theory (Chair, Michael R. Douglas): Duiliu-Amanuel Diaconescu, Jaume Gomis, Chris M. Hull, Albrecht Klemm, José M. F. Labastida, Marcos Marino, Nikita Nekrassov, Christoph Schweigert and Angel M. Uranga

Symplectic and contact geometry and Hamiltonian dynamics (Chair, Mikhail B. Sevryuk): Paul Biran, Yuri V. Chekanov, Hansjörg Geiges, Viktor L. Ginzburg, Alberto Ibort, Àngel Jorba Dietmar Salamon and Vladimir M. Zakalyukin

Wavelet applications in signal processing (Chair, Andrew T. Walden): Richard G. Baraniuk, Peter F. Craigmile, Patrick Flandrin, Emma McCoy, Vasily Strela and Andrew T. Walden

Poster sessions took place over three successive afternoons. In parallel with these was a range of interesting and often colourful video exhibitions with the following titles: *Multicoloured fractals*, *Quadro – a compact soap bubble of genus 4*, *Geodesics and waves*, *Platonic solids*, *Knot energies*, *Interpolation of triangle hierarchies*, *Polytope sections and surfaces*, *Flows and holonomy*, *The optiverse*, *Distorted space*, *CMC – pictures of constant mean curvature*, *Numerical simulations of unstable detonations*, *On Gorgonne's problem*, *Soap bubbles* and *The dynamics of* the *rabbit*.

There were seven interesting Round Tables, in which panellists gave prepared statements and then engaged in discussions with each other and the audience:

Mathematics teaching at the tertiary level: Vladimir Tikhomirov (Chair), Deborah Hughes-Hallet, John Mason and Robert Mattheij

The impact of mathematical research on industry and vice-versa: Irene Fonseca (Chair), Mark Davis and Martin Grötschel

How to increase public awareness of mathematics: Vagn Lundsgaard Hansen (Chair), Jean-Michel Kantor, Carlo Sbordone and Jorge Wagensberg

What is mathematics today?: Zbigniew Semadeni (Chair), Pilar Bayer, Jaime Carvalho de Silva and Henri Lombardi

Building networks of co-operation: Friedrich Hirzebruch (Chair), Eva Bayer, Bodil Branner and Anatoly Vershik

The impact of new technologies on mathematical research: Rafael de la Llave (Chair), Bruno Buchberger, Sergei Matveev and Mika Seppala

Shaping the 21st Century: Miguel de Guzmán (Chair), Alexandra Bellow, Jean-Pierre Bourgignon and Helmut Neunzert

On two afternoons there were sessions on Mathematical Software, in which the following participated: Anna Maria Bigatti and Lorenzo Robbiano (CoCoA), Harmut Häfner (LINSOL), Mario Essert (Internet), Jordi Guàrdia and Jesús Montes (Newton), Torsten Adolph (DFEM), Bob Matthews (Math Type), Gerd-Martin Greuel (Singular), Alexander Makarenko (societal problems), Immaculada Fortes (Grammarkov), Peter Dräxler and Rainer Nörenberg (CREP), Arkadii Kim (Time-delay system), Francis Sergeraert (Kenzo), Konrad Polthier (Java view), Lancelot Pecquet (Magma) and Ewgenij Gawrilow (Polymake).

Overall the programme for the five days was very full and exciting, but with many opportunities for everyone to sit quietly to talk with colleagues as well as to enjoy a varied diet of excellent talks. All participants were agreed that the arrangements and the whole meeting had been excellent, and were really sad to leave Barcelona after 3ecm!

3ecm : Opening Address

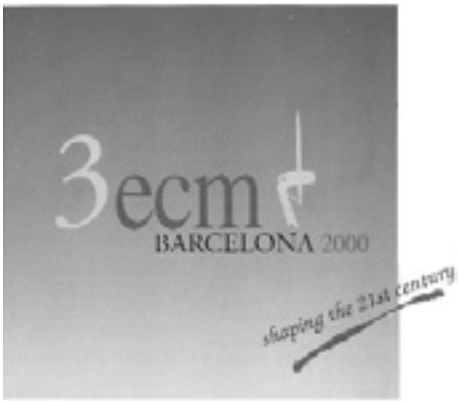
Manuel Castellet
President of the Institut d'Estudis Catalans

The opening of the Third European Congress of Mathematics in Barcelona gives me special satisfaction in my double capacity of mathematician and of President of the Institut d'Estudis Catalans. The Institut d'Estudis Catalans (Institute for Catalan Studies) is the National Academy of Catalonia and the parent body of the Catalan Mathematical Society, organiser of this Congress, which I hope will be to the satisfaction of all of you. Catalonia is a small country in surface area and population, a country which has never had a strong mathematical tradition. If you consult the *Zentralblatt für Mathematik* or the *Mathematical Reviews* for the 1970s you will notice that the probability of finding an article by a Catalan mathematician, even by a Spanish one, is effectively less than any epsilon. But now, 25 years later, there is an abundance of Catalan mathematical research published in prestigious journals, and there are outstanding Catalan mathematicians in all areas.

This reality is demonstrated by a recent study carried out by the Institut d'Estudis Catalans into mathematical research in Catalonia. The ratio between the number of articles published in Catalonia and the total population, scaled by the Gross National Product, is similar to the ratio in Norway, Great Britain or Germany; furthermore, 8.2% of all mathematical articles are published in the top quality journals. This situates Catalonia, according to these criteria, among the most scientifically significant countries of the world.

Doubtless this situation is the fruit not only of the labours of recent generations of Catalan mathematicians, but also of the efforts of our whole society and of the recent entry of the country into the current democratic framework. But this alone would not be sufficient. It must also be because the famous phrase from Cicero's *Tusculanae* suits us perfectly: "Nature has placed in our spirit an insatiable desire to know the truth". A truth which this country in its thousand year history has always sought, with more or less success, and almost always with limited resources. A truth which the Catalan countries, scientifically, have always sought looking towards Europe, a Europe of which we were an important nucleus in the Middle Ages, before a sharp decline, and of which we have been steadily forming a more integral part since the beginning of the twentieth century. The Institut d'Estudis Catalans, founded in 1907, is an academic, scientific and cultural institution which has been an important factor in this cultural and scientific integration.

The aim of the Institut d'Estudis Catalans is to advance research, both in science and in all areas of Catalan culture. It contributes to the planning, co-ordination



and realisation of research in various fields of science, technology and the humanities. It works to stimulate the progress and general development of Catalan society and. on occasion, serves as a consultancy for public bodies and institutions. The Institut d'Estudis Catalans is divided by broadly-defined subject areas into five sections (including the Academy of the Catalan language) each of which has a maximum of 21 full Fellows; associated to it there are also 25 scientific societies, one of which is the Catalan Mathematical Society, with a total of more than nine thousand members altogether.

Let me now give a brief review of our mathematical history in Catalonia.

Did you know that Gerbert d'Orlhac, a monk from the Catalan Pyrenees who in the year 1000 was better known as Pope Sylvester II, made an in-depth study of the *Quadrivium*, transformed calculation methods throughout Europe two centuries before Fibonacci, and built an original abacus?

Did you know that the Majorcan Ramon Llull, one of the most important writers in the Catalan language of the thirteenth century, already understood that the Earth was a sphere and wrote *Ars Combinatoria* and *Art de Navegar*, a book unsurpassed until the sixteenth century, which describes the astrolobe and refers to the use of the magnetic compass? Alexander von Humboldt maintained over 100 years ago that these scientific advances were transmitted from Catalonia via other Mediterranean nations to the rest of the civilised world.

Did you know that in 1375 the Majorcan Jew Abraham Cresques drew the world map known as the *Catalan Atlas*, a representation of the known world which was essential for the navigators of the epoch?

Did you know that the second book of arithmetic ever printed (after the anonymous arithmetic text of Treviso) was *Summa de l'art d'Aritmetica* by Francesc Santcliment, printed in Catalan in Barcelona in 1482? And that the first mathematics book printed in Spain was the Spanish translation of Santcliment's book?

Did you know that the Valencian Josep Chaix, author of works on differential and integral calculus, carried out with Pierre Mechain in 1793 the calculations to measure the meridian arc between the Pyrenees and Barcelona?

I do not wish to bore you with this history lesson, but I must mention two outstanding contemporary researchers from our country: Lluís Santaló, born in Girona and emigrated to Argentina, pioneer of integral geometry, stereology and geometric probability, who cannot attend this conference due to his delicate state of health. And Ferran Sunyer i Balaguer, possibly the greatest Catalan mathematician throughout the 1950s and 60s, born a tetraplegic, friend of Hadamard, Mandelbrot and Malliavin, among others, whose theorem on polynomials you can read on the stand of the Catalan Mathematical Society and in whose honour the Institut d'Estudis Catalans awards each year a prize for a monograph which best expounds and summarises advances in an active area of mathematics.

But the greatest change, the integration of Catalan mathematicians to the ideas and scientific trends, both European and international, has happened in the last twenty or twenty-five years, when some of us made contact with André Lichnerowicz, Beno Eckmann or Paul Malliavin, to choose just three truly significant names of European mathematicians. The mathematics departments of the universities of Barcelona started to become active research centres and with great effort and dedication were able to gradually break through the scientific and cultural isolation to which we had been subjected by a dictatorial government and a closed society.

At the beginning of the 1980s the Catalan universities, that of Barcelona, the Autonomous University and the Polytechnical University, began to discover that they could compete in high quality

mathematical research. The various mathematics departments have intensified the training of doctoral students and the production of research work. But to do so they had to keep in touch with the mathematical research being carried out in the developed world.

Thus the Institut d'Estudis Catalans, in view of these changes, created in 1984 the Centre de Recerca Matemàtica, the only research institute in Spain, with the objective of facilitating contact between Catalan mathematicians and the European and international scientific elite; an institute for visiting professors and young researchers, whose aim is to stimulate growth in quality and quantity of Catalan mathematical research, organising specialised research semesters, awarding postdoctoral grants, inviting outstanding researchers, organising seminars, conferences, advanced courses, etc. The Centre de Recerca Matemàtica, which is a member of ERCOM (European Research Centres on Mathematics) has been and continues to be an infrastructure at the service of all Catalan mathematicians to facilitate access to the most advanced scientific trends and the incorporation of our local community in the international mathematical community.

It is not an isolated fact, then, that there are five mathematical events being held in Barcelona this year with the support of the European Commission: this Large Euroconference which we inaugurate today, two Euroconferences on Login and on Algebraic topology, a PhD Euroconference on Complex dynamics, and a Euro Summer School on Quantum groups. Next year we celebrate the new century with six Euroevents organised by the Centre de Recerca Matemàtica: a Euroconference on Combinatorics and graph theory, a PhD Euroconference on Algebraic topology, and four Euro Summer Schools on Modular forms, Hamiltonian systems, Riemannian geometry and Algebraic topology.

Neither is it an isolated fact that eight research groups in Catalonia (four at the Universitat Autònoma, one at the Politècnica and three at the Universitat de Barcelona) form part of various research training networks of the Improving Human Research Potential programme and that two of the groups, those of Operator Theory and of Algebraic Topology, both at the Universitat Autònoma, are the only mathematics groups in all of Spain which have been selected as Marie Curie Training Sites. The Centre de Recerca Matemàtica will host five Marie Curie postdoctoral fellows during the next academic year.

For the first time in Catalonia, and in Spain, the words of Konrad Knopp, pronounced at the 1927 inaugural lecture of the University of Tübingen, are being understood: "Mathematics is the basis of all knowledge and contains all other culture". Certainly our world is more complex every day and at the same time more fragile and unstable. Mathematics has an increasingly decisive role to play in the management of complex systems, be they technological, financial or social, in the century we now enter. Mathematics will increasingly be an instrument of power which is sometimes dangerously underestimated.

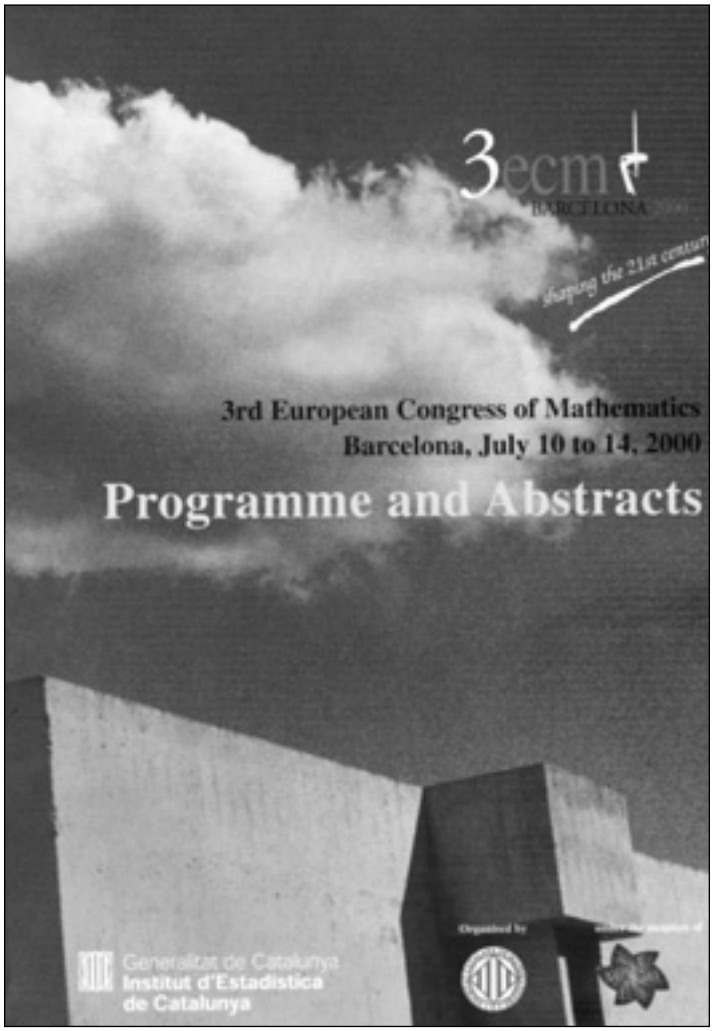
I think all of you are aware that these words are not intended to convince mathematicians, but rather the political and administrative authorities that we have with us here at the presidential table. Catalonia is prepared to face the complexity of the twenty-first century. In recent years a real effort has been made towards technological renovation and measures have been taken which have encouraged spectacular economic developments and ensured good levels of social welfare. One must also take into account, however, that the intellectual resources of a country are at least as important, or even more important, than the material resources. Our administrators and governors should not forget that mathematics is the cheapest of all the sciences: it takes little more than brains, and networks for communication. And our country, rich in brains, must protect the second aspect, strengthening, for example, the two networks of mathematical communication that we have: the Centre de Recerca Matemàtica and the Catalan Mathematical Society.

I will close this parenthesis addressed to our authorities, and return to the desire of the Catalan mathematicians for a place in the European and international scientific community. It is true that there have always been internationally recognised Catalan researchers in some scientific areas and in recent years this recognition has extended to areas where previously we had no presence, as is the case for mathematics; it is also true that our research groups are beginning to be visible in the literature. But it is one thing to be known and recognised individually and quite another for the country to be recognised in this way. Without the first we could not achieve the second, but the latter must always be our objective. We want Barcelona, and Catalonia, to be known internationally, not just for Gaudí or Barça. We want to be recognised also as a scientific community, as a mathematical community, and this is the role of the Catalan Mathematical Society.

The Catalan Mathematical Society is a scientific society that, in a country with a population of six million, has 1000 members and acts on two different fronts: as a meeting ground for all Catalan mathematicians, organising conferences, courses, publishing periodically a *Butlletí* and a *Notíces* in Catalan; and on the other hand as a nucleus for direct connection with mathematical institutions of other countries and especially with the European Mathematical Society.

The participation of the Catalan Mathematical Society in the European Mathematical Society has been intense since the outset, collaborating on the Council and on the Executive Committee, and ultimately presenting its candidature four years ago now to host this Third European Congress of Mathematics, which was awarded to us at the Council meeting in Budapest.

We want not just to offer you good organisation, a welcoming city and country, a good climate and lots of sun; all this we do offer; but on top of all these ingredients we hope that you, the European mathematicians, and by extrapolation all the international mathematical community, take note that Catalonia is a country which is mathematically developed and prepared to face the complexities of which I spoke to you a moment ago.



Prizes awarded at 3ecm

The Felix Klein Prize

The Felix Klein prize has been established by the European Mathematical Society and the endowing organisation, the Institute for Industrial Mathematics in Kaiserslautern. It is awarded to a young scientist or a small group of young scientists (normally under the age of 38) for using sophisticated methods to give an outstanding solution, which meets with the complete satisfaction of industry, to a concrete and difficult industrial problem. The prize is presented every four years at the European Congresses of Mathematics.

The prize committee consists of six members appointed by agreement of the EMS and the Institute for Industrial Mathematics in Kaiserslautern. For the 2000 Congress, they were: Helmut Neunzert (Kaiserslautern) [Chair], Heinz Engl (Linz), Andras Frank (Budapest), Horst Loch (Mainz), Olivier Pironneau (Paris), John Ockendon (Oxford)

The winner was ***David C. Dobson (USA)***

David C. Dobson started his work on the diffraction of electromagnetic waves from periodic structures, when he was a postdoctoral student at the famous Institute of Mathematics and its Applications of Professor Avner Friedman. The Honeywell Technology Center had posed the problem to model and analyse the diffraction and to develop appropriate numerical algorithms. In a next step an optimal shape design problem for phase lenses was solved. The fact that he used a 'Fraunhofer approximation' was not the reason to give him a prize endowed by the Fraunhofer Institute for Mathematics; what convinced the committee that he should be the first prize winner, was that he used rigorous and sound mathematical methods in a quite tricky way for a problem which Honeywell states to be of very high industrial importance.

The Ferran Sunyer i Balaguer Prize

Ferran Sunyer i Balaguer (1912-1967) was a self-taught Catalan mathematician who, in spite of a serious physical disability, was very active in research in classical mathematical analysis, an area in which he acquired international recognition. Each year, in honour of the memory of Ferran Sunyer i Balaguer, the Institut d'Estudis Catalans awards an international mathematical research prize bearing his name, open to all mathematicians. This prize was awarded for the first time in April 1993. For further information on the Ferran Sunyer i Balaguer Foundation, see Website: http//crm.es/info/ffsb. htm

The Prize committee for the 2000 Congress consisted of: Hyman Bass (Michigan), Pilar Bayer (Barcelona), Antonio Córdoba (Madrid), Paul Malliavin (Paris), Alan Weinstein (Berkeley)

The winners were ***Juan-Pablo Ortega (Spain)*** *and* ***Tudor Ratiu (Romania)***

The Institut d'Estudis Catalans has awarded the Ferran Sunyer i Balaguer Prize to Professors Juan Pablo Ortega and Tudor Ratiu for their monograph entitled *Hamiltonian Singular Reduction*.

The awarded monograph deals with the reduction of hamiltonian systems using its symmetries. In the case of smooth systems there is a standard formulation of this procedure due to Marsden and Weinstein. In the presence of singularities, several approaches exist to the reduction procedure. The main contribution of the authors is to show that all these approaches are in some sense equivalent, by giving a sort of universal model for singular reduction. The monograph is self-contained and will be of great use to researchers in this area.

Professor Tudor Ratiu, professor at the École Polytechnique Fédérale de Lausanne, is a well-known specialist in the field. Professor Juan-Pablo Ortega completed in 1998 a PhD thesis in the area at the University of California at Santa Cruz and he is presently at the École Polytechnique Fédérale de Lausanne as well.

EMS prizes

The EMS prizes were established by the European Mathematical Society. They are meant to recognise excellent contributions in mathematics by young researchers, not older than 32 years. The prizes are presented every four years at the European Congress of Mathematics.

The prize committee is appointed by the EMS. It consists of about fifteen internationally recognised mathematicians covering a large variety of fields. For the 2000 Congress they were: Jacques-Louis Lions (Paris) [Chair], Noga Alon (Tel Aviv), Werner Ballmann (Bonn), Jan Derezinski (Warsawa), Maxim Kontsevich (Bures-sur-Yvette), Eduard Looijenga (Utrecht), Angus Macintyre (Edinburgh), David Nualart (Barcelona), Aleksei Parshin (Moscow), Ragni Piene (Oslo), Itamar Procaccia (Tel Aviv), Mario Pulvirenti (Roma), Rolf Rannacher (Heidelberg), Caroline Series (Warwick), Vladimir Sverák (Praha) and Dan Voiculescu (Berkeley)

The winners were:

Semyon Alesker (Israel)

Semyon Alesker has contributed greatly both to the asymptotic theory of convexity and to classical convexity theory. His most significant work is on valuations (additive functionals) on convex bodies and it has remodelled a central part of convex geometry.

Group invariant valuations were studied since Dehn's solution of Hilbert's third problem, with later contributions by Blaschke and others, and culminating in Hadwiger's celebrated characterisation theorem for the intrinsic volumes. The latter theorem was considered the top result in this area for almost fifty years. Alesker has now considerably extended this theory, obtaining very complete classification results under weaker invariance assumptions. He approximated (continuous) rotation invariant valuations by polynomial valuations and characterised the latter, making use of representations of the orthogonal group. This enabled him to extend Hadwiger's theorem to tensor valued valuations. In another direction, he solved a problem of McMullen, in a much stronger form, showing that translation invariant valuations are essentially (up to linear combinations and approximation) mixed volumes. The approach is via representation theory of the general linear group and involves a surprising application of D-modules. The new approach has also opened the way to finiteness result for valuations with other group invariances.

Raphael Cerf (France)

Raphael Cerf became known through his results on probability theory. Using a large deviation principle in the proper topology, he has established a Wulff construction for the supercritical percolation model in three dimensions. This result is a very

major advance in the subject, and provides the right formulation for the geometry of the problem. He has been able to carry out this programme using a correct mixture of combinatorial arguments, geometric ideas and probabilistic tools.

In addition to this research Raphael Cerf has made original contributions in generic algorithms. He has solved a central problem in bootstrap percolation and extended to three dimensions the metastable behaviour of the stochastic Ising model in the limit of low temperatures.

Dennis Gaitsgory (USA)
Dennis Gaitsgory is one of the leaders in the geometric Langlands correspondence and related areas. In the modern 'geometric' representation theory one replaces functions by complexes of constructible sheaves on (infinite-dimensional) algebraic varieties. In this way many deep structures appears, and classical results in the theory of automorphic forms can be seen much more clearly.

In his thesis and in the subsequent work with Braverman, Gaitsgory established fundamental properties of Eisenstein series in the geometric setting. In a recent paper on nearby cycles, he proposed an extremely elegant construction of the convolution of equivariant perverse sheaves on so-called affine Grassmannians. This implies that the centre of the affine Hecke algebra coincides with the whole spherical Hecke algebra. Also, it gives the best conceptual explanation of the Satake equivalence.

Recent work of Gaitsgory relates finite quantum groups and chiral Hecke algebras. It is a very important step in the program of Beilinson and Drienfield in the geometric Langlands theory.

Emmanuel Grenier (France)
Emmanuel Grenier greatly contributed to the asymptotic analysis of Euler and Navier-Stokes equations with large Coriolis force. The simplest case (when the equations are set on the unit cube with periodic boundary conditions) was solved by Grenier around 1995. Later, in collaboration with Desjardins, Dormy and Masmoudi, he gave rigorous derivations of several asymptotic models currently used in ocean and atmosphere modelling, or in magnetohydrodynamics.

Grenier obtained both positive and negative important results on the problem of convergence of the Navier-Stokes equations to the Euler equations in a domain with solid boundary conditions. In particular, he showed that the positive results of Caflisch and Sammartino obtained for analytic initial data, cannot be extended to Sobolev data. He also justified the hydrostatic limit of the Euler equations in a two-dimensional infinitesimally thin strip.

Grenier gave a very elegant proof of convergence for the semi-classical limit of the non-linear Schrödinger equations (before appearance of shocks). He also obtained, simultaneously with E. Rykov and Sinai, a hydrodynamic limit for the Zelodvich adhesion particle model.

Dominic Joyce (UK)
Dominic Joyce's work on the existence of metrics with special holonomy is among the best in Riemannian geometry in the last decade. The question of the existence of Riemannian metrics with special holonomy has a long history beginning with the work of Cartan. It includes some of the best work of such people as M. Berger, J. Simons, S. T. Yau and R. Bryant. Using a dazzling display of geometry and analysis, Joyce constructed compact examples in the exceptional cases where the holonomy is Spin7 and G2 the only remaining possibilities, the others on Berger's list had been eliminated. Joyce also computed the dimension of the deformation spaces of such metrics and many others of their invariants. As a result he also discovered a totally unexpected version of mirror symmetry for such spaces. Dominic Joyce is one of the leading young differential geometers.

Vincent Lafforgue (France)
Vincent Lafforgue's work is a major advance in the *K*-theory of operator algebras; the proof of the Baum-Connes conjecture for discrete co-compact subgroups of $SL_3(R)$, $SL_3(C)$, $SL_3(Q_p)$ and some other locally compact groups. The Baum-Connes conjecture predicts the *K*-theory of the reduced C*-algebra of a locally compact group (and of more general objects). The conjecture plays a central role in non-commutative geometry and has far-reaching connections with the Novikov conjecture on higher signatures in topology, to harmonic analysis on discrete groups and the theory of C*-algebras. Lafforgue's result is the first passage of the barrier which property T of Kazhdan has posed for many years in the proof of the Baum-Connes conjecture. The proof involves several remarkable technical and conceptual developments, like a bivariant *K*-theory for Banach algebras (versus Kasparov's by now classical one for C*-algebras) or establishing the conjecture for various completions of the L^1 algebras of the groups.

Michael McQuillan (UK)
Michael McQuillan has created the method of dynamic diophantine approximation which has led to a series of remarkable results in complex geometry of algebraic varieties. Among these results one can mention a new proof of Bloch's conjecture on holomorphic curves in close sub-varieties of abelian varieties, the proof of the conjecture of Green and Griffiths that a holomorphic curve in a surface of general type cannot be Zariski-dense, and the hyperbolicity for generic hypersurfaces in a projective space P^3 of high enough degree (Kobayashi conjecture).

Stefan Yu. Nemirovski (Russia)
S. Yu. Nemirovski has obtained several strong results on topology and complex analysis. Using modern techniques like the famous Seiberg-Witten invariants he has solved some old classical problems about sub-manifolds in complex domains. First, he generalised the Thom inequality proved by P. Kronheimer and T. Mrowka. As a very particular case he proved that there are no non-constant holomorphic functions in a neighbourhood of an embedded non-trivial 2-sphere in a complex projective plane. Another application of his main theorems is also very attractive. Suppose that an analytic disc is attached from the outside to a strictly pseudoconvex domain *U* in a complex 2-plane; then there is no smooth disc inside *U* with the same boundary. As a corollary one gets that it is impossible to attach an analytic disc from the outside to a strictly pseudoconvex domain that is diffeomorphic to a closed ball.

Paul Seidel (France)
Paul Seidel became known through his work on symplectic topology. In his Ph.D. thesis he studied the fundamental question of whether symplectic diffeomorphisms which are diffeotopic to the identity are also symplectically diffeotopic to the identity. He showed that the answer is negative in many cases, already in dimension 4. His counter-examples are generalised Dehn twists, and his proof involves Floer homology. In further work, Seidel constructed a natural representation of the fundamental group of the group of Hamiltonian symplectomorphisms into the quantum cohomology ring. This work was basic for later work of Lalonde, McDuff and Polterovich on the topology of the group of symplectomorphisms. There is more to say about other work. His latest work is related to mirror symmetry, showing his broad horizons.

Wendelin Werner (France)
Wendelin Werner has obtained deep results on stochastic processes and, more precisely, he has proved a number of significant results on Brownian path properties, including the shape of Brownian islands and Brownian windings.
He has made remarkable contributions to the study of self-avoiding random walks and the corresponding critical exponents. More specifically, he obtained the first non-trivial upper bound of the disconnection exponent, and he developed an elegant approach for studying the limiting behaviour of the non-intersection exponents for a great number of independent Brownian motions. Among many other interesting works, he constructed, with a collaborator, the so-called true self-repelling motion using an ingenious method involving infinite systems of coalescing Brownian motions

Asymptotic combinatorics with application to mathematical physics

EMS Summer School

Euler International Mathematical Institute, St Petersburg, Russia
9 – 22 July 2001

This EMS Summer School will concentrate on recent progress in the asymptotic theory of Young tableaux and random matrices from the point of view of combinatorics, representation theory and the theory of integrable systems. This subject belongs both in mathematics and in theoretical physics, and tentative participants are mathematicians and physicists. Systematic courses on these subjects and current investigations will be presented.

Organisation
The Summer School will take place from 9 to 22 July 2001 at the International Euler Institute, St Petersburg, Russia. The Summer school already has financial support from the EMS and the RFBR. Additional information can be found from emschool@pdmi.ras.ru or from http://www.pdmi.ras.ru/EIMI/2001/emschool/index.html.

Scientific committee
A. Vershik (Chair), E. Brezin, O. Bohigos, P. Deift, L. Faddeev, V. Malyshev.
Local Organising Committee
A. Vershik, Ju. Neretin, K. Kokhas, E. Novikova.

Main speakers

P. Biane	ENS, Paris, France
E. Brezin	ENS, Paris, France
P. Deift	Univ. of Pennsylvania, USA
K. Johansson	KTH, Stockholm, Sweden
V. Kazakov	ENS, Paris, France
R. Kenyon	University Paris-11, Orsay, France
M. Kontsevich	IHES, France
A. Lascouix	University Marne-la-Valiee, France
A. Okoun'kov	UCB, USA
G. Ol'shansky	IPPI, Moscow, Russia
L. Pastur	University Paris-7, France
R. Speicher	University of Heidelberg, Germany
R. Stanley	Massachesetts Institute of Technology, USA
C. Tracy	UCD, USA
H. Widom	UCSanta Cruz, USA

The lectures will be devoted to asymptotic combinatorics and its applications in the theory of integrable systems, random matrices, free probability, quantum field theory, etc. — also those topics concerned with low-dimensional topology, QFT, new approach in the Riemann-Hilbert problem, asymptotics of orthogonal polynomials, symmetric functions, representation theory and random Young diagrams.

During the last few years great progress has been made in this direction, and new links and new problems have appeared. The following old problems have been solved recently: fluctuation of random Young diagrams and of the maximal eigenvalues of the random Hermitian matrix. A new approach to the Riemann-Hilbert problem and integrable systems was developed by Deift-Baik-Johansson (based on the Korepin-Izergin-Its approach, papers by Tracy-Widom and others). The alternative methods came from asymptotic theory of representations and in particular from studying the Plancherel measure. These ideas allowed the calculation of the correlation functions of the corresponding point processes (Ol'shansky-Borodin and previous results by Kerov-Vershik) and also to application of the boson-fermion correspondence (Okoun'kov). The explicit distribution of the fluctuations of the characteristics of the diagrams was one of the main results, as well as the precise distribution of the fluctuations of the eigenvalues of the random matrices.

This progress has initiated a great activity in many topics: the growth of polymers, ASEP, and random walks on groups and semigroups. Many perspective problems and applications of the results will be discussed in seminars and round table discussions during the Summer School.

Applied Mathematics in our Changing World

First Joint EMS-SIAM Conference

Berlin : 2 – 6 September 2001

Organiser: Peter Deuflhard, *e-mail*: deuflhard@zib.de

Co-Chairs: Rolf Jeltsch (EMS), Gil Strang (SIAM), Peter Deuflhard (Organiser)

Programme committee:
EMS: Heinz Engel, Björn Engquist, Stefan Müller
SIAM: David Levermore, Volker Mehrmann, Bill Morton
ECMI: Vincenço Capasso

Preliminary topics (ordered by applications and not by mathematical subject):

1. Medicine
Computational assistance of surgery, therapy planning, medical imaging methods, hospital information systems, pharmacokinetics, tumor growth modelling, artificial organs, immune system modelling, infectious disease control, epidemic spreading

2. Biotechnology
Conformational molecular dynamics, drug design, mathematical modelling in polymerisation, biomolecular structural storage schemes, patent recognition and circumvention, computational statistics, sequence alignment, fuzzy reasoning, density functional theory, *ab initio* computation

3. Material sciences
Realistic modelling and simulation of superconductivity, composite materials, phase transitions, crystal growth, hystesis, quantum-classical approximation and calculation

4. Environmental science
Climate research, climate impact research, short-term and medium-term meteorology, computational modelling of pollution of air, water and soil, atmospheric chemistry, ozone hole, porous media

5. Nanoscale technology
Integrated optics, optical networks, quantum electronics and optics, general microwave technology, nanoscale techniques in medicine, porous materials

6. Communication
Analysis, simulation and optimisation in telecommunication, optical networks, transmission rate optimisation, survivable networks

7. Traffic
Discrete and continuous models of traffic flow, traffic on-line control

8. Market and finance
Financial mathematics and statistics, option pricing, derivative trading

9. Speech and image recognition
Signal analysis, pattern recognition, wavelets

10. Engineering design
Engineering design in transport systems for air, land and water, in energy production, distribution and conservation, and in consumer products

EMS Committee for Women and Mathematics

Emilia Mazzetti

The Committee for Women and Mathematics of the EMS was set up in January 1991 by the Executive Committee, with Eva Bayer as the first Chairperson. Then Christine Bessenrodt chaired the Committee from 1995 to 1999 and I was appointed as the new Chair last October.

The main purpose of the Committee is to work as a fact-finding unit, exposing the problems and supporting the recognition of achievements of women in mathematics. The first main project of the Committee was to gather statistical information about the presence of women among mathematicians in the European countries with a low percentage of women in mathematics. Moreover, Round Tables on themes related to Women and Mathematics have been co-organised by the Committee at International Congresses (ECM 1992 and 1996; ICM 1994 and 1998).

In her report of 1998, Christine Bessenrodt wrote:

It has often been noted that biographies of women and men in mathematics (and the sciences in general) differ in many respects. A more detailed investigation into a larger number of CVs would be necessary for this . . . It would be worthwhile to carry such a project through and initiate a discussion on some specific issues found in such a comparison.

It is a fact that age limits are stipulated in many announcements for grants and prizes. But it has often been observed that, maybe because of duties at home, women are more likely to have a late start in education or a slower career path. So age limits seem to be particularly harmful to women.

During the last meeting of the EWM (European Women in Mathematics), which took place in September 1999 at Loccum, near Hannover, the above themes were discussed in an informal Round Table, moderated by Laura Tedeschini Lalli. As a consequence of the discussion, a questionnaire was prepared. The text was then discussed in our Committee, which added some questions and decided to distribute it as widely as possible to women and men all over Europe. We hope to collect a large number of answers, so as to be able to carry out a meaningful analysis of the data and to have a basis for further discussion. The text of the questionnaire follows. Please fill it in and send it to me, *Emilia Mazzetti, Dipartimento di Scienze Matematiche, Università di Trieste, Via Valerio 12/1, 34127 Trieste, Italy; e-mail: mazzette@univ.trieste.it*

Questionnaire

1. *Are you male or female?* .....
2. *How old are you?* .....
3. *What is your nationality?* .....
4. *How many children do you have?* .....
5. *At what age did you complete your Ph.D.?* .....
6. *How many countries have you studied in/worked in?* .....
7. *What is your mother's job?* .....

   What is your father's job? .....
8. *Do you have a permanent job?* .....
9. *How many years after your Ph.D. did you obtain your first permanent job?* .....
10. *How many temporary mathematical jobs have you had?* .....
11. *At what age did you write the paper of which you are most proud (so far)?* .....
12. *Have you had any gaps in your mathematical career?* .....

    If so, how long were those gaps? .....

    In your opinion, what were the reasons for those gaps? .....

    .....
13. *Any further comments?* .....

    .....

Mathematical modelling in the biosciences

Philip Maini (Oxford)

The spectacular biotechnological advances of the past two decades have led to an explosion of data in the biomedical sciences. We have recently completed the mapping of the human genome, we can now determine when in development certain genes are switched on, and we can accurately follow the fate of single cells. The list is endless. However, we are perilously close to falling into the practices of the nineteenth century, when biology was steeped in modes of classification and there was a tremendous amount of list-making activity. This was recognised by D'Arcy Thompson [1] in his classic work *On Growth and Form*, first published in 1917. He was the first to develop theories as to how certain forms arose, rather than simply cataloguing different forms, as was the tradition at that time.

Of course, we have come a long way since then. The identification of a gene that causes a certain disease or deformity has huge benefits for medicine. We must recognise, though, that genes only specify the properties of proteins and cells. It is the physico-chemical interactions of these cells that lead to (for example) the development of structure and form in the early embryo. Cell fate can be determined by environmental factors, and cells respond to signalling cues. Therefore, a study at the molecular level alone will not help us to understand how cells interact. Having devoted a huge amount of effort to taking Humpty Dumpty apart, we must now find out how to put him together again.

Since the interactions that govern biological processes are highly non-linear and may be non-local, they must be couched in a language that is designed to compute the results of such complex interactions. At the moment, the only language we have for doing such calculations is mathematics. Mathematics has been extremely successful in helping us to understand physics. It is now becoming clear that mathematics and computation have a similar role to play in the life sciences.

Self-organisation

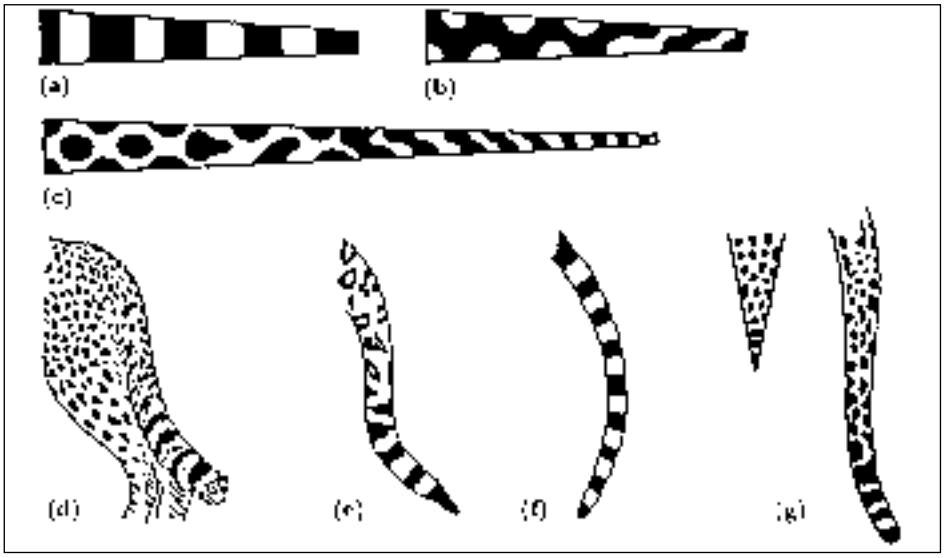
One of the key puzzles in developmental biology is the understanding of how the vast array of spatial patterns and structure we observe in the animal kingdom emerge from the almost homogeneous mass of dividing cells that constitute the early embryo. The skeleton, for example, is laid down during *chondrogenesis*, when specialised cells (chondroblasts) condense into aggregates that lead eventually to bone formation. Butterfly wings exhibit beautiful colours and patterns, and many animals develop dramatic coat markings.

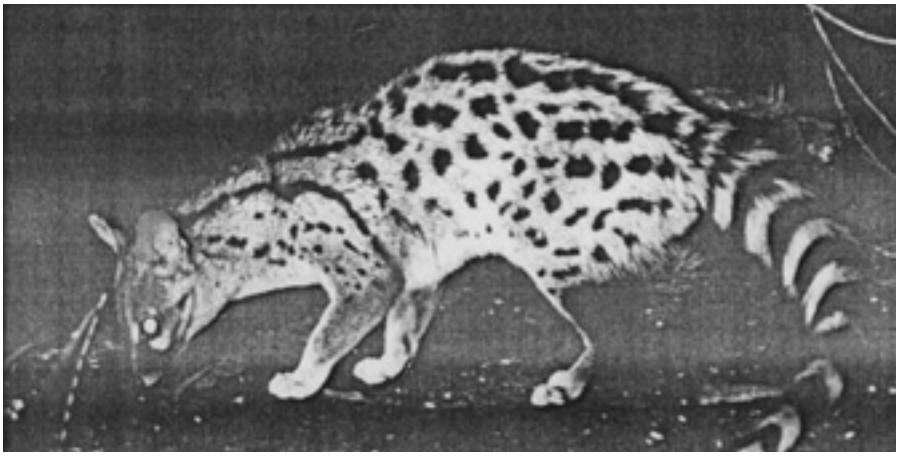
In all of these examples, although genes play a key role, genetics say nothing about the actual *mechanisms* that produce spatial pattern. The first major advance in this field was made by Alan Turing [2]. He was interested in *morphogenesis* – the process by which form and structure arise. He considered a system of chemicals reacting and diffusing, modelled by equations of the form

$$\partial \mathbf{u}/\partial t = \mathbf{D}\nabla^2\mathbf{u} + \mathbf{f}(\mathbf{u}, \mathbf{p}),$$

where $\mathbf{u}(\mathbf{x}, t)$ is the vector of chemical concentrations at spatial point $\mathbf{x}$ and time t, $\mathbf{D}$ is a diagonal matrix of diffusion coefficients, and $\mathbf{f}$ models the reaction kinetics, which are functions of the chemical concentrations and various kinetic parameters $\mathbf{p}$. The problem was completed by imposing certain boundary conditions – for example, periodic if one wants to model a cylindrical structure, or zero-flux if one wants to model an impermeable boundary. Turing showed that one could choose equations of this form which exhibited a uniform steady state that was stable in the absence of diffusion, but became destabilised when diffusion was introduced and evolved to a spatially varying state – a spatial pattern. This phenomenon is known as *diffusion-driven instability* and is an example of *self-organisation* or an *emergent property*. Assuming that one of these chemicals was a growth hormone, Turing then postulated that points where the concentration of hormone was highest would grow fastest, resulting in spatial structure. For this reason, the chemicals were termed *morphogens*. More generally, one assumes that these chemicals activate a gene switch if they breach a threshold value, causing cells to differentiate. This theory thus hypothesises that the structures one sees overlie a pre-pattern in chemical concentrations.

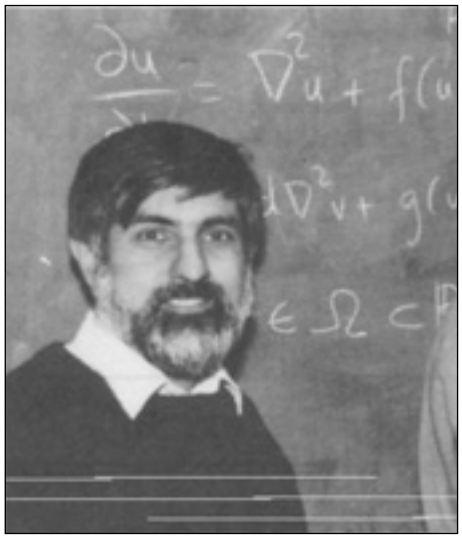
Although the identification of mor-





(h)

(a)-(c) Some computed solutions of a Turing reaction-diffusion model. (d)-(g) Typical animal coat markings. (h) Photograph of a common genet exhibiting a spotted body and striped tail (from Murray, 1993, with permission).



Philip Maini

phogens has thus far proved elusive, Turing structures have now been shown to exist in chemical systems. When Turing first proposed his theory, he met with some hostility from chemists who were convinced that such patterns could not arise in chemical systems. This is a nice example of mathematics driving research in other scientific areas.

A number of theories based on different biological hypotheses have since been proposed for self-organisation, but many of these models rely on the common patterning mechanism of *short-range activation, long-range inhibition*. It is thus possible to make predictions that do not rely on specific biological details. One such prediction is that a spotted animal with a striped tail is more likely to occur than a striped animal with a spotted tail. This is an example of a developmental constraint. The book by James Murray [3] has an excellent in-depth discussion of this and related issues.

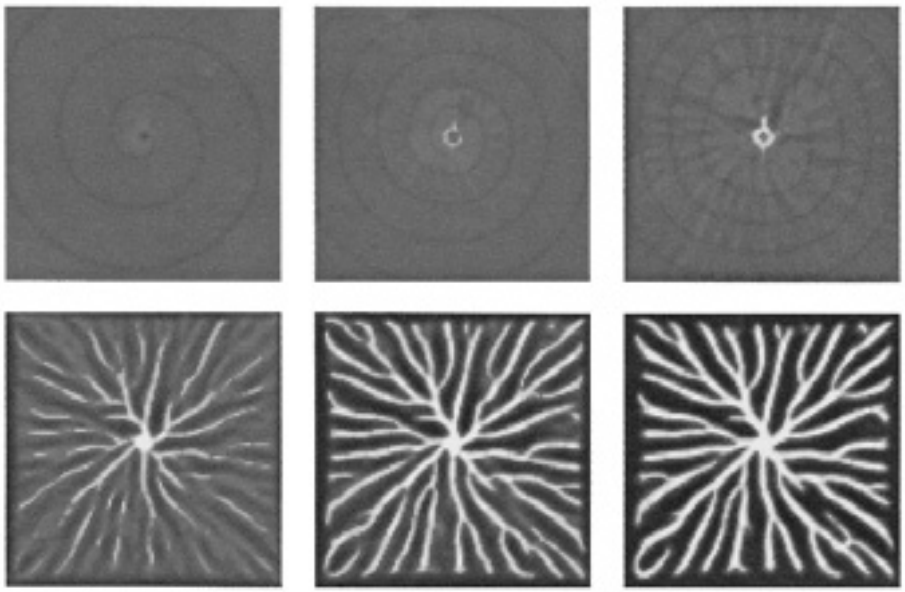
It transpires that models of the same general form as that above can exhibit a wide variety of patterns, such as propagating fronts, spiral waves, target patterns and toroidal scrolls. Indeed, the *Hodgkin-Huxley model* for electrical signalling in nerve axons (for which they won the Nobel prize) is of the above form. The most famous example in chemistry of pattern formation is the *Belousov-Zhabotinsky (BZ) reaction*, in which bromate ions oxidise malonic acid in a reaction catalysed by cerium, resulting in sustained periodic oscillations in the cerium ions. If, instead, the catalysts Fe^{2+} and Fe^{3+} and phenanthroline are used, the periodic oscillations are visualised as colour changes between reddish-orange and blue. This system has been thoroughly modelled mathematically and it emerges that the key to patterning here is a phenomenon termed *excitability*. An excitable system is one in which the steady state is stable to small perturbations, but to large (supra-threshold) perturbations, the system undergoes a large deviation before coming back to its original steady state. During this transient period, the system does not respond to perturbations. Coupling diffusion to this type of kinetic behaviour allows for waves of activity to propagate through the medium.

Excitable media also play a role in the aggregation of certain amoeboid species, such as the cellular slime mould *Dictyostelium discoideum* (Dd), which has served as an important model paradigm because it is simple enough to allow experimentation, yet sufficiently sophisticated to exhibit many physico-chemical processes that are similar to those observed in higher organisms. Under starvation conditions, these amoebae signal each other via the chemical messenger cyclic AMP, resulting in the propagation of spiral waves of the chemical. The amoebae move up gradients of cyclic AMP, resulting in the formation of aggregations. The formation of aggregates seems to be a vital component of the Dd life cycle, as it appears to be necessary to enable the cells to differentiate into a spore type that can survive harsh conditions. This species has been extensively studied theoretically and the modelling has resulted in crucial biological insights that could not have been gained easily in any other way.

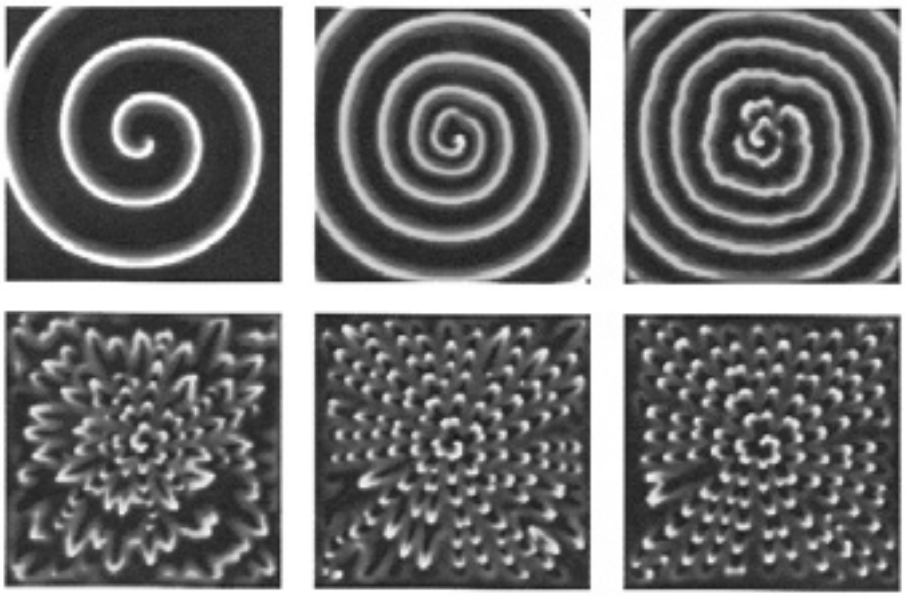
This example illustrates the power of mathematics as the universal scientific language because, although the details of the biology underlying Dd aggregation are very different from the chemistry underlying the BZ reactions, the resulting mathematical equations are very similar, so that insights gained in one field can be transferable to another, seemingly very different field.

Medical applications

Intriguingly, the heart is another example of an excitable system, allowing electrical activity to propagate across its surface as the signal for the heart to beat. Many heart abnormalities arise as the result of disturbances to this wave propagation, and these have been studied using simple models of the above general form. More sophisticated models have been developed that allow one to predict what effect a single gene mutation will have on the global dynamics of the heart. We are now enter-



Development of spiral waves leading to cell streaming in a mould for slime mould aggregation.

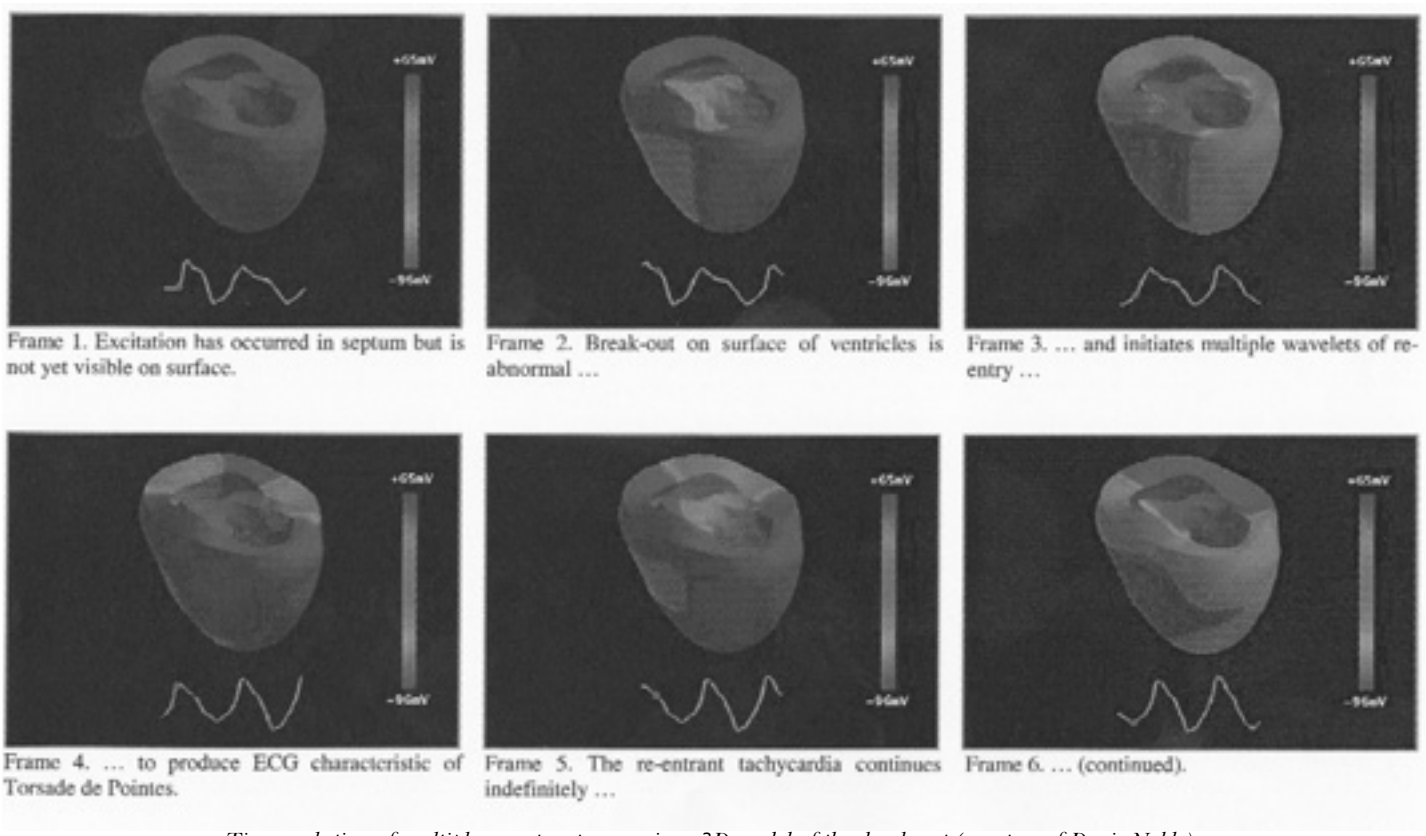


ing the realm of the 'virtual human', in which even surgical procedures may be first tested in virtual reality – after all, we do not allow commercial airline pilots to fly a plane until they have completed several hours of training on a flight-simulator, yet we are happy to let surgeons loose on our brains without equivalent training! *In silico* drug-testing is already approaching reality and is attracting a lot of interest from pharmaceutical companies. The reduction in the costs (presently some 450m euros) of bringing a drug to market by the use of good models is beginning to motivate such companies to invest in modelling research.

Recently, the multi-national pharmaceuticals giant Hoffman-LaRoche approached Denis Noble and his colleagues in the Department of Physiology, Oxford, to help with a problem that arose during the approval process for one of their drugs by the US Food and Drug Administration. The FDA had noticed a glitch in the electro-cardiograms of people taking the drug, and clinicians had concluded that the drug was dangerous. Noble applied the drug to his virtual heart model and found that it developed the same glitch. He found that the glitch was not a sign of major malfunction and the drug was approved [4].

These types of models are highly computational, as they involve intricate molecular details linked to cellular activity. As computing power increases daily, more complicated models can be analysed. Such models also throw up interesting mathematical questions, such as how can one properly model the interactions of processes occurring over many different length and time scales.

The second biggest killer in the developed world, after heart disease, is cancer. Despite the huge proliferation of experimental data and clinical treatments, there has been no decrease in the death rates due to the most common cancers. This is largely because there is still no basic consensus models of tumour growth and survival, metastasis (the process whereby potentially fatal secondary tumours are formed from a primary tumour), tumour angiogensis (whereby nutrients are diverted to the tumour), and extra-cellular matrix breakdown by tumour cells. One of the challenges of the next decade is to develop mathematical models that clarify these fundamental processes and that can predict new strategies of clinical therapy. At present this area is attracting a lot of research, and modelling is being used to address such problems as effective drug-delivery strategies and ways of decreasing angiogenesis.



Time evolution of multiple re-entrant waves in a 3D model of the dog heart (courtesy of Denis Noble).

Bioinformatics

As technology continues to advance, we must develop ways to exploit and interpret the flood of data, not drown in it. Probability theory, statistics, stochasticity and high-powered computing will play an important role in the rapidly emerging field of bioinformatics. Some of the important questions here are pattern finding, data mining and pattern recognition, to name but a few. Presently a major aim is to understand how protein structures form, and how specific protein structure determines function. Here, there may be a role for topology, geometry, electrostatics and mechanics.

Summary

We are entering the post-genomic period, and it is clear that mathematics has an ever-increasing role to play in biomedicine. In 1997 the International Union of Physiological Sciences set up the Physiome Commission to 'promote anatomically and biophysically based computational modelling for analysing integrative function in terms of underlying structure and molecular mechanisms'. More recently, the research councils have set up programmes funding research at the interface between computation, mathematics and the life sciences.

Mathematical biology is a rapidly growing subject and the number of full-time university faculty engaged in this type of research is increasing. The subject area itself has expanded enormously and the above represents a very brief review. Other areas of active research include neural networks, neurophysiology, immunology, epidemiology and ecology. It is clear that the life sciences will continue to pose exciting, novel and challenging problems for mathematicians.

References

1. D. W. Thompson, *On Growth and Form* (abridged version), Cambridge University Press, 1992.
2. A. M. Turing, The chemical basis of morphogenesis, *Phil. Trans. Roy. Soc. (London) B* **327** (1952), 37-72.
3. J. D. Murray, *Mathematical Biology*, Springer-Verlag, 1993.
4. Cyberheart, *New Scientist* No. 2178, 20 March 1999.

Philip Maini [maini@maths.ox.ac.uk] is at the Centre for Mathematical Biology, Oxford University.

EMS Poster Competition

Hvorfor danner solsikkens frø et mønster med 34 kurver med uret og 21 kurver mod uret?

In EMS Newsletter 34 (December 1999) we gave the results of the EMS Poster Competition, where we invited competitors to design posters for use during World Mathematical Year 2000. Here are some further entries that have appeared in Denmark.

Interview with Martin Grötschel
(Berlin)

Interviewer: Jean-Pierre Bourguignon (Bures-sur-Yvette)

Your research belongs to domains that were for a time neglected by mathematicians. How do you now see the situation?

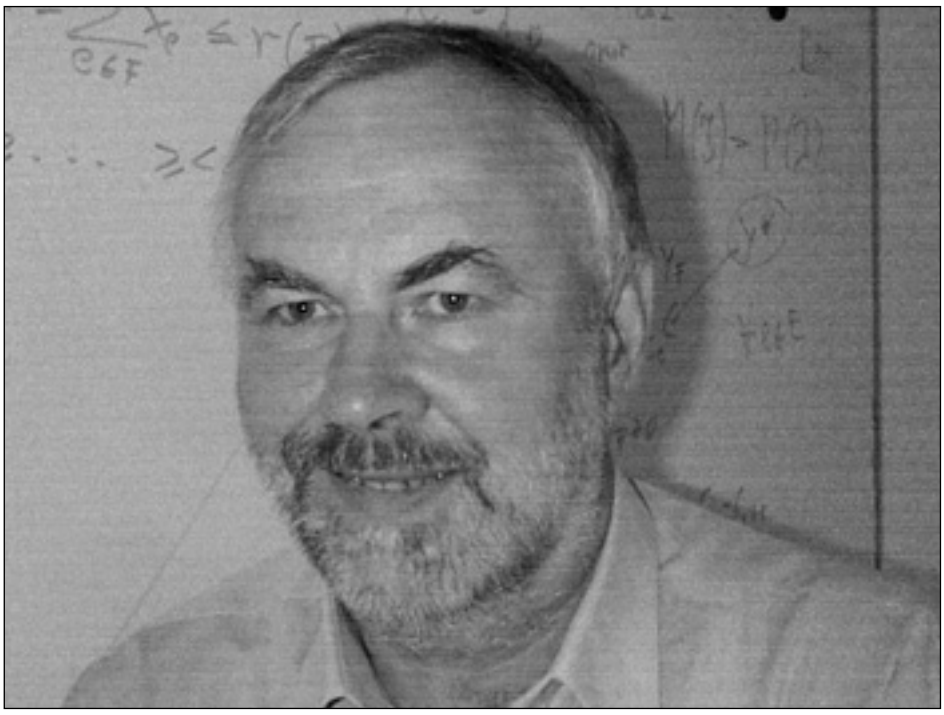
I started as a pure mathematician but got very interested in applied mathematics – more precisely applications of mathematics – and now my field of research is optimisation and discrete mathematics, both from the theoretical and the practical side. Both these areas were looked down on by mathematicians in general. Combinatorics and graph theory were considered trivial subjects. Optimisation was, from an organisational point of view, not part of mathematics: it belonged to industrial engineering in the US, and in Germany optimisation was a branch of operations research within economics faculties. I do think that these areas are truly mathematical subjects. Giving them away to other disciplines is a big mistake, because their heart – their real content – is mathematical. These areas have contributed a lot to the development of mathematics in the recent years. Their own progress mainly comes from mathematics, but also from computer science. At my University (TU Berlin), a large portion of the student body now studies these areas, writes diploma or PhD theses and gets good jobs in industry – on the basis of this training.

This does not mean that applied mathematics should dominate mathematics. We need the right balance between these areas – and we must have people leaning more to the theoretical and more to the practical side. The role of persons 'in between' is important.

The focus of my own research is combinatorial optimisation, a domain that is booming in industry since we are now in a position to solve really large models.

Could you be more specific about these models?

Let me give you some examples that are particularly interesting at present. Telecommunications is an industry that is very competitive due to the recent worldwide deregulation. As a result, competitors in the market need to reduce costs and provide new and better service: this immediately means optimisation. So my group has been developing models to design networks that have certain properties: they survive certain failures, provide a certain service, and are cost-effective. Another example is the assignment of channels to antennas in mobile communication. To give you a specific instance: in one system, we were able to reduce interference by 80-



90% by inventing and solving appropriate models. These were based initially on colouring theory for graphs but – due to additional side constraints – they got more and more complex and we had to develop the theory further in order to solve models of this type.

The second area of great importance is public transportation: in Berlin, for example, we help to optimise the public transportation systems by finding the least number of buses that Berlin needs in order to supply all lines serving the city. We determine the optimal assignment of drivers to buses and approach similar problems. These tasks lead to extremely large optimisation problems; for instance, the bus-scheduling problem results in an integer multi-commodity flow problem with about 100 million variables. So we need to develop methods that solve problems of this extremely large size. This combines research in computer science, hardware technology and mathematics. It leads to acceptable models that resolve and help to design plans that are practically feasible, that are used in practice, and that save tens of millions of Deutschmarks.

What typically happens in a practical application is that the mathematical models that arise have not been investigated sufficiently. So we have to look at these models from the theoretical side and continue developing whatever mathematics is relevant. There are always two-way exchanges between theory and practice, and this combination is very attractive and interesting.

Many mathematicians have difficulty positioning themselves and their students vis-à-vis industrial demands. How do you improve this situation? Do you see an evolution in this respect?

I try to position myself and my students, and I do help my colleagues if they ask, but I cannot give advice to everybody in this respect. I believe we need theoretical research 'in its own right', research that is not linked with real applications; this is an important part of our culture and I don't think all mathematicians have to position themselves with respect to industry. It is necessary, however, for mathematics as a field to be aware of its interfaces with other sciences and industry. If we don't want to become an ivory-tower science, we must think about the way we teach, how we communicate with our environment, and in particular, about how we support industry. Industry, after all, is what we live from. Mathematics can contribute a lot to it, and it should.

It is a 'global challenge' to find the right way to handle problems in industry mathematically. There are so many areas where mathematics can significantly contribute to progress in industry. We need on-going

discussions with industrialists through joint projects. For me, this is the only sensible way to learn about new technologies and to find out how we can contribute. New technologies are real challenges for mathematics, often involving mathematical questions we never thought about before. If we continue addressing only the hard problems that mathematicians of former centuries left open, then we may overlook the challenges of our own time. So, sometimes it is a good idea to put aside the hard questions of the past and look at the (maybe equally hard) problems of our day.

Let me mention information technology, biotechnology, telecommunication, transportation, and manufacturing processes. All of these topics have mathematical components: control of robots or of logistic systems, production planning in general, design of new materials, the understanding of mechanisms in biosystems: these are areas where we really don't know yet what is going on. So mathematics as a whole has to think about how it can develop the mathematics involved in order to help the specialists understand their (typically very complex) systems. This is not the job of individual mathematicians, but must be the task of the whole community. We must reach out into these areas and start putting research effort into such projects, for the long-term survival of our discipline as a rich domain with active research.

For myself, I have currently chosen several areas of applications, but they change whenever new technologies arise, and whenever new challenges come up. In my research institute, the Konrad-Zuse-Zentrum, we do research; we are not a factory or a software provider. Of course, we do produce software, but we only work on problems where no standard solution is available and where no company in the world has software of the type that is needed. In some cases this has led to spin-off companies that develop and extend some of the software further. I think that this entrepreneurial aspect is an important new development in mathematics.

To change topic, you chaired the organising committee of the Berlin International Congress of Mathematicians and presided over it. ICM98 was recognised by all participants as a great success. At a distance now, can you share with us your feelings about the experience?

We were delighted to hear that many participants really enjoyed the Congress. Organising ICM'98 was a lot of work, not only for myself. Many colleagues, students, assistants, secretaries, etc. were involved and contributed significantly. Working together, having to rely on each other's efforts stimulated a new spirit of cooperation within the mathematical community in Berlin, and more broadly, in Germany.

In addition to deepened personal relations, there were many other spin-offs. A few examples: the Video Math Festival inspired Springer to start a new series on mathematical videos; the general public lectures at the Urania were highly successful, and there will be a book containing these talks. Enzensberger's lecture was broadly publicised (e.g. printed in the *Frankfurter Allgemeine Zeitung* the weekend after) and brought mathematics into the literature pages of journals and newspapers. The ICM was an event we wanted to stage for both mathematicians and the general public.

There is always the question as to whether such big meetings are really necessary. Certainly for research, specialised meetings are much more appropriate: you meet your closest colleagues and learn the latest news. But there is space for big meetings that provide surveys and overviews, and where you can learn about progress elsewhere and get ideas from other fields. I enjoy attending such meetings. They are excellent opportunities to obtain the newest information presented by the best person in a field in a didactically pleasant form for non-specialists.

I think the speakers at ICM 98 in general did a very good job. Many participants I talked to felt well served by the speakers and the organisation. Also, international communication is extremely important, and I was particularly happy to learn from people from Eastern Europe and developing countries how they benefited from ICM'98. It was an efficient means to meet people from other parts of the world and make new contacts. For those who work in rich countries at top institutes, this is all trivial: they can travel at any time, anywhere. But this is not so for many excellent mathematicians around the world, and ICMs play an important role here.

ICMs do have a role in the future, I think. The question is: should a particular city (like Berlin) make all these enormous efforts, just as a service for society or for the mathematical community? When the first thoughts about organising an ICM in

ZIB building, Konrad-Zuse Zentrum

Berlin were voiced, Berlin was divided into two cities. Time passed by, the two became one, and we thought it might be a good idea to invite the world to Berlin and to Germany. There are still bad feelings about Germany (that we experienced in some letters we received), but I think we gave answers by our special events, exhibitions and the lectures about the Nazi period. So, we did try to present the 'new Germany'. We also felt that research in mathematics has not had the publicity it deserves in Germany, so we thought of using ICM as a vehicle to carry our message.

You made big efforts to make the congress a media event in Germany. Were they successful? Have the relations between mathematicians and the German press changed?
I think they have changed considerably. We thought for a long time about how to present ICM to journalists. In the end, the organising committee hired a professional journalist with a Masters degree in mathematics to produce material for the press. Mathematicians are not good at writing readable texts for non-mathematicians, so he would be in charge of the interface between us and the press. A journalist would read his articles, get interested, and then interview mathematicians, do TV interviews, and the like. From the Technical University's press office came other good ideas on how to involve the press, make announcements at the right time, and so on.

Our press conference was attended by almost 50 journalists, which is very unusual: seven TV stations and more than twenty radio stations came. We participated in at least ten major TV programmes and gave uncountably many radio interviews world-wide. The TU press office collected about 300 pages of published newspaper material about ICM'98. I think this was a real success story, at least within the mathematical world. At the same time journalists got excited about mathematics. Interviews usually started with a statement by the journalist that he/she was very poor in mathematics. With simple examples we showed how one can get excited about mathematics; and this worked.

The only bad experience was with *Der Spiegel*. The other papers were very favourable and there was ICM information almost daily in each of the five major Berlin newspapers. Without public events this would not have been possible. All the presentations in the Urania drew newspaper interest. It still keeps on – for example, just last week I had a phone call from a German TV station that wants to feature the Hilbert problems. Journalists really enjoyed seeing where mathematics hides in everyday life, and all those I met said that it is something worth reporting on.

Of course we were lucky that the Fermat problem had been solved shortly before, and that Wiles was present and was a wonderful interviewee. Journalists loved him: certainly a superstar helps. I really think that lots of articles that now appear about mathematics would never have appeared before. To give another example, an article of mine in the German edition of *Scientific American* generated a lot of requests from readers, and they are now reprinting it in a special issue; this has also happened to several of my colleagues. Making mathematics a public event and familiarising our fellow scientists with where mathematics is, was one goal we really achieved with ICM 98: many of my colleagues in engineering, chemistry, medicine, etc., heard about mathematics, looked at TV programmes, and became excited about the new mathematics that is developing.

Martin Grötschel at the ICM'98, Berlin

Recently the German federal government introduced programmes to enhance electronic means of communication. Through the FachInformationsZentrum (Karlsruhe) it supported the Zentralblatt für Mathematik, which as Zentralblatt-Math is becoming a European – the EMS joining as copyright holder being one sign. You have been involved in some of these actions. Where do you stand on them?
This is a very complicated topic. First, projects like this were not started by the German government, but by mathematicians and physicists. I fear that in the near future we will no longer have easy and cheap access to the literature, since prices are sky-rocketing and nobody can buy journals any more. The paradox is that we produce more publications but have access to fewer of them. This concerns everybody around the world.

I (and many colleagues) believe that we have to do something about this, and that the remedy should be easy now that we can do things electronically. Building a world library is in the background but is not achievable. So my idea is to change our publication system in the long run. The difficulty is that we do not exactly know how to, what the economics of the system are, and who does what for what price. My suggestion is to experiment, see how

things go, and then let the market decide what is to be done. It would be a disaster to stop all printed journals now and go electronic right away; there must be a transition period. For me, journals should be electronically available for many reasons. One particular reason is the exceptional search features that these media provide. But you should also be able to print articles out. At the moment we are far away from that service, so we have to try some steps that involve different actions.

This is not an issue that concerns only mathematics: all sciences face it, and solutions to this problem will not only apply to mathematics but to all sciences. The first priority is to join the other sciences, since 95% of what we do is not topic-specific. For the other 5% that are particular to mathematics we must find our own solutions. In Germany four scientific societies (mathematics, chemistry, physics, and computer sciences) started a consortium on electronic information and communciation. About ten disciplines are now part of it: psychology, education, biology, sociology, etc., have representatives who discuss what should be done for the future. For mathematics we decided to start with an information system for mathematicians, for which we developed a prototype in Germany with the aim of making it globally available and transforming it into an international framework. This is called MATH-NET.

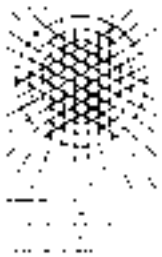
The Executive Committee of the International Mathematical Union has decided to develop MATH-NET as a global information and communication system for mathematics, and I do hope that the EMS is willing to play an important role in it.

While building up MATH-NET we must link it with existing systems, such as *Zentralblatt-MATH*, *MathSci*, and traditionally produced journals. We have to negotiate with publishers about what they make available for the communication system. The German government have supported activities that help the different societies to work together. Workshops of all kinds have been organised and have been successful in helping us to learn from each other, and in improving the understanding of the scientific communication in general. Emphasis was put on how we can cope with our differences.

The German government have leaned very strongly towards developing these markets commercially. The idea was that mathematicians develop prototypes that publishers take over and make money from; but there was strong resistance to this within the mathematics community: that's why we should go our own way. I want to convince my colleagues that a reasonable way to progress is to get national, European and international mathematical societies to work with scientific societies world-wide to set up a user-friendly system with clear interfaces that can be understood by all – free of charge.

A main task, indeed, is setting up interfaces so that we can communicate with each other easily. This is what the future of electronic information and communication is about: a few central navigation and coordination systems and agreements of mutual support; data to be provided locally, and ownership and rights to be local; the system itself to be decentralised; the central components to have the aim of guiding us to the individual data and seeing the global picture. We should not cut ourselves off from what publishers are doing: they provide a service of value, they referee, they judge. All participants in the market should take part in this publications forum.

An important aspect is to have libraries working with us. Libraries guarantee long-term access to data from the past, they have existed for three thousand years or more, and they do a good job. It is not clear what the job of a librarian will be in fifty years. Of course, books will not disappear, but we have to shape the future by listing what we want, and what the special



needs are for our research. I think we will increasingly lean to the electronic side and to the service that electronic information systems can offer. This is likely to be particularly true for research journals; it may not be true for books, but books may be supported by CD-ROMs, on-line supplements, etc.

The future is unclear. There are major developments at present, and in ten years the winners may be visible, but we must be ready to move now. We cannot wait for the commercial market to tell us what we have to use. I don't believe that monopolies will arise, because mathematicians are too intelligent and too strong to accept that. Many will fight against them.

Many mathematicians now realise that, unless a high price is paid, long-term access to mathematical data is not guaranteed if they are stored electronically. Who should pay for this? How can long-term accessibility be guaranteed?

Right now, I cannot say who will pay, but in the long run it will be the State through its support of research in universities, libraries, etc. But let me be a bit more specific.

First, it is a fairy tale that printed publications have long-term survival. I guess that 80% of the books printed in the 17th or 18th century have disappeared completely; we don't know them any more. And I think this is even more so in music: all music pieces that have ever been composed, where are they? They were written and printed, but most have completely disappeared. So printing on paper is no guarantee for survival.

Secondly, if we print everything we produce now, we won't have enough space to store it all, so I see no way to use paper in the long run as the main medium of storage. Next, paper also deteriorates, and we now know that texts printed on acid paper disintegrate. We can learn a lesson from the library in Alexandria. They had people who copied the papyri of those days; every hundred years, a papyrus was copied simply because it was disintegrating.

So two thousand years ago they had copy mechanisms already in place. This is what we should also do, and I think it is very simple. Since we know that electronic storage devices such as discs or tapes will disintegrate, we must learn to copy them systematically. I personally don't believe that archiving is a problem; the problem is to organise the copying. And 'copying' means also copying the software necessary to retrieve and to read the data. If we don't want to do this, we must find mechanisms to transform them into new formats, as some 'dialects' may not be readable in the future. This means active archiving: passive archiving will not be enough. Just putting things somewhere was not effective with books, because rats or mice sometimes ate them or water or fire destroyed them, and the same is true here.

However, active archiving may mean that we have to be selective. We should probably not copy everything that is available. So, to concentrate on mathematics, we may consider it reasonable to look at the body of literature produced within a year and decide what should be archived. Alternatively, we could simply archive everything, but who will then be responsible for its maintenance? So I think we will have a problem of choice and selection, because we want to have institutions that will be responsible for active archiving.

Here, of course, some publishers will say "We are the active archivists", but I don't think this is a long-term solution. Who guarantees that Elsevier, for example, will still exist next year? They could be bought by Microsoft or somebody else and completely change their policies. So archiving must be outside the commercial sector. This task should be the responsibility of public enterprises as part of the conservation of our culture. It has to be supported by the State, just as the State supports libraries, museums, and the like. I imagine that the Deutsche Bibliothek and other national libraries could be active archivers, while institutions like FachInformations-Zentrum or a similar agency run by the State could say "We archive for certain subjects". We then immediately have a problem of the management of rights: can FIZ-Karlsruhe actively archive journals published by Springer, Elsevier, Academic Press or the AMS? Here are difficult copyright issues that I want to see resolved. It is all a matter of organisation. I don't think it is extremely urgent, but in the next ten years we need to come up with schemes that solve the archiving problem in the way I describe. Costs must clearly be covered by the State, and libraries should be responsible for taking up the task

Interview with Bernd Wegner

(Zentralblatt MATH)

Interviewer: Steen Markvorsen (Lyngby, Denmark)

You have contributed more than 25 years of dedicated work to the Zentralblatt MATH information service. How did you get involved? And how did it evolve?

At the beginning of the 1970s a colleague of mine at TU Berlin asked me to serve as a consultant for *Zentralblatt für Mathematik* (the traditional title of *Zentralblatt MATH*), for all areas dealing with topology. Though my main area of research interest is geometry, I became quite fascinated by the possibility of getting a comprehensive view of the developments in these neighbouring subjects, and also by the chance to contribute to the flow of scientific information. Rather soon, the subjects I had to handle also included global analysis, Lie groups, topological groups and classical mechanics.

The Editors-in-Chief at that time were Ulrich Güntzer (for the office in West Berlin) and Walter Romberg (for the one in East Berlin). Due to a call to Tübingen, and for several other reasons, Güntzer left his position in 1974 and I was asked by the Heidelberg Academy of Sciences to become his successor. The joint German co-operation on *Zentralblatt* stopped in 1978 as a consequence of the reorganisation of the government-supported information and documentation activities in the western part of Germany. The partner in East Berlin was more-or-less forced to take the stronger involvement of a non-academic institution like FIZ Karlsruhe [Fachinformationszentrum Karlsruhe] in the editing of *Zentralblatt* as a reason to cancel the co-operation. The editorial staff from East Berlin found some other occupation in the Academy of Sciences of the GDR.

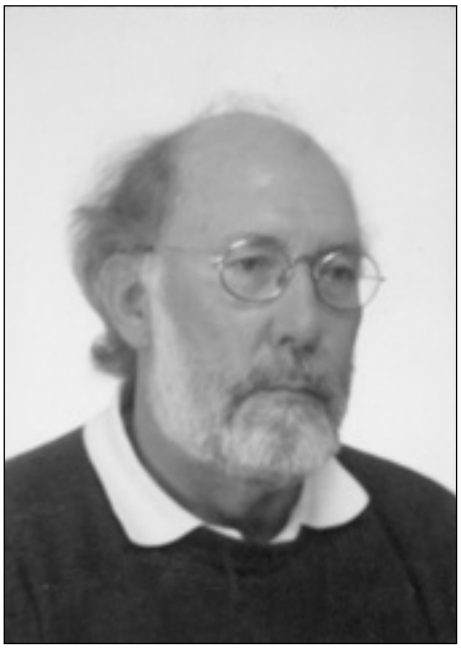
The development of my activities at *Zentralblatt* could easily cover a full article by itself, so let me just mention some of the milestones. The main achievements always developed from taking up the challenges of new situations and of new frameworks into which the *Zentralblatt* had to adjust, in order to guarantee its survival as a leading world-wide reviewing service. To be a bit more specific, these included:

– the administrative transition of *Zentralblatt* to FIZ Karlsruhe, where all publicly supported information and documentation activities in mathematics, physics, astronomy, computer science, nuclear engineering and aviation engineering had to be concentrated;

– cancelling the co-operation from the editorial office in East Berlin, as alluded to above;

– unsuccessful efforts to arrange a merger between *Zentralblatt* and *Mathematical Reviews* on the basis of a fair distribution of work and income;

– permanent discussions to orchestrate the



role of *Zentralblatt* as an 'author' and that of Springer-Verlag as the author's publisher, in a more transparent and efficient way with respect to costs;

– a successful approach towards extending the editorial basis of *Zentralblatt* in the European domain and establishing an international involvement for the scientific supervision of this service, as is now done by the EMS.

These developments were accompanied by:

– technological changes concerning editing and usage of the service: installation of the searchable database in different networks and on different platforms (this had already started in 1978);

– transition from obsolete to new editorial tools such as TeX, offers on CD-ROM, adjustments of the web-service to the rapidly evolving needs of the internet users, and redesign of the service from a searchable database to a comprehensive portal for mathematical literature with convenient user facilities.

Clearly, all these activities led to a reduction of my duties as a subject editor for *Zentralblatt*, though I succeeded in becoming in charge of my favourite area (differential geometry) rather soon, and I looked after this until quite recently.

You are currently expanding the Zentralblatt MATH project into developing countries. What is the philosophy behind this?

The web-service increased the possibilities of offering *Zentralblatt* to more users with convenient subscription conditions. To arrange this turned out to cost quite a lot of my time, but being at the disposal of as many mathematicians as possible should be one of the main goals of *Zentralblatt*, and this has to be taken care of from the 'author's' side, for the benefit of the mathematical community.

We should strive towards a situation where every mathematician can use *Zentralblatt* to get information about, and access to, the research literature in mathematics. Previously this was a privilege for those living in a country with good financial support for libraries, because subscription rates to both *Zentralblatt* and *Mathematical Reviews* became higher and higher.

Assuming that mathematicians in richer countries accept that these rates could, or should, be cut down (even drastically) for developing countries, the idea is then to figure out case by case what these mathematical communities can afford, and to make corresponding fair offers. However, as an isolated action this will not help much. In particular, we should also take care of the parallel task of establishing robust and reliable document delivery facilities for the developing countries; this has to be done in close co-operation with the big libraries in Europe. Also, care must be taken about sponsoring the initial installation of the technical infrastructure so as to enable them to read the electronic products.

I know that this is not in accordance with the policy of some commercial publishers. The mathematical community and colleagues with high reputation should put pressure on them to make these things more-or-less freely available to mathematicians in developing countries.

How do you see your relationships with other projects, such as the EULER project?

Zentralblatt is currently associated with five main projects: EMIS (the European Mathematical Information Service), EULER (EUropean Libraries and Electronic Resources in mathematical sciences), ERAM (Electronic Research Archive in Mathematics), LIMES (Large Infrastructures in Mathematics-Enhanced Services) and MPRESS (Mathematical

PREprints Search System).

The common feature is that they are all designed to improve access to information on mathematics and communication between mathematicians. ERAM and MPRESS extend the information service to sources which are not covered by *Zentralblatt*, like preprints and the literature before 1931. ERAM and EMIS provide easily accessible articles which can be linked with the *Zentralblatt* database. EMIS (the website of the EMS) and its close-to-40 mirrors provide an excellent environment for using these services world-wide; it extends the information provided by *Zentralblatt* in several different directions, and includes (for example) a conference calendar and a directory of mathematicians. EULER connects this with information on library holdings and mathematics websites. Finally, LIMES has just recently been designed to improve these offers (in particular, those of *Zentralblatt*) and to establish them as a large facility for the daily work of the mathematician in national and regional networks [see *EMS Newsletter* **36**, pp. 8-9].

Concerning the use of Zentralblatt MATH, you have expressed the opinion that the user-flow-statistics should not be made public. Could you explain?

This is not exactly my favourite question, but let me answer it this way. My only reservation is actually the same as for statistics concerning primary publications in mathematics. A large part of the subscription rate is justified by making the service available at any time to almost everybody. Moreover, those who are using these services, use them at quite different levels. Hence uncommented statistics lead to misinterpretations and improper usage of the figures. The SCI [Science Citation Index] is the best example of such an unfortunate development in mathematics. I have no objection to revealing such figures if they are commented on properly.

Concerning the interface with electronic journals, what do we do about the archiving problem? Is it special to mathematics? Could the Zentralblatt MATH database play a role in solving it?

The archiving problem is a general problem for all electronic products, though there may be particular difficulties with mathematics because of the coding of formulas, the addition of animations and the links to mathematical software. Some publishers propose that the high price for electronic products is a result of their duty to take precautions for the future archiving of the contents, but I do not believe that most of them really will reinvest money into the archiving once a change of technology needs major work to keep the old electronic offers readable. Back volumes of mathematical journals do not earn much money, and moreover, the publishers currently seem to have a short life period only before being merged, swallowed or converted into a totally commercial business, which typically then mainly takes care of the shareholder values.

In my opinion the only institutions who care about reliable archiving are the big libraries. This was their obligation with paper publications, and they will have to develop skills for the archiving of electronic stuff also. But at present, libraries have to catch up with the transition of their activities to the usage of electronic media and they are confronted with a fundamental problem which makes archiving impossible for them. In contrast to the time when they delivered printed journals, the publishers (at least the bigger ones) are now reluctant to give the content of the electronic journals to libraries. The role of the library is simply to take care of the payment of the subscription and to install the links from their clients to the corresponding publisher. Here pressure will have to be come from authors, readers and librarians so that the contents of journals will be available at a set of selected libraries representing the interest of all subscribers.

At present I do not see any role for *Zentralblatt* in this discussion, but having once installed a system of reference libraries, *Zentralblatt* should provide appropriate links to their holdings for those who have the license for accessing these journals.

Some publishers argue (correctly, I guess?) that what they mostly sell are the 'fancy wrappings', including some search engines and web-portals etc. to their respective publishing houses. This is where they add value and is what we pay for. Shouldn't we be happy about this?

As long as no rough figures are given concerning what is really needed by the publishers to create and maintain these added values, the whole discussion will take place without any verifiable background and everybody can propose what they happen to have in mind.

There is no question that the main value of an article consists of its scientific content. If publishers tell us that the reason for the high prices are the fancy wrappings, then they should give us the chance to decide what we really want. My experience is that these added values do not automatically have to be expensive. However, if my estimate of the costs is wrong, we should simply claim the possibility of getting the content without these expensive additions. The main added value to a paper is organised by the editors and contributed by the referees. These services will not change for electronic journals and, in all cases I know, have been completely voluntary and – up to a marginal cost – without any expense on the publishers' side.

The reviewing philosophy of *Zentralblatt* is strictly oriented towards scientific content. Hence, as with *Mathematical Reviews*, we require that articles reviewed in *Zentralblatt* must have been subject to peer-reviewing before. Both services are the only ones in mathematics that are comprehensive.

There are linked offers by some publishers providing free or charged access to bibliographic data and summaries of their journals. These are called databases, of course, and they also have modest search facilities and metadata, but they are of comparably low quality. The main aim of these offers is clearly to increase the visibility of the products of one given publisher or a group of publishers. After all, if the purpose were really to increase the navigation possibilities for the user, then these publishers should have cared more about making the links fully comprehensive. Moreover, the recent initiative for the DOI [Digital Object Identifier] would have been arranged in such a way that small publishers could also benefit from it. At present, most major commercial publishers in science and two or three society publishers share this facility.

Projects like EULER and other portals developed by libraries in co-operation with *Zentralblatt* will soon be more appropriate

for getting comprehensive entrances to mathematical literature, and will provide the user with more convenient search facilities by investing more efforts in the production of the metadata.

It seems to me that review-databases would fit in very nicely with cross-reference and DOI initiatives …
It would be highly desirable to have cross-referencing between all mathematical journals, and not only between those that can pay for the DOI. Links to and from *Zentralblatt* and digital object identifiers on a less commercial level may provide a chance to extend this linking to a wider set of journals. At present, *Zentralblatt* tries to implement as many links as possible, offering to publishers the opportunity to link the references sections in their mathematical journals with the corresponding entry in our database. This will be freely accessible for the readers of these journals. But unique identifiers of electronic products will be an essential requirement to establish this linking as a reliable tool.

Why don't we have more survey articles?
The problem with surveys is a very old one. The reputation of surveys is generally lower, and the work to be done is considerably higher, than the production of a research article. Electronic media will open new perspectives for surveys, handbooks and encyclopaedic publications. I hope that such articles will come up soon as living projects, supported by a team and updated regularly. Electronic publication provides many new degrees of freedom for such publications.

Through license agreements we now have access to electronic journals from other fields, journals that we previously did not even know existed. Will this access change the directions of mathematical research, and hence maybe also of the reviewing process?
Being able to read journals from other fields more easily will have only a modest impact on the development of mathematical research. This mainly concerns journals at the borderline of mathematics, journals that are only partially covered by *Zentralblatt*. If mathematicians develop a growing interest in these journals, then this may lead to the decision that they will be handled in their entirety, even though some articles may just marginally deal with mathematics. But this development only needs the availability of subscriptions to the electronic versions of these specific journals. That the access will be open for the whole campus, as it had been for the printed version, should be taken for granted. So there is still no need to enter into such kinds of licensing agreements, where a customer is more-or-less pressed to buy a whole bunch of journals from the same publisher just in order to get a fair subscription rate.

How do you find time for other activities, such as differential geometry?
Finding time for this gets harder and harder. It is also very difficult to maintain my private activities, such as tennis and sailing. There are two commitments which always force me to care about my geometric research – the more challenging is my research students, the more relaxing consists of my participation at conferences on geometry. But the latter have increasingly had to be reduced in favour of general mathematical meetings and conferences on information and communication in science.

How did you become interested in geometry?
Mathematics was one of my three favourite topics in the natural sciences – chemistry and astronomy were the other two. The chance to graduate in mathematics in a reasonable time seemed to be the best, so I chose mathematics, and I enjoyed the study. There were two reasons for the choice of geometry. I use a lot of geometric intuition for my mathematical thinking – though I do not forget about the need for precise mathematical arguments. Moreover, during my studies and for my thesis, Kurt Leichtweiss was my main advisor. He was a reliable counterpart for suggesting research topics and judging the relevance and the correctness of my research. More importantly, he did not try to force my work into the directions of his own main interests, but left the preferences to me. Such conditions and possibilities cannot be found everywhere.

Differential geometry is strongly represented at TU Berlin. Could you tell some of the history behind the Berlin school and maybe speculate on the future and importance of differential geometry?
TU Berlin was founded as a polytechnic high-school with main activities in engineering science. Differential geometry and descriptive geometry were important mathematical subjects needed there, so there has been a chair of geometry for quite a long time at TU; Christoffel held the chair for some time. When the capacities of the universities were extended in the 1960s and 1970s, geometry was elected as a favourite subject at TU; this led to an expansion in the positions available. At present we have five professors in the group, though not all of them do research in differential geometry exclusively.

I think that classical differential geometry will play an important role in future mathematics, due to its applications to other sciences – in particular, the engineering sciences. Graphics tools will give new possibilities for handling objects from differential geometry and for providing new insights into their structure. As a companion, discrete geometry will receive more attention, because the use of computers makes solutions to problems accessible, which could not have been obtained with the human brain alone. There will be links between both subject areas.

The development of differential geometry will also be subject to the problems that we face in mathematics in general. There are different reasons for the reduced motivation of young people to study mathematics and care about mathematical research. The main reason is that there is more money in business: those who graduate in mathematics prefer to accept a better paid job in industry. The lack of people in this area is a current matter of discussion, and in some countries in Eastern Europe in particular is a very urgent problem; academic jobs are among the worst paid there. If you think of the many good geometers who have been educated in Eastern European countries, there is one pertinent question: who will be their successors?

Nevertheless, I am optimistic that there will be no reduction in mathematical research and training on a world-wide level. I am also confident that *Zentralblatt MATH* will have an ever-increasing number of interesting papers to review in the future – there is no likelihood of a reduction of this (net-)work within our mathematical community.

A stamp for the World Mathematical Year

F. Dumortier and D. Huylebrouck

The year 2000 was proclaimed 'World Mathematical Year 2000' by UNESCO. On that occasion, the Belgian Post Office recently released a special stamp, entitled 'Mathematical formulas and the Ishango bone'. Here is a description of what can be seen on the tiny graphical composition, of about the standard Belgian stamp size – that is, 27.66 mm by 40.20 mm.

The upper right and left corners mention the price of the stamp in Belgian Francs (17BEF), and equivalently in the new European currency, the Euro (0.42 Euro). These amounts (less than 0.40 US$) are mentioned at both sides of the indication *Belgique-België* of the country of issue, printed in French and Dutch, the two official languages of Belgium. The Post Philately Department sells the stamp separately or in sheets of 30. It can be obtained at the Centre Monnaie, B-1000 Brussels, Belgium (or through e-mail, at philately@ philately.post.be).

The stamp, as presented in a Belgian catalogue of the Post Philately Department.

The composition carries another identification, that of the designer, Clotilde Olyff. This graphic artist and typographer 'metamorphoses' letters in her artwork, to analyse the alphabet and to simplify and structure it into geometrical forms. Her letter sets and typographic games have been released in the US, Canada and Germany. This time, she turned her attention to mathematical symbols.

The background of the stamp is mainly blue, except for the white part on the top above the serrated line. 'Blue is the color of hope', confessed Olyff, and this of course was willingly accepted as a very good reason for using it on a stamp about mathematics. A circle, in yellow, surrounds the formulas. It is a pity that the stamp is not square, since then it could have referred to the 2000-year-old mathematical problem of 'squaring the circle'. A red Gauss curve crosses the drawing, producing a rather peculiar effect on the complete 30-stamp sheets when they all seem linked to each other. This normal curve emphasises the growing impact of applied mathematics, and in particular of statistics.

Clotilde Olyff, the designer of Belgium's mathematical stamp

The two formulas are shown in green. Above is Stokes' formula in its unified form: $\int_X d\omega = \int_{\partial X} \omega$. The expression was quoted by André Weil, in his autobiography *The Apprenticeship of a Mathematician*, as the initial mathematical reason for starting the Bourbaki group (see the outlined text and [2]). It goes without comment that the reference below, $x^n + y^n = z^n$, points to Fermat's last theorem, proved about five years ago by Andrew Wiles.

Finally, on the bottom of the stamp, in the postage margin, there are white marks, in a group of three and a group of six lines. It is not a new kind of bar code, although this misinterpretation would not have been an unfortunate one. The marks refer to the Ishango bone, which is one of the oldest mathematical finds. Prof. J. de Heinzelin discovered the bone, now preserved at the Royal Belgian Institute for Natural Sciences, in Africa (see [1]). Its presence on the stamp emphasizes the importance of mathematics for Africa, and this was one of the goals UNESCO had set in declaring 2000 the 'World Mathematical Year'. This expression stands, in English, in the lower part of the stamp, as to underline the statements made by the formulas.

Two special seals were issued on the occasion of the release of the stamp. One carried a reproduction of the formulas, and was issued in four Belgian cities, during an advanced sale. The second, called Cancellation "Date of issue", showed some Ishango marks.

Weil associated the birth of Bourbaki to Stokes' formula in his autobiography (see [2]). In the English translation of the original French monograph, he declared the following (pages 99-100):

Awaiting me upon my return to Strasbourg were Henri Cartan and the course on 'differential and integral calculus', which was our joint responsibility – here I had escaped being saddled with 'general mathematical'. We were increasingly dissatisfied with the text traditionally used for the calculus course. Because Cartan was constantly asking me the best way to treat a given section of the curriculum, I eventually nicknamed him the Grand Inquisitor. Nor did I, for my part, fail to appeal to him for assistance. One point that concerned him was the degree to which we should generalize Stokes' formula in our teaching.

This formula is written as follows

$$\int_{b(X)} \omega = \int_X d\omega,$$

where is a differential form, d is its derivative, X its domain of integration and b(X) the boundary of X. There is nothing difficult about this if for example X is the infinitely differentiable image of an oriented sphere and if is a form with infinitely differentiable coefficients. Particular cases of this formula appear in classical treatise, but we were not content to make do with these.

In his book on invariant integrals, Elie Cartan, following Poincaré in emphasizing the importance of this formula, proposed to extend its domain of validity. Mathematically speaking, the question was of a depth that far exceeded what we were in a position to suspect. Not only did it bring into play the homology theory, along with Rham's theorems, the importance of which was just becoming apparent; but this question is also what eventually opened the door to the theory of distributions and currents and also to that of sheaves. For the time being, however, the business at hand for Cartan and me was teaching our courses in Strasbourg. One winter day toward the end of 1934, I thought of a brilliant way of putting an end to my friend's persistent questioning. We had several friends who were responsible for teaching the same topics in various universities. "Why don't we get together and settle such matters once and for all, and you won't plague me with your questions any more?" Little did I know that at that moment Bourbaki was born.

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F. Dumortier, University of Limburg, B-3950 Diepenbeek, Belgium;
D. Huylebrouck, Sint-Lucas Architecture, Paleizenstraat 42, 1030 Brussels, Belgium.

The London Mathematical Society
A brief history

Adrian Rice

Despite its name, the London Mathematical Society (LMS) has, almost since its foundation, served as the national society for the British mathematical community. Its establishment in 1865 made Britain one of the first countries in the world to have such an organisation, prompting and/or influencing the formation of several other national societies world-wide, such as the Société Mathématique de France (1873), the Circolo Matematico di Palermo (1884), the American Mathematical Society (1888), and the Deutsche Mathematiker-Vereinigung (1890).

University College London

Before its creation, other mathematical societies had existed in Britain, such as the Manchester Society, founded in 1718, and the Oldham Society of 1794. But these were very much local bodies, more akin to working men's clubs than learned societies. Moreover, although they flourished for a time, none survived; even the famous Spitalfields Mathematical Society of East London [1], which dated from 1717, was forced to dissolve in 1845, due to a rapid decline in membership.

The formation of the LMS was inspired by the increasing need for specialised scientific outlets during the nineteenth century. In Britain, this resulted in the foundation of national societies specifically devoted to geology (1807), astronomy (1820), statistics (1834) and chemistry (1841).

What was to become the British mathematical society arose from a chance remark in a conversation between two former students of University College London in the summer of 1864. During a discussion of mathematical problems, it occurred to them that "it would be very nice to have a Society to which all discoveries in Mathematics could be brought, and where things could be discussed, like the Astronomical [Society]" [4, p.281]. The two young men were Arthur Cowper Ranyard and George Campbell De Morgan, the son of one of the most influential British mathematicians of the day.

Augustus De Morgan was the founding professor of mathematics at University College, which he had single-handedly established as the home of advanced mathematical education in London. Conscious of the key role the Professor's reputation could play in attracting members to the Society, it was agreed "that George should ask his father to take the chair at the first meeting" [4, p.281].

Arthur Ranyard

George De Morgan

Agreeing to this, the senior De Morgan apparently insisted that their tentative title of 'The London University Mathematics Society' be changed, first to the 'University College Mathematical Society', and then, in order to widen the scope of the society's membership, to the 'London Mathematical Society'.

The newly retitled society held its inaugural meeting at University College London on Monday 16 January 1865, with Augustus De Morgan as its first president giving the opening address. The venue was an appropriate one, for the Society's rejected title of 'University College Mathematical Society' was still more accurate at this stage: of the 27 founding members, no fewer than 26 were, or had been, associated in some way with the College. Within months, the Society had attracted over sixty new members from around the country, including many of the leading British mathematicians of the nineteenth century, such as Arthur Cayley, James Joseph Sylvester, Henry John Stephen Smith, George Salmon, William Kingdon Clifford and James Clerk Maxwell.

Right from the Society's inception, it had been intended that papers presented at meetings should be printed and circulated among the members. However, the increase in the cost of printing and distribution caused by the sharp increase in membership resulted in the first volume of the Society's *Proceedings*, covering the period from January 1865 to November 1866, containing just 11 of the 37 papers presented during that time. The need for financial retrenchment was to be a characteristic feature of the Society's formative years.

Even an increase in the members' sub-

scription from its initial ten shillings (50p) to one guinea (£1.05) in November 1867 proved insufficient, and by 1873 the Society found its balance in the red for the first time, due to its ever-increasing publication of papers. The Society was thus faced with surviving on an even tighter budget than before. Money-saving ideas, such as reducing subscriptions to certain journals, cutting back on printing, and charging members for copies of papers, were seriously considered until the applied mathematician Lord Rayleigh (1842-1919) made a generous bequest of £1,000 in 1874. This gift was gratefully accepted, the financial pressure was relieved, and the LMS was thus saved from what could have resulted in its early demise.

Before long, distinguished members were presenting papers that would previously have graced the pages of the Royal Society's *Philosophical Transactions* or the *Proceedings of the Cambridge Philosophical Society*. De Morgan's influence may have given the Society much needed initial momentum, but it was papers by later presidents such as Cayley, Sylvester, Rayleigh and Smith which placed it on a level with other scientific societies. What had begun life as a simple club of De Morgan's ex-students at University College had been transformed into the national body for research-level mathematicians [7].

There was now no obstacle to the publication of papers, which increased substantially from this point. By 1900, over 900 papers had been published in the *Proceedings*, with the volume of pages for that year exceeding 700. The next century saw a massive expansion in the Society's publication activities. In 1926, under the influence of G. H. Hardy, the driving figure of the Society for the first half of the twentieth century, the *Journal* was founded, followed by the *Bulletin* in 1969. More recently, in keeping with the times, 1997 saw the launch of a purely electronic journal, the *LMS Journal of Computation and Mathematics*. Joint publication ventures have included the *Journal of Applied Probability* (from 1964), *Nonlinearity* (from 1988), and the *History of Mathematics* book series (from 1989).

As soon as its finances permitted, the LMS sought to promote and reward mathematical achievement by means of prizes and awards. Its premier award, the De Morgan Medal (awarded every three years), was endowed through subscriptions of members in honour of the Society's first president. Initially awarded in 1884 to Arthur Cayley, subsequent medallists have included J. J. Sylvester, Felix Klein, Bertrand Russell, G. H. Hardy, and the most recent recipient, the number theorist Robert Rankin [6]. Other prizes regularly awarded by the LMS are two Berwick Prizes, up to four annual Whitehead Prizes and the Pólya Prize, all instituted in commemoration of important figures in the Society's history.

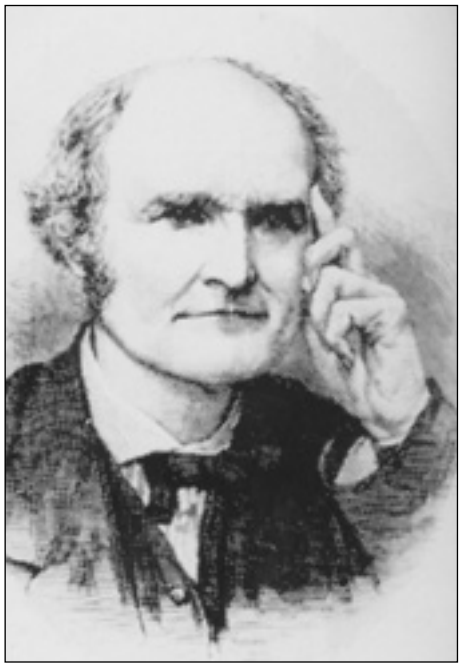
The Society has also been instrumental in bringing the work of mathematicians from overseas to the attention of a British audience. Its first initiative was the establishment of the honorary foreign member category in 1867, of which the first recipient was the French geometer Michel Chasles. Later honorary members included Kronecker, Poincaré, Cantor and Hilbert. More recently, to honour the work of G. H. Hardy, not just in mathematics, but in the internationalisation of the subject, a Hardy Lectureship (recently renamed the Hardy Fellowship) was set up to enable distinguished overseas mathematicians to visit the United Kingdom for an extended period to work and exchange ideas. By means of this scheme, such distinguished individuals as Ahlfors, Dynkin, Bombieri, Tits and Feit have visited the UK as Hardy lecturers in the last 25 years. As this brief survey has shown, since its foundation in 1865, the LMS has grown steadily in size and importance. From an initial size of 27, its membership swelled to 250 by 1900, and currently stands at over two thousand. From a college club, it has grown into a learned society, was incorporated as a limited company in 1894, and was finally granted a Royal Charter in 1965. Although originally intended as a purely research-based organisation, recent years have seen a huge increase in the diversity of activities in which the Society is involved – from education to popularisation to government policy. But perhaps the most significant recent development has been its move in 1998 to its first exclusive headquarters (see EMS *Newsletter* **31**). The impressive building, appropriately renamed De Morgan House, is a fitting reflection of its status as Britain's national mathematical society – a far cry from the modest collection of University College alumni who gathered for their first meeting 135 years ago.

Further reading

1. J. W. S. Cassels, The Spitalfields Mathematical Society, *Bull. London Math. Soc.* **11** (1979), 241-258.
2. E. F. Collingwood, A century of the London Mathematical Society, *J. London Math. Soc.* **41** (1966), 577-594.
3. H. Davenport, Looking back, *J. London Math. Soc.* **41** (1966), 1-10.
4. S. E. De Morgan, *Memoir of Augustus De Morgan*, Longmans, Green and Co., London, 1882.
5. J. W. L. Glaisher, Notes on the early history of the Society, *J. London Math. Soc.* **1** (1926), 51-64.
6. A. C. Rice, The origin of the De Morgan medal, *London Math. Soc. Newsletter* **240** (1996), 20-22.
7. A. C. Rice, R. J. Wilson and J. H. Gardner, From student club to national society: the founding of the London Mathematical Society in 1865, *Historia Matematica* **22** (1995), 402-421.
8. A. C. Rice and R. J. Wilson, From national to international society: the London Mathematical Society, 1867-1900, *Historia Mathematica* **25** (1998), 376-417.

Adrian Rice is an assistant professor of mathematics at Randolph-Macon College, Virginia, USA

Augustus De Morgan



Arthur Cayley

G. H. Hardy

Problem Corner

Contests from Romania, part 2

Paul Jainta

In the last corner I sang the praises of Romania's pioneering work in identifying and breeding rising generations of mathematicians and scientists. This path of success has headed upwards for decades now, and remains unbroken. It is no wonder that last summer Romania hosted the International Mathematics Olympiad for the fourth time and attained fourth place among 81 participating nations.

The secret ingredient of these amazing achievements is probably a sound underpinning in the lengthy practice of spotting mathematically able teenagers. Aside from the National Mathematics Olympiad that acts as the flagship of home competitions, there is a close network of local and regional contests. One of these is the *District Mathematics Competition*, a cross between a warm-up and the pinnacle of the National Romanian Mathematics Olympiad, and is therefore not formally part of the national event. Nonetheless, this kind of contest is useful for students who want to compete for the best solutions to somewhat unwieldy problems. Such encounters have become very popular in the last twenty years, because they provide a proper training for the real thing, a showdown with the best competitors in the national finale.

The competing teams are chosen from the first-rate mathematical wizards at district level. The problems posed at this event and its rules are similar to those in the final stage of the nation-wide Olympiad. As always, the irrepressible journal *Gazeta Matematica* provides an inexhaustible fund of challenging problems. Every offshoot from these peculiar contests is named after a Romanian mathematician of outstanding merit: according to Vasile Berinde, Dean of the Faculty of Science, the prototype is designated *The Gheorge Titeica contest*. It was initiated in 1979 by a handful of mathematicians from the University of Craiova in order to stimulate interest in mathematics in grade 7 – 12 students from Oltenia, a province in the southern part of Romania. Soon after, further competitors from around the country and from outside (Moldova, Greece, Bulgaria and Yugoslavia) joined in this competition.

The most striking difference between the structures of the Titeica contest and the National Olympiad is the terraced configuration of the former. Each of the three rounds has two levels. The prelude to this intellectual bout is open to all registered participants at the second stage, the team contest, where only teams of three members engage in combat. And another peculiarity is that only three age-groups race the others (at level 1 grades 7 – 8, at level 2 grades 9 – 10, and at level 3 grades 11 – 12). The reason for this division into three classes is two-fold, for one thereby obtains a pick of individual contestants as well as team-mates. Both individual and team prizes are awarded.

That completes the Corner for this quarter. Please send me your solutions as well as contest materials, and propose problems for readers to solve. Wherever possible, proposals should be accompanied by a solution, references and other insights, to help the editor. The problems can range from elementary to advanced, from easy to difficult, and original ones are particularly sought. So, please submit any interesting problems you come across, especially those from (problem) books and contests that are not easily accessible – but other interesting problems may be acceptable provided that they are not well known and references give their provenance

116 Let x be a natural number. Prove that x is a perfect square if and only if for every natural number y there is a natural number z such that $x + yz$ is also a perfect square.

117 Let x, y and z be positive numbers satisfying $xyz = 1$. Show that

$$(x^9 + y^9)/(x^6 + x^3y^3 + y^6) + (y^9 + z^9)/(y^6 + y^3z^3 + z^6) + (z^9 + x^9)/(z^6 + z^3x^3 + x^6) \geq 2.$$

118 Which five integers have the following property: if we add in different ways four of these numbers we obtain 21, 25, 28 and 30?

119 A rectangular sheet of dimensions 12×10 is cut into two pieces of equal area. What is the minimum length of the line of intersection?

120 For real numbers a, b, c, d, consider the two sets

$$A = \{x : x^2 + a|x| + b = 0\} \text{ and } B = \{x : [x]^2 + c[x] + d = 0\},$$

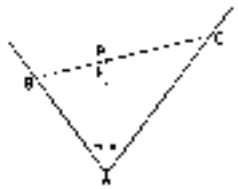
where $[x]$ denotes the integer part of x. Prove that if the intersection of A and B has exactly three elements then a cannot be an integer.

121 Given a line l in the plane and three circles with centres A, B, C tangent to l and pairwise externally tangent to one another, show that triangle ABC has an obtuse angle and find all possible values for this angle.

Solutions to some earlier problems

104 Choose a point P on the bisector of an angle with vertex A. A line through P meets the arms of the angle in points B and C. Show that $1/AB + 1/AC$ is constant as the line rotates about P.

Solution *by J. N. Lillington, Winfrith Technology Centre, Dorchester, UK; also solved by Niels Bejlegaard, Stavanger (Norway), André Brémond, Avignon (France), Dr. M. Dzamonja, UEA, Norwich, UK, and Dr. Z. Reut, London.*



Let $\angle BAC = 2\alpha$ = constant, and let BC make an arbitrary angle δ with AP.
By the sine rule for the triangles ABP, ACP we have
$AP/\sin\delta = AP/\sin[\pi - (\delta + \alpha)] = AP/\sin(\delta + \alpha)$
and $AC/\sin\delta = AP/\sin[\pi - (\pi - \delta + \alpha)] = AP/\sin(\delta - \alpha)$.
Hence: $1/AB + 1/AC = 1/(AP \sin\delta).[\sin(\delta + \alpha) + \sin(\delta - \alpha)]$
$= 2 \sin\delta \cos\alpha /(AP \sin\delta) = 2\cos\alpha/AP$ independent of δ
(using $\sin x + \sin y = 2 \sin[(x + y)/2] \cos[(x - y)/2]$).

105 Find all non-negative integers x, y, z which satisfy the equation $3(x + y + z) = xyz$.

Combined solution by Niels Bejlegaard and J. N. Lillington.

Given $3(x + y + z) = x\,y\,z$ (*), suppose without loss of generality that $x \geq y \geq z \geq 0$ (**)
Trivially, (0, 0, 0) is a solution.
Otherwise, suppose that $x \geq y \geq z \geq 1$; then (*) and (**) imply that $x\,y\,z = 3(x + y + z) = 9 \geq y\,z$ (***).
We seek solutions first with $z = 1$.
Because $3(x + y + z) > 3x$, $1 \leq y \leq 3$ is impossible, by (*).
Thus $y = 4$ yields $3(x+5) = 4x$, and so $x = 15$.
Similarly, $y = 5$ yields $x = 9$ and $y = 6$ yields $x = 7$; and $7 = y = 9$ contradicts assumption (**).
Therefore, **(15, 4, 1)**, **(9, 5, 1)** and **(7, 6, 1)** are the only possible solutions for $z = 1$.
Now consider $z = 2$.
$y = 2$ yields $x = 12$, $y = 3$ yields $x = 5$, and $y = 4$ gives no integer solution for x.
So **(12, 2, 2)** and **(5, 3, 2)** are the only possible solutions for $z = 2$.
Finally, consider $z = 3$.
$z = 3$ yields $y = 3$ and $x = 3$; thus, **(3, 3, 3)** is the only possible solution for $z = 3$.

106 Let (x, y, z) be the coordinates of a point on the surface of a sphere with centre 0 and radius 1.
Find the greatest and least values of the expression $xy + xz + yz$.

Solution *by Niels Bejlegaard. Also solved by J. N. Lillington and Dr. Z. Reut.*

We have $(x + y + z)^2 = (x^2 + y^2 + z^2) + 2(xy + xz + yz)$ and $(x + y + z)^2 \leq 3(x^2 + y^2 + z^2)$.
So $1 + 2(xy + xz + yz) \leq 3$ and $xy + xz + yz \leq 1$.
Otherwise, we have $x^2 + y^2 + z^2 \geq 0$
which leads to $1 + 2(xy + xz + yz) \geq 0$ and $xy + xz + yz \leq -0.5$.
Thus $-0.5 \leq xy + xz + yz \leq 1$.

107 The towns in a country are connected by one-direction roads. For any two towns, one can be reached from the other.
Prove that there is a town from which all the other towns can be reached.

Solution *by Oren Kolman, London; also solved by Niels Bejlegaard, Dr. M. Dzamonja and J. N. Lillington*

We apply induction on the number n of towns in the country C.
For $n = 1$ or 2, the assertion is trivial.
For $n > 2$, consider the country C\{t} with one town t removed.
This depleted country of $n - 1$ towns still satisfies the induction hypothesis, since its towns are connected by one-way roads, and hence there is a town t_0 in C\{t} which can be reached from every town in C\{t}.
If t_0 can also be reached from t, then t_0 is as required; if t_0 cannot be reached from t, then the one-way road connecting t_0 and t runs from t_0 to t, and so t is as required.

108 Find all polynomials p(x) for which $p(x^2) = (p(x))^2$ for all x.
Use the result to determine which polynomials fulfil the condition $p(x^2 - 2x) = (p(x - 2))^2$.

Solution *by J. N. Lillington; also solved by Niels Bejlegaard.*

Let $p(x) = a_0 + a_1x + a_2x^2 + \ldots + a_nx^n$.
Suppose p(x) contains a term $a_rx^r + a_sx^s$, where the coefficients between a_r and a_s are 0, a_r and a_s are non-zero, and $r < s$.
Then $p(x^2)$ contains $a_rx^{2r} + a_sx^{2s}$, but $[p(x)]^2$ also contains $2a_ra_sx^{r+s}$ with $2r < r + s < 2s$.
Since this is impossible, there can be only one non-zero coefficient in the expression of p(x).
Thus, $p(x) = x^n$ $(n = 0, 1, 2, \ldots)$ or $p(x) = 0$.
Now, we write p(x) in the form $p(x) = b_0 + b_1(1 + x) + b_2(1 + x)^2 + \ldots + b_n x^n$ and apply the same argument as above.
Suppose p(x) contains a term $b_r(1 + x)^r + b_s(1 + x)^s$, where the coefficients between b_r and b_s are 0, b_r and b_s are non-zero, and $r < s$.
Because $1 + (x^2 - 2x) = (x - 1)^2$, it follows that $p(x^2 - 2x)$ contains $b_r(x - 1)^{2r} + b_s(x - 1)^{2s}$
and $[p(x - 2)]^2$ also contains $2b_rb_s(x - 1)^{r+s}$, with $2r < r + s < 2s$.
Since this is impossible, there is only one non-zero coefficient in p(x).
Thus the polynomial p(x) has the form $(1 + x)^n$, for arbitrary n.

109 Find all positive real numbers c such that the sequence $a_0, a_1, a_2, \ldots$, where $a_0 = 1$, $a_i = c^{a_{i-1}}$, $i = 1,2, \ldots$, is bounded.

Solution *by Niels Bejlegaard; also solved by Dr. M. Dzamonja, J. N. Lillington and Dr. Z. Reut*

We make use of the fact that a monotone and bounded sequence is convergent.
For any $0 < c < 1$, the sequence $1, c, c^c, c^{(c^c)}, \ldots$, is bounded by $M = 1$.
We therefore assume that $c > 1$, and monotonicity is assured.
To find the maximum value of c for which the sequence is bounded, we consider the function $f(x) = c^x - x$.
Using $a_i = c^{a_{i-1}}$, we can write the expression for f(x) as $f(a_i) = c^{a_i} - a_i = a_{i+1} - a_i$.
Since $\lim_{i \to \infty} a_i = \lim_{i \to \infty} a_{i+1} = a$, we have $f(a) = 0$, so $c^a = a$ and hence $c = a^{1/a}$.
But $a^{1/a} = e^{1/a \ln a}$, so we can differentiate the function $g(a) = (\ln a)/a$ to obtain the required maximum value of $(1 - \ln a)/a^2$.
This expression vanishes for $a = e$, so for $1 \leq c \leq e^{1/e}$ we obtain the upper bound $M = e$.
Thus, the sequence is bounded for all $0 \leq c \leq e^{1/e}$.

Forthcoming conferences

compiled, for this issue, by Barbara Maenhaut

Please e-mail announcements of European conferences, workshops and mathematical meetings of interest to EMS members, to k.a.s.quinn@open.ac.uk. 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

October 2000

1-7: International Workshop and Fall School 'Geometric Analysis', Potsdam, Germany
Scope: the meeting will reflect a good part of the research activities of the EU research and training network 'Geometric analysis'
Topics: operator algebras, index theory, noncommutative Chern character, pseudodifferential operators on manifolds with singularities, *K*-theory
Speakers: J.-M. Bismut, A. Connes, M. Karoubi, B.-W. Schulze, N. Teleman
Programme: plenary talks and special sessions on the above mentioned topics
Organisers: A. Connes, N. Teleman, E. Schrohe, B.-W. Schulze
Sponsors: EU research and training network and the Clay Mathematical Institute
Information: contact the organisers:
N. Teleman, Univ. di Ancona,
e-mail: teleman@popcsi.unian.it
E. Schrohe, Universität Potsdam,
e-mail: schrohe@math.uni-potsdam.de
B.-W. Schulze, Universität Potsdam,
e-mail: schulze@math.uni-potsdam.de

7-10: International Conference on Mathematical Modelling and Computational Experiments (ICMMCE), Dushanbe, Tajikistan
Information:
Web site: http://www.tajnet.com/

8-11: X Congress of Yugoslav Mathematicians, Belgrade, Yugoslavia
The congress is included in the project 'World Mathematical Year 2000' of
the International Mathematical Union (http://wmy2000.math.jussieu.fr)
Topics: Logic, Algebra, Geometry and topology, Real and complex analysis, Functional analysis and operator theory, Differential equations, Combinatorics and graph theory, Probability and statistics, Numerical analysis and optimisation, Computer science, Applied mathematics, Teaching, History and popularisation of mathematics
Main speakers: Invited lectures will be delivered by outstanding Yugoslav and foreign mathematicians – the names will be given in the second announcement
Programme: Invited lectures, section lectures, short communications, poster sections, round table, mini-symposium, workshops
Organising and programme committee: Neda Bokan (chair), Sinisa Vrecica, Zoran Ivkovuc, Bosko Jovanovic, Milan Jovanovic, Zoran Kadelburg, Miodrag Mateljevic, Zarko Mijajlovic,
Vladimir Micic, Pavle Mladenovic, Predrag Obradovic, Zarko Pavicevic,
Gordana Pavlovic-Lazetic, Stevan Pilipovic, Dragoslav Herceg, Stevo Segan, Radoje Scepanovic
Site: Faculty of Mathematics, Studentski trg 16, Belgrade, Yugoslavia
Deadlines: September 25
Information:
e-mail: matkon10@matf.bg.ac.yu
for application: prijave@matf.bg.ac.yu
for abstracts: apstrakti@matf.bg.ac.yu
Web site: http://www.matf.bg.ac.yu/matkon10/

15-21: DMV Seminar on the Riemann Zeta Function and Random Matrix Theory, Mathematisches Institut Oberwolfach, Germany
Information: Prof. Dr Matthias Kreck, Universität Heidelberg, Mathematisches Institut, Im Neuenheimer Feld 288, 69120 Heidelberg, Germany

15-21: DMV Seminar on Motion by Curvature, Mathematisches Institut Oberwolfach, Germany
Information: Prof. Dr Matthias Kreck, Universität Heidelberg, Mathematisches Institut, Im Neuenheimer Feld 288, 69120 Heidelberg, Germany

16-17: Workshop on Non-Newtonian and Viscoelastic fluid flows:
Mathematical theory, Modelling and Applications, Pisa, Italy
Theme: Applied mathematics, computational fluid dynamics
Main speakers: M. Deville (Switzerland), R. Glowinski (USA), J. M. Marchal (Belgium), M. Picasso (Switzerland), A. Sequeira (Portugal), A. Fasano (Italy), K. R. Rajagopal (USA)
Programme: The workshop will consist of invited lectures by seven international experts in applied mathematics and computational fluid dynamics – in particular, in the field of non-Newtonian and viscoelastic fluid flows.
Language: English
Organising committee: A. Quarteroni (Switzerland/Italy), A. Fasano (Italy), G. Da Prato (Italy)
Sponsors: ESF through the program AMIF and the 'Associazione Amici della Scuola Normale'
Site: Scuola Normale Superiore di Pisa, Piazza dei Cavalieri 7,
56126 Pisa, Italy
Grants: AMIF grants for European young researchers
Deadlines: for registration: 30 September (16 September if an AMIF grant is requested)
Information:
e-mail: amicisns@sns.it
Web site: http://www.sns.it/html/Home/Associazione_Amici_della_Normale/amici10c.html

20-22: One Hundred Years of the Journal *L'Enseignement Mathématique*, Geneva, Switzerland
Information:
e-mail: EnsMath@math.unige.ch
Web site: http://www.unige.ch/math/EnsMath
[For details, see EMS Newsletter 36]

20-23: Singularities in Classical, Quantum and Magnetic Fluids, Coventry, UK
Information:
Web site:
http://www.maths.warwick.ac.uk/research/programmes/current

23-25 Third International Conference on Applied Mathematics and Engineering Sciences, Casablanca, Morocco
Information:
Web site: http://www.cimasi.org.ma/

30-3 November: International Conference Dedicated to M. A. Lavrentev on the Occasion of his Birthday Centenary, Kiev, Ukraine
Information:
Web site: http://www.imath.kiev.ua/lavconf.htm

30-3 November: Clifford Analysis and its Applications, NATO Advanced Research Workshop, Praha, Czech Republic
Information:
Web site: http://www.karlin.mff.cuni.cz/~clifford

30-4 November: Evolution Equations 2000: Applications to Physics, Industry, Life Sciences and Economics, Levico Terme (Trento), Italy
Information: contact Mr. A. Micheletti, Secretary of CIRM, Centro Internazionale per la Ricerca Matematica Istituto Trentino di Cultura 38050 Povo (Trento)
tel: (+39)-0461-881628, *fax*: (+39)-0461-810629
e-mail: michelet@science.unitn.it
Web site: http://alpha.science.unitn.it/cirm/
[For details, see EMS Newsletter 36]

November 2000

12-18: DMV Seminar on Computational Mathematics in Chemical Engineering and Biotechnology, Mathematisches Institut Oberwolfach, Germany
Organisers: Peter Deuflhard (Berlin), Rupert Klein (Potsdam/Berlin) and Christof Schütte (Berlin)
Information: Prof. Dr Matthias Kreck, Universität Heidelberg, Mathematisches Institut, Im Neuenheimer Feld 288, 69120 Heidelberg, Germany

12-18: DMV Seminar on Characteristic Classes of Connections, Riemann-Roch Theorems, Analogies with *e*-Factors, Mathematisches Institut Oberwolfach, Germany
Organisers: Spencer Bloch (Chicago) and Helene Esnault (Essen)
Information: Prof. Dr Matthias Kreck, Universität Heidelberg, Mathematisches Institut, Im Neuenheimer Feld 288, 69120

Heidelberg, Germany

27-1 December: Foundations of Probability and Physics, Vaxjo, Sweden
[*For details, see EMS Newsletter 36; however the following information has changed.*]
Invited Speakers: S. Albeverio (Bonn, Germany), H. Atmanspacher (Freiburg, Germany), L. Ballentine (Burnaby, Canada), J. Bricmont (Belgium), A. Holevo (Moscow, Russia), S. Gudder (Denver, U.S.A.), T. Kolsrud (Stockholm, Sweden), P.
Lahti (Turku, Finland), H. Narnhofer (Wien, Austria), V. Serdobolskii
(Moscow, Russia), J. Summhammer (Wien, Austria), O. Viskov (Moscow, Russia), I. Volovich
(Moscow, Russia)
Information:
e-mail: send abstracts and application forms to Robert Nyqvist <robert.nyqvist@msi.vxu.se>
Web site: http://www.msi.vxu.se/aktuellt/konferenser.html

December 2000

1-3: 2000 WSES International Conference on Linear Algebra and Applications, Vravrona (suburb of Athens), Greece
Proceedings: CD-ROM Proceedings plus WSES Press Luxurious Books
Deadline: for submission of papers, 30 September
Notification: of acceptance/rejection, 30 October
Information:
e-mail: M.Makrynakis, math@worldses.org
Web site: http://www.worldses.org/wses/math/
1-3: 2000 WSES International Conference on Numerical Analysis and Applications, Vravrona, Greece
Details: as for above WSES Conference on Linear Algebra
1-3: 2000 WSES International Conference on Differential Equations: Theory and Applications, Vravrona, Greece
Details: as for above WSES Conference on Linear Algebra
1-3: 2000 WSES International Conference on Optimization and Applications, Vravrona, Greece
Details: as for above WSES Conference on Linear Algebra
1-3: 2000 WSES International Conference on Probability, Statistics, Operational Research, Vravrona, Greece
Details: as for above WSES Conference on Linear Algebra
1-3: 2000 WSES International Conference on Computer mathematics - Education, Vravrona, Greece
Details: as for above WSES Conference on Linear Algebra
1-3: 2000 WSES International Conference on Algorithms, Discrete Mathematics, Systems and Control, Vravrona, Greece
Details: as for above WSES Conference on Linear Algebra
1-3: 2000 WSES International Conference on Topology and Differential Geometry, Vravrona, Greece
Details: as for above WSES Conference on Linear Algebra

16-21: Applications of Singularity Theory to Geometry, Liverpool, UK
Information: contact Peter Giblin
e-mail: pjgiblin@liv.ac.uk

18-20: 5th International Conference on Mathematics in Signal Processing, Coventry, UK
[For details, see EMS Newsletter 34, but updated details are given below]
Theme: Recent developments such as non-linear/non-Gaussian signal processing, multi-rate signal processing, blind deconvolution/signal separation and broadband systems
Aim: To bring together mathematicians and engineers with a view to exploring recent developments and identifying fruitful avenues for further research
Main speakers: D. Broomhead (UK), J. Chambers (UK), S. McLaughlin (UK), P. Rayner (UK), P. Regalia (UK), R. Riedi (USA).
Organising committee: J. G. Mcwhirter (UK), O. R. Hinton (UK), M. D. MacLeod (UK), M. Sandler (UK), S. McLaughlin (UK), I. K. Proudler (UK)
Sponsors: The Institution of Electrical Engineers
Site: University of Warwick, UK
Information: contact Pamela Bye, The Institute of Mathematics and its Applications, Catherine Richards House, 16 Nelson Street, Southend-on-Sea, Essex SS1 1EF, England, *fa*x: (+44)-(0)1702-354111
e-mail: conferences@ima.org.ac.uk
Web-site: http://www.ima.org.uk

January 2001

5-10: Finite and Infinite Combinatorics, Budapest, Hungary
The special occasion for this meeting is to honour the 70th birthdays of Professors Vera T. Sós and András Hajnal.
Theme: graph theory, combinatorics, set theory
Topics: graph theory, extremal graphs, extremal families of subsets, combinatorial optimisation, combinatorial number theory, discrepancy theory, infinite combinatorics, set theory, random graphs
Main speakers: Noga Alon, Béla Bollobás, Jaroslav Nesetril, Saharon Shelah, Miklós Simonovits, Robert Tijdeman
Language: English
Organising committee: L. Lovász (Co-Chair), G. O. H. Katona (Co-Chair), E. Gyõri, P. Komjáth, I. Z. Ruzsa, G. Y. Katona (Secretary), Á. Kisvölcsey (Secretary).
Sponsors: János Bolyai Mathematical Society, Mathematical Institute of the Hungarian Academy of Sciences
Information:
e-mail: finf@renyi.hu
Web site: http://www.renyi.hu/~finf

8-18: ICMS Instructional Conference in Nonlinear Partial Differential Equations Edinburgh, UK
Theme: The aim is to instruct young mathematicians on modern methods for non-linear PDE theory. Talks will be presented at three levels. Around one-third of the total time will be spent presenting basic methods and applying them to prototypical examples which illustrate both their power and their limitations. This material will be suitable for students at the start of their postgraduate studies. Talks at the intermediate level will be devoted to refining these basic methods to cover more subtle and complex situations. The series of more advanced lectures will review recent developments and current research.
Topics: Modern methods for non-linear PDE theory, where the motivation comes from important new areas in applied science, including image processing, materials science, gas and fluid dynamics, and quantum mechanics of atoms and molecules. Although this set of topics has been selected for detailed analysis, the methods are universal in their scope.
Main speakers: A. Aftalion (France), L. Ambrosio (France), J. M. Ball (UK), Y. Brenier (France), G. R. Burton (UK), V. Caselles (Spain), M. J. Esteban (France), J. Kristensen (UK), C. Le Bris (France), A. Quarteroni (Switzerland), C. A. Stuart (Switzerland), V. Sverak (USA), J. F. Toland (UK), N. Touzi (France), N. S. Trudinger (Australia)
Organisers: J. M. Ball (Oxford), M. J. Esteban (Paris), J. Toland (Bath)
Sponsors: Engineering and Physical Sciences Research Council of the United Kingdom & EC Framework V
Site: Heriot-Watt University Campus, Edinburgh, UK
Grants: To citizens of the EU or associated states who are under 35 years of age (see Website for full details)
Information:
Mailing address & telephone: The International Centre for Mathematical Sciences, 14 India Street, Edinburgh EH3 6EZ, UK.
tel: (+44)-(0)131-220-1777;
fax (+44)-(0)131-220-1053
e-mail: icms@maths.ed.ac.uk
Web site: http://www.ma.hw.ac.uk/icms/current/npde/index.html

28–3 February: 2001 XXI International Seminar on Stability Problems for Stochastic Models, Eger, Hungary
Information:
e-mail: stabil@math.klte.hu or kolchin@mi.ras.ru
Web site: http://neumann.math.klte.hu/~stabil
http://bernoulli.mi.ras.ru
[For details, see EMS Newsletter 36]

February 2001

11-15: 2001 WSES International Conference on Fuzzy Sets & Fuzzy Systems (FSFS '01), Puerto De La Cruz, Tenerife, Canary Islands
Topics: Fuzzy logic, fuzzy sets, fuzzy topology and fuzzy functional analysis, fuzzy differential geometry, fuzzy differential equations, fuzzy algorithms, fuzzy geometry, fuzzy languages, fuzzy control, fuzzy signal processing, fuzzy subband image coding, VLSI fuzzy systems, approximate reasoning, fuzzy logic and possibility theory, fuzzy expert systems, fuzzy systems theory, connectionist systems, learning theory, pattern classification and clustering, hybrid and knowledge-based networks, artificial life, fuzzy systems in robotics, fuzzy systems for operational research, NN training using fuzzy logic, interaction between: neural networks – fuzzy logic – genetic algorithms, fuzzy systems and non-linear systems, fuzzy systems and chaos and fractals, modelling and simulation, hybrid intelligent systems, oceanic and vehicu-

lar engineering, man-machine systems, cybernetics and bio-cybernetics, relevant topics and applications, parallel and distributed systems, fuzzy systems and fuzzy engineering for: electric machines, power systems, Real-time systems, information systems, decision support systems, discrete event systems, communications, multimedia, educational software, software engineering, adaptive control, aerospace, special topics, others.
Language: English
Call for papers:
http://www.worldses.org/wses/fsfs
Scientific committee: Chairs: D. Fogel (USA), N. E. Mastorakis (Greece), E. Oja (Finland), F. Torrens (Spain), M. Makrynaki (Greece). Members: G. Antoniou (USA), H. Arabnia (USA), H.-G. Beyer (Germany), H.-H. Bothe (Denmark), A. L. L. Chye (Singapore), R. Ciegis (Lithuania), P. Corr (Northern Ireland), S. Dlay (UK), M. J. Er (Singapore), J. Fodor (Hungary), K. Hirota (Japan), D. Kalpic (Croatia), D.-S. Kang (Korea), N. Kasabov (New Zealand), R. Kruse (Germany), F. Kurfess (Canada), P Lorenz (France), V. Mladenov (Netherlands), A. Mohamed (Egypt), M. Mohammadian (Australia), F. Murtagh (Northern Ireland), F. Naghdy (Australia), M. Paprzycki (USA), H. Radev (Bulgaria), R. Rojas (Germany), D. Sanchez (Kluwer, USA), T. Whalen (USA), Y. Zhang (USA), H.-J. Zimmermann (Germany), J. Zurada (USA).
Sponsors: WSES, IIARD, IMACS
Deadline: for paper submission, 30 October
Information:
e-mail: fsfs@worldses.org
Web site: http://www.worldses.org/wses/fsfs

11-15: 2001 WSES International Conference on Evolutionary Computations (EC '01), Puerto De La Cruz, Tenerife, Canary Islands
Topics: Genetic algorithms (GA), mathematical foundations of GA, evolution strategies, genetic programming, evolutionary programming, classifier systems, cultural algorithms, simulated evolution, artificial life, learning theory, pattern classification and clustering, evolutionary computations (EC) in knowledge engineering, evolvable hardware, molecular computing, EC in control theory, EC in signal processing, EC for image coding, approximate reasoning, EC in robotics, EC for operational research, neural networks training using EC, interaction between: neural networks – fuzzy logic – evolutionary, computations, EC and non-linear systems theory, modeling and simulation, hybrid intelligent systems, EC for electric machines, EC for power systems, EC for real-time systems, EC for information systems, EC for decision support systems, EC for discrete event systems, EC for communications, EC for multimedia, EC for educational software, EC for software engineering, EC for adaptive control, EC for aerospace, oceanic and vehicular engineering, global optimisation, man-machine systems, cybernetics and bio-cybernetics, relevant topics and applications, parallel and distributed systems, special topics, others.
Language: English
Call for papers:
http://www.worldses.org/wses/ec
Scientific committee, Sponsors, Deadline: as for above WSES Conference on Fuzzy Sets
Information:
e-mail: ec@worldses.org
Web site: http://www.worldses.org/wses/ec

11-15: 2001 WSES International Conference on Neural Networks and Applications (NNA '01), Puerto De La Cruz, Tenerife, Canary Islands
Topics: Biological neural networks, artificial neural networks, mathematical foundations of neural networks, virtual environments, neural networks (NN) for signal processing, connectionist systems, learning theory, architectures and algorithms, neurodynamics and attractor networks, pattern classification and clustering, hybrid and knowledge-based networks, artificial life, implementation of (artificial) NN, VLSI techniques for NN implementation, neural control, NN for robotics, NN for optimisation, systems theory and operational research, NN in numerical analysis problems, NN training using fuzzy logic, NN training using evolutionary computations, interaction between: neural networks – fuzzy logic – genetic algorithms, NN and non-linear systems, NN and chaos and fractals, modeling and simulation, hybrid intelligent systems, NN for electric machines, NN for power systems, NN for real-time systems, NN in information systems, NN in decision support systems, NN and discrete event systems, NN in communications, NN for multimedia, NN for educational software, NN for software engineering, NN for adaptive control, NN for aerospace, oceanic and vehicular engineering, man-machine systems, cybernetics and bio-cybernetics, relevant topics and applications, parallel and distributed systems. special topics, others.
Language: English
Call for papers:
http://www.worldses.org/wses/nna
Scientific committee, Sponsors, Deadline: as for above WSES Conference on Fuzzy Sets
Information:
e-mail: nna@worldses.org
Web site: http://www.worldses.org/wses/nna

19-23: New Trends in Potential Theory and Applications, Bielefeld, Germany
Theme: This conference is meant to be a continuation of a series of international conferences on Potential Theory and related fields (as, e.g., the ones in Prague 1987, Amersfoort 1991, Kouty 1994, Hammamet 1998). The beginning of the new millennium seems appropriate to reflect on the current developments and to specify new promising directions of research in this classical area of mathematics. Emphasis will be given to various applications, in particular, in mathematical physics. We would also like to celebrate the 60th birthday of our colleague and friend, Wolfhard Hansen, on the afternoon of February 22.
Topics: differential geometry, Dirichlet forms, fractals, linear and non-linear PDE, Schrödinger operators, Markov processes, stochastic analysis.
Site: University of Bielefeld, Bielefeld, Germany.
Information: V. Metz, Fakultät für Mathematik, Universität Bielefeld, Postfach 10 01 31, D-33501 Bielefeld, Germany
e-mail: metz@mathematik.uni-bielefeld.de.
Web site: http://www.ams.org/mathcal/info/2001_feb19-23_bielefeld.html

25-1 March: NATO Advance Research Workshop: Application of Algebraic Geometry to Coding Theory, Physics, and Computation, Eilat, Israel
Aim: To present some of the best recent work in algebraic geometry with emphasis on possible relations with and applications to mathematical physics, coding theory, industrial and computational aspects. Proceedings will be published with the contribution of NATO. Scientists from all NATO countries, Middle East countries and the former Soviet Union are invited to participate.
Sponsors: NATO Scientific Affairs Division, Emmy Noether Research Institute of Mathematics in Bar-Ilan University
NATO Organising committee: C. Ciliberto (Roma Tor Vergata), F. Hirzebruch (MPI, Bonn), R. Miranda (Colorado State Univ.), M. Teicher (Bar-Ilan Univ.).
Local organisation: B. Kunyavskii (Bar-Ilan Univ.).
The following people are planning to participate: E. Arbarello (SNS, Pisa), V. Batyrev (Tübingen), A. Beauville (Paris), J. Bernstein (Tel Aviv), F. Catanese (Göttingen), A. Conte (Turin), R. Donagi (Philadelphia), G. van der Geer (Amsterdam), P. Griffiths (Princeton), V. Iskovskih (Moscow), V. Kaminski (Ramat Gan), M. Kontsevich (Bures-sur-Yvette), V. Kulikov (Moscow), A. Libgober (Chicago), V. Lin (Haifa), R. Livné (Jerusalem), Y. Miyaoka (Kyoto), N. Mok (Hong Kong), D. Mumford (Providence), T. Peternell (Bayreuth), M. Salvetti (Pisa), R. Schoof (Roma Tor Vergata), E. Sernesi (Roma III), Y. T. Siu (Cambridge, USA).
Information:
e-mail: NATO@macs.biu.ac.il
Web site: http://www.mat.uniroma2.it/~cilibert/workshop.html

March 2001

18-24: Workshop on Geometric Analysis and Index Theory, Trieste, Italy
This conference is organised by the European Research Training Network 'Geometric Analysis', in collaboration with the International Centre for Theoretical Physics in Trieste, the Università di Ancona and the Institut de Mathematiques de Luminy in Marseille.
The workshop is dedicated in memory of Prof. Enzo Martinelli
Organisation: ICTP, Trieste, in collaboration with the University of Ancona, Italia, and Institut de Mathématiques , Luminy, Marseille
Support: European Research Training Network 'Geometric Analysis' and International Centre for Theoretical Physics, Trieste.
Organising Committee: Jean-Paul Brasselet (jpb@iml.univ-mrs.fr), G. Landi (landi@math-sun1.univ.trieste.it), N. Teleman (teleman@popcsi.unian.it).
Scientific and Advisory Committee: A. Connes (IHES), N. Teleman (Ancona), J.-M. Bismut (Orsay), J. Bruening (Berlin), B. W. Schulze (Potsdam), C. Baer (Hamburg), J. Bellissard (Toulouse), A. Legrand (Toulouse), J. P. Brasselet (Marseille), P. Almeida (Lisbon), R. Nest (Copenhagen), A. Valette (Neuchatel), T. Kappeller (Zürich), B. Bojarski (Warsaw), D. Andrica (Cluj-Napoca), G. Landi (Trieste).

26-29: Workshop on Quantum Field Theory,

Noncommutative Geometry and Quantum Probability, Trieste, Italy
The main subjects are non-commutative structures (non-commutative geometry and its applications to physics, notably quantum field theory, and quantum probability)
Organisation: International School for Advanced Studies, Trieste, Italy, in collaboration with the International Centre for Theoretical Physics.
Supported by: Regione Friuli-Venezia Giulia, International School for Advanced Studies, University of Trieste, European RTN 'Geometric Analysis'
International Advisory Committee: A. Connes (IHES Paris), B. Dubrovin (SISSA), Yu. Manin (MPI Bonn)
Scientific Committee: U. Bruzzo, (SISSA), C. Cecchini (Udine), L. Dabrowski (SISSA), A. O. Kuku (Trieste), G. Landi (Trieste), N. Teleman (Ancona)
Organising Committee: U. Bruzzo, L. Dabrowski, G. Landi
Each of the following scientists will deliver two lectures:
L. Accardi (Università Roma Tor Vergata and Centro Vito Volterra), A. Connes (IHES Paris), D. Kreimer (IHES Paris), S. L. Woronowicz (Warsaw University)
Moreover some additional 12 one-hour lectures will be delivered.
Information about the Workshop is available from the web page http://www.sissa.it/\~{} bruzzo/ncg2001 /ncg2001.html

27-29: Modelling permeable Rocks, Cambridge, UK
Topics: Faults and fractures, modelling techniques, quantification and modelling at various scales, process modelling/pattern formation, quantitative techniques for data collection, model validation, uncertainty modelling.
Main Speakers: G. De Marsily (France), D. Sanderson (UK), C. White (USA).
Organising committee: A. H. Muggeridge (UK), L. M. Abriola (USA), P. Burgess (UK), A. Galli (France), J. Gomez-Hernandez (Spain) , L. Holden (Norway), A. D. W. Jones (UK), P.R. King (UK), C. Mijnssen (Netherlands), G. Pickup (UK), C. Ravenne (France), J. J. Walsh (UK).
Sponsors: BP Exploration Operating Company Limited, Elf Exploration UK plc and Schlumberger Cambridge Research Limited.
Site: Churchill College, Cambridge, UK
Deadlines: 29 September for abstracts
Information: Conference Officer: Pamela Bye
e-mail: conferences@ima.org.uk
Web site: http://www.ima.org.uk

April 2001

9-11 : Modelling in Industrial Maintenance and Reliability, Greater Manchester, UK
Aim: To provide a forum for discussion of traditional and innovative modelling approaches to improve the performance of plant, products and processes.
Topics: Maintenance (inspection, preventive maintenance, replacement, spares), Condition monitoring (methodology, decision support), Reliability (design improvement, reliability and risk analysis, reliability-centred-maintenance), Warranty modelling (methodology, human factors).
Organising Committee: P. Scarf (UK), W. Wang (UK), L. Thomas (UK), R. Dekker (Netherlands).
Site: University of Salford, Greater Manchester, UK.
Deadlines: 31 October 2000 for abstracts
Information: Conference Officer: Pamela Bye
e-mail: conferences@ima.org.uk
Web site: http://www.ima.org.uk

May 2001

6-13: SPT2001 – Symmetry and Perturbation Theory, Cala Gonone (Sardinia, Italy)
Third of a series after SPT96 (Torino) and SPT98 (Roma)
Theme: The interactions between symmetry and perturbation theory
Language: English
Scientific committee: D. Bambusi (Milano), P. Chossat (Nice), G. Cicogna (Pisa), A. Degasperis (Roma), G. Gaeta (Roma), J. Lamb (London), G. Marmo (Napoli), M. Roberts (Warwick), G. Sartori (Padova), F. Verhulst (Utrecht), S. Walcher (Munich), B. Zhilinskii (Dunkerque)
Organising committee: G. Gaeta, D. Bambusi
Proceedings: to be published
Site: Hotel Villaggio Palmassera, Cala Gonone (a small village on the eastern coast of Sardinia), special full board rate for participants but you can stay elsewhere if you wish.
Grants: reduced registration fee for students and participants from developing countries
Deadlines: No deadline, but limitations on the number of participants (pre-registration to start in autumn)
Information:
e-mail: spttre@tiscalinet.it
Web site: http://web.tiscalinet.it/SPT2001/spt.html

28-1 June: Harmonic Morphisms and Harmonic Maps, Luminy, France
Site: Centre International de Rencontres Mathématiques, Luminy
Information: Contact M. Ville
e-mail: ville@math.poytechnique.fr

28-1 June: Marmonic morphisms and maps, Marseille, France
Language: English
Scientific committee: James Eells (Cambridge and Warwick), Luc Lemaire (Brussels), John C. Wood (Leeds).
Organising committee: Eric Loubeau (Brest), Stefano Montaldo (Cagliari), Marina Ville (Paris).
e-mail: ville@math.polytechnique.fr
website: http://beltrami.sc.unica.it/harmor/

June 2001

6-10: 3d International Conference on Large-Scale Scientific Computations, Sozopol, Bulgaria
Information:
e-mail: scicom01@parallel.bas.bg
Web site: http://copern.bas.bg/Conferences/SciCom01.html

8-10: 2001 Belgian Mathematical Society and Deutsche Mathematiker Vereinigung Meeting, University of Liège, Belgium
Information:
Web site: http://math-www.uni-paderborn.de/Liege2001/

19-22: Computational Intelligence, Methods and Applications (CIMA 2001), Bangor, UK
Theme: advanced computing
Topics: CIMA 2001 features 4 symposia: Fuzzy logic and applications (FLA 2001), Advances in intelligent data analysis (AIDA 2001), Advanced computing in biomedicine (ACBM 2001), Advanced computing in financial markets (ACFM 2001)
Main speakers: Jim Bezdek (USA), Andrew Webb (UK)
Language: English
Call for papers: maximum 7 pages. Please include contact details and a short c.v. paragraph. Electronic submissions are encouraged: operating@icsc.ab.ca. Submissions are accepted by fax (+1-780-352-1913) or mail (2 copies) at ICSC International Computer Science Conventions, 5101C-50 Street, Wetaskiwin, AB, T9A 1K1, Canada
Programme committee: General chair Ludmila Kuncheva (UK), Co-chair Tim Porter (UK);
Symposia chairs: FLA 2001, Vilem Novak and Irina Perfilieva (Czech Republic); AIDA 2001, Mayer Aladjem (Israel), ACBM 2001, Friedrich Steimann (Germany), ACFM 2001, Christian Haefke (USA).
Organising committee: Jeanny Ryffel, ICSC, (Canada), http://www.iscs.ab.ca; Karen Tallents, University of Wales, Bangor (UK)
Sponsors: University of Wales, Bangor; British Computer Society (more are expected)
Proceedings: all accepted papers will be included in the conference proceedings; some papers will be selected for journal publication
Site: University of Wales, Bangor
Deadlines: for submissions, 31 October 2000; notification of acceptance, 31 December 2000; final paper/registration, 15 February 2001
Information:
e-mail: planning@icsc.ab.ca; operating@icsc.ab.ca; l.i.kuncheva@bangor.ac.uk
Web site: http://www.icsc.ab.ca/cima2001.htm

July 2001

1-6: Eighteenth British Combinatorial Conference, Brighton, UK
Information:
e-mail: bcc2001@susx.ac.uk
Web sites:
http://www.maths.susx.ac.uk/Staff/JWPH/
http://hnadel.maps.susx.ac.uk/TAGG/Confs/BCC/index.html
[For details, see EMS Newsletter 36]

August 2001

5-18: Groups St Andrews 2001, Oxford, UK
Information: Groups St Andrews 2001, Mathematical Institute, North Haugh, St Andrews, Fife KY16 9SS, Scotland
e-mail: gps2001@mcs.st-and.ac.uk
Web site: http://www.bath.ac.uk/~masgcs/gps01/
[For details, see EMS Newsletter 36]

27-31: Equadiff 10, Czechoslovak International Conference on Differential Equations and Their Applications, Prague, Czech Republic
Information:
Web site: www.math.cas.cz/~equadiff/

Recent books

edited by Ivan Netuka and Vladimír Souček

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

J. Albree, D. C. Arney and V. F. Rickey, *A Station Favorable to the Pursuits of Science: Primary Materials in the History of Mathematics at the United States Military Academy,* *History of Mathematics* **18**, *American Mathematical Society, London Mathematical Society, Providence, 2000, 272 pp., US$59, ISBN 0-8218-2059-1*
This book is devoted to the history of the U. S. Military Academy at West Point, the first national military school, founded on 16 March 1802. The first part of the first chapter discusses the history of the department of mathematics, and the second part describes the formation and development of the West Point's Library during the nineteenth century. The third part describes the teaching of mathematics and mechanics at West Point in the nineteenth century; a short section describes the development of the curriculum and the leadership by such people as Sylvanus Thayer, Charles Davies and Albert Church. The fourth part describes the history of the foundation of the *Catalog of books* at West Point, and the fifth part explains the catalogue's organisation. The last part contains some important references on the history and development of West Point.

The second chapter – the major part of this book – reveals the rich collection of mathematical works located at West Point. The printed catalogue of the West Point collection contains more than 1300 works published between 1496 (Regiomontanus, *Epytoma Joanis de mote regio in almagestii ptolomei*) and 1917 (Darboux, *Principes de géométrie analytique*). The collection shows the strong European influence on the early Academy and includes numerous textbooks written at West Point. Significant contributions were made in algebra, geometry, calculus and descriptive geometry.
At the end are four appendices. The first is the *Catalog of 1803*, the catalogue of books, maps and charts that belong to the Military Academy at West Point. The second contains thirty photographs of attractive and interesting title pages, frontispieces and other visual features. Appendices 3 and 4 includes the portraits and frontispieces of the books in this catalogue.

This book provides an important source for a general audience, as well as for those looking for more scholarly information. Both expert and general reader will find something of interest. (mnem)

C. D. Aliprantis and K. C. Border, *Infinite Dimensional Analysis,* *Springer, Berlin, 1999, 672 pp., DM 119, ISBN 3-540-65854-8*

This is the second, completely revised and enlarged (paperback) edition. The original motivation for the authors was "to present and organize the analytic foundations underlying modern economics and finance", including "the material which appears only in esoteric research monographs that are designed for specialists".

Because of the non-homogeneity and a large amount of the material of this important book, a detailed description follows. The necessary material on set theory (18 pp.), topology (50 pp.), metric spaces (54 pp.) and set systems and measurable functions (38 pp.) is introduced. This is followed by material on topological vector spaces (76 pp.), normed spaces (26 pp.), Riesz spaces (38 pp.) and Banach lattices (30 pp.), and by charges and measures (34 pp.), measures and topology (30 pp.), integrals (32 pp.), L_p-spaces (28 pp.), the Riesz Representation theorems (18 pp.) and probability measures on metric spaces (20 pp.). Other topics include spaces of sequences (30 pp.), correspondences (34 pp.), measurable correspondences (30 pp.), Markov transitions (34 pp.) and ergodicity (13 pp.). The list of references has 307 items.

Most of the theorems are proved (including Tychonoff's theorem, the Choquet capacitability theorem, the Bishop-Phelps Theorem, the Lyapunov convexity theorem, the Riesz representation theorem and the Michael and Kuratowski-Ryll-Nardzewski selection theorems), but some are stated (with a precise reference) without proof (the Eberlein-Šmulian and James theorems, the Stone-Weierstrass theorem, the Radon-Nikodym theorem and also the Knaster-Kuratowski-Mazurkiewicz theorem, from which fixed-point theorems are deduced).

The book is well organised and written in a lucid style. It is a very good 'guide' for any non-specialist interested in the topics included. The authors have managed "to write the book so that it will be useful as both a reference and a textbook". (lz)

H. Amann and J. Escher, *Analysis I,* *Grundstudium Mathematik, Birkhäuser, Basel, 1998, 445 pp., ISBN 3-7643-5974-9 and 3-7643-5976-5*
The book under review is the second volume of a course of analysis. In about four hundred pages it brings together a large portion of material in a very condensed form. The book contains many exercises and the authors express their hope that the book will be helpful to teachers leading seminars.

The present volume contains three chapters devoted to integration, to functions of several variables and to the curvilinear integral. This could give the wrong impression that it is a calculus book, but all things are done in considerable depth and with high precision. To give an example, the chapter on integration contains among other things sections on Fourier series and the gamma function; the last one contains the Gauss formula, the product formula for $1/\Gamma$, the Stirling formula and the formula relating the gamma and beta functions. The authors broadly use modern techniques and do not hesitate to include many things that traditionally form part of advanced courses: for example, the last chapter contains the Goursat lemma and the residuum theorem.

The book is a good reference book and a useful companion for teachers; from students it will demand intensive but rewarding work. It is highly recommended book for mathematically orientated university libraries. (jve)

G. A. Anastassiou and S. G. Gal, *Approximation Theory. Moduli of Continuity and Global Smoothness Preservation,* *Birkhäuser, Boston, 2000, 525 pp., DM 188, ISBN 0-8176-4151-3 and 3-7643-4153-3*
This monograph, in two parts, is an intensive and comprehensive study of the computational aspects of the moduli of smoothness and the global smoothness preservation property.

In Part I, the authors study the computational aspect of almost all moduli of continuity over wide classes of functions, exploiting some of their convexity properties. Numerous applications of approximation theory are presented and exact values of errors in explicit forms are given.

In Part II, the authors study and examine the global smoothness preservation property (GSPP) for almost all known linear approximation operators in approximation theory, including trigonometric operators and algebraic interpolation operators of Lagrange, Hermite-Féjer and Shepard type, also operators of stochastic type, convolution type, wavelets type integral operators and singular integral operators, etc. A great variety of applications of GSPP to approximation theory, functional analysis and computer-aided geometric design is provided.

This monograph contains the research of both authors over the past ten years in these subjects. It also references most of the works of other main researches in these areas. It is well worth reading, and can be strongly recommended to researchers and graduate students involved in approximation theory, applied mathematics, numerical analysis and engineering disciplines. (kn)

G. E. Andrews, R. Askey and R. Roy, *Special Functions*, *Encyclopedia of Mathematics and its Applications* **71**, *Cambridge University Press, 1999, 664 pp., £55, ISBN 0-521-62321-9*
Books in the *Encyclopedia of Mathematics and its Applications* series are designed as encyclopedic treatments with an emphasis on a wide range of applications of the chosen topic. Special functions form a typical example of a subject with a long and inter-

esting history, together with a broad and deep modern development. The field is too large now, so a selection has had to be made. The book concentrates on hypergeometric functions and the associated hypergeometric series, including their various generalisations.

In this book, modern tools of representation theory are not used. The book starts with a description of classical gamma and beta functions, including their finite fields and p-adic analogues. Later, the Selberg multi-dimensional generalisation of the beta integral and its finite fields versions are presented. The book also contains q-extensions of gamma function and beta integrals. Throughout, the theory developed is used in applications to other parts of mathematics (such as combinatorics and spherical harmonics) and there are a lot of beautiful and useful explicit formulas. Each chapter ends with a series of exercises. (vs)

M.-C. Arnaud, ***Le "Closing Lemma" en Topologie C1****, Mémoires de la Société Mathématique de France* ***74****, Société Mathématique de France, Paris, 1998, 120 pp., ISBN 2-85629-071-X*
The whole booklet (115 pages) concentrates on one special problem and its variants. Suppose that f is a diffeomorphism of a manifold M and suppose that $x \in M$ is a point which is an accumulation point of its orbit. Is it possible to find a diffeomorphism g close to f in the C^j topology such that x is a periodic point of g? The answer for $j = 0$ is yes, and the proof is simple; nothing is known for $j \geq 2$. The case $j = 1$ is the subject of the book. The positive answer was proved first by Pugh and Robinson. This book brings a simpler proof and more precise results, and also studies new versions of the problem, such as the case of symplectic vector fields and the ergodic version of the orbit closing lemma. (vs)

V. I. Arnold, G.-M. Greuel and J. H. M. Steenbrink (eds.), ***Singularities,*** *Progress in Mathematics* ***162****, Birkhäuser, Basel, 1998, 458 pp., DM 148, ISBN 3-7643-5913-7*
This volume contains papers on singularity theory and its applications, written by participants of a conference organised at the Mathematical Institute in Oberwolfach in July 1996 in honour of E. Brieskorn on the occasion of his 60th birthday. Some of these papers are extended version of talks presented at the conference.

At the beginning of the book, there is a chapter written by G. M Greuel presenting an overview of results of E. Brieskorn and his contribution to the theory of singularities. The following twenty-one contributions are divided according to some aspects of singularity theory into four parts: Classification and invariants, Deformation theory, Resolution, and Applications (also containing various different topics).

The first part includes a contribution by W. Huang and J. Lipman (Differential invariants of embeddings of manifolds in complex spaces). In this paper a reduced complex space with an r-dimensional connected submanifold $i: W \to V$ is considered, and its Segre classes are defined. These Segre classes are up to sign C^1-invariants of the pair (V, W). Another differential invariant is the multiplicity of W in V.

In the second part (Deformation theory), there is a paper of E. Shustin: Equiclassical deformation of plane algebraic curves where sufficient conditions for the existence of a deformation of a plane irreducible curve into a curve of the same degree, genus and class, having only nodes and cusps are given. (jbu)

B. Artmann, ***Euclid – The Creation of Mathematics****, Springer, New York, 1999, 343 pp., DM 98, ISBN 0-387-98423-2*
As the title indicates, the main object of this book is Euclid's *Elements*, the book at the core of mathematical education and the heart of western culture for two thousand years.

The book is divided into 31 chapters. The first two, General historical remarks and The contents of the *Elements*, have an introductory character. The following thirteen chapters contain a general description of the contents and structure of all thirteen books of Euclid's *Elements*. The remaining sixteen chapters, with common title 'The Origin of Mathematics', present some important and interesting topics, general remarks about typical mathematical procedures, subjects of particular philosophical and historical interest, and others (Pythagoras of Samos, squaring the circle, problems and theories, the birth of rigour, incommensurability and irrationality, etc.). In the author's opinion, the *Elements* are read, interpreted, and commented upon from the point of view of modern mathematics.

At the end of the book there are 'Notes' where we find hints for further reading, the bibliography and the index. The book has 116 illustrations. This book can be warmly recommended for students, teachers and lovers of mathematics. A solid background in high school mathematics is necessary. (jbe)

Y. Benyamini and J. Lindenstrauss, ***Geometric Nonlinear Functional Analysis 1****, Colloquium Publications* ***48****, American Mathematical Society, Providence, 2000, 488 pp., US$65, ISBN 0-8218-0835-4*
This important monograph, written by leading specialists in the field, is devoted mainly to the study of *general uniformly continuous and general Lipschitz mappings* between Banach spaces. The authors treat neither 'infinite-dimensional topology' (which considers general homeomorphisms) nor 'classical non-linear functional analysis' (non-linear differential equations, degree theory, bifurcation results, etc.) which deal mostly with more special nonlinear mappings. This study is naturally connected with the theory of classification of Banach spaces with respect to uniform homeomorphisms and bi-Lipschitz maps.

Besides this theory, the following topics are covered in detail: retractions, extensions, selections, approximations and fixed points of uniformly continuous and Lipschitz mappings; Radon-Nikodým property of Banach spaces and its connection to Gâteaux differentiability of Lipschitz mappings (including Christensen's Haar null sets and Gaussian and Aronszajn null sets); differentiability of convex functions on separable spaces; oscillation of uniformly continuous functions on unit spheres of subspaces (related to Dvoretzky's theorem); small perturbations of isometries (e.g. Hyers-Ulam problem).

The notes and remarks that follow each of the seventeen chapters contain interesting historical notes and information about a vast amount of related results (with references). The bibliography contains 596 items. Challenging open problems are described and explained. The vast majority of the material appears for the first time in book form, and many quite recent deep results are proved. A basic knowledge of real and functional analysis is necessary, but more specialised topics are explained in appendices at the end. Volume 2 of this useful book will treat, for example, Fréchet differentiability of Lipschitz mappings and the analytic Radon-Nikodym property of Banach spaces. (lz)

B. Bertram, C. Constanda and A. Struthers (eds.), ***Integral Methods in Science and Engineering,*** *Research Notes in Mathematics* ***418****, Chapman & Hall/CRC, Boca Raton, 2000, 360 pp., £58, ISBN 1-58488-146-1*
This text is based on lectures presented at the Fifth International Conference on Integral Methods in Science and Engineering held at Michigan Technological University, Houghton, Michigan, 1998. It contains three invited papers and 57 contributed papers – a collection of papers that address the solution of mathematical problems arising in various branches of physics by integral methods in conjuction with various approximation schemes. Written by acknowledged experts, these peer-reviewed papers offer valuable insight into recent developments in both theory and applications.

Topics and applications include: scattering processes, micromechanics, fluid mechanics, elasticity theory, hydrodynamics, plates and shells, acoustics, population genetics, optimal control, combustion problems, fracture theory, inverse problems, non-linear problems, boundary value problems at resonance, variational methods, boundary element methods, potential methods, wavelet expansions, integral equations and reaction-diffusion system.

The book provides inspiration for further research and can be strongly recommended to applied mathematicians, engineers and physicists. (kn)

L.J. Billera, A. Björner, C. Greene, R. E. Simion and R. P. Stanley (eds.), ***New Perspectives in Algebraic Combinatorics,*** *Mathematical Sciences Research Institute Publications* ***38****, Cambridge University Press, 1999, 345 pp., £32.50, ISBN 0-521-77087-4*

Algebraic combinatorics involves the use of techniques from algebra, topology and geometry in the solution of combinatorial problems, or the use of combinatorial methods to attack problems in these areas.

During 1996-97 the Mathematical Sciences Research Institute held a full academic year programme on combinatorics, with special emphasis on the connections with other branches of mathematics, such as algebraic geometry, topology, commutative algebra, representation theory and convex geometry.

This book represents work done or presented at seminars during the programme. It contains contributions on matroid bundles, combinatorial representation theory, lattice points in polyhedra, bilinear forms, combinatorial differential topology and geometry, Macdonald polynomials and geometry, enumeration of matchings, the generalised Baues problem, and Littlewood-Richardson semigroups. (mloe)

D. van Dalen, *Mystic, Geometer, and Intuitionist. The Life of L.E.J. Brouwer, Vol. 1: The Dawning Revolution,* *Clarendon Press, Oxford, 1999, 440 pp., £75, ISBN 0-19-850297-4*

'Child and student' is the title of the first chapter of the biography and the tenth chapter is named 'The breakthrough'. Roughly speaking, the period 1920-1930 is treated, and concerns of Brouwer's linguistic and philosophical activities connected with the development of his own intuitionism. Generally, great activity, including moral positions on anti-nationalism and passion for justice, were characteristic for L. E. J. Brouwer.

Mysticism, topology, intuitionism and philosophy of language are treated as major themes of Brouwer's life, while topics such as a quarrel with Lebesgue or a rejection of the Denjoy policy are treated as smaller ones. The reader can find intelligible and adequate explanations of a nature of mathematical problems and a documentation of the foundational activity in mathematics in the first third of the twentieth century, represented, together with Brouwer, by H. Weyl. The book concludes with a Bibliography of Brouwer's writings and the Contents of Volume 2 are included. The book is comprehensive and interesting. (jml)

H. Davenport, *The Higher Arithmetic,* *Cambridge University Press, 1999, 241 pp., £16.95, ISBN 0-521-63269-2 and 0-521-63446-6*

This is the seventh edition of the well-known and charming introduction to number theory. In a comparatively small number of pages, the text contains a surprisingly wide spectrum of topics. The book does not assume any training in number theory, so the book can serve for undergraduate courses. Despite this, the reader can find a formulation of remarkably deep results (e.g., on elliptic curves). The topics discussed are treated in a transparent way, and each chapter ends with notes giving additional important information on the subject. Since the book is well known and has proved itself since its first appearance in 1952, it can be recommended both for independent study and as a reference text for a general mathematical audience. (šp)

P. Deligne, P. Etingof, D. S. Freed, L. C. Jeffrey, D. Kazhdan, J. W. Morgan, D. R. Morrison and E. Witten, *Quantum Fields and Strings: A Course for Mathematicians, 2 vols.,* *American Mathematical Society, Providence, 1999, 723 and 725 pp., ISBN 0-8218-1987-9 and 0-8218-1988-7*

This book in two volumes consists of written notes from a programme in quantum field theory organised by the Institute for Advanced Study in Princeton in 1996-1997, taken either from the speakers themselves or by mathematicians in the audience. It is a concise introduction to the quantum field theory and perturbative string theory, with as much emphasis on a mathematically satisfying exposition and clarity as possible.

The topics contained include: notes on supersymmetry; classical field theory; supersolutions; introduction to quantum field theory; perturbative quantum field theory; index of Dirac operators; renormalisation groups; dimensional regularisation; conformal field theory; string theory; super space descriptions of super gravity; two-dimensional conformal field theory and string theory; Kaluza-Klein compactifications, supersymmetry and Calabi-Yau spaces; dynamics of quantum field theory; and the dynamics of $N = 1$ supersymmetric field theories in four dimensions.

This book will be helpful to all mathematicians and mathematical physicists who wish to learn about the beautiful subject of quantum field theory. It is, however, not a textbook and assumes some preliminary knowledge of the topics covered. (mm)

J. D. Dixon, M. P. F. du Sautoy, A. Mann and D. Segal, *Analytic Pro-p Groups,* *Cambridge Studies in Advanced Mathematics, Cambridge University Press, 1999, 368 pp.* £37.50, ISBN 0-521-65011-9

This book presents a fairly straightforward account of the theory of p-adic analytic groups. The central topic of the book is how the group-theoretic properties of a pro-p group reflect its status as a p-adic analytic group.

The book is divided into three parts. Readers seeking a simple introduction to pro-p groups and to p-adic analytic groups will find this in Parts I and II.

The first chapter of Part III (Chapter 10) gives an account of the theory of pro-p groups of finite coclass; the *coclass* of a group G of order p^n is $n - c$, where c is the nilpotency class of G; this theory is central to the classification of finite pro-p-groups. The next two chapters discuss the dimension subgroup series in finitely generated pro-p groups and its associated graded Lie algebra. In Chapter 13, sketches of the beginnings of a theory of analytic groups over pro-p rings other than the p-adic integers are given, together with a proof of the following theorem of £ubotzky and Shaler (1994): Every R-perfect group satisfies the Golod-Shafarevich inequality.

This book can be highly recommended to all mathematicians working in group theory, p-adic analysis and Lie groups and algebras. (tk)

M. Fey and R. Jeltsch, *Hyperbolic Problems: Theory, Numerics, Applications, I, II,* *International Series of Numerical Mathematics* ***129/130****, Birkhäuser, Basel, 1999, 502 and 503 pp., ISBN 3-7643-6123-9, 0-8176-6123-9, 3-7643-6087-9 and 0-8176-6087-9*

This book is the Proceedings of the Seventh International Conference on Hyperbolic Problems, held in Zürich in February 1998. It contains, in two volumes, more than one hundred papers presented at this conference.

The majority of the papers are concerned with non-linear hyperbolic equations of conservation laws. They can be divided into three groups. A large number of papers are devoted to mathematical aspects of conservation laws such as existence, uniqueness, asymptotic behaviour, large-time stability or instability of waves and structures, various limits of the solutions, the Riemann problem, and so on. Approximately the same number of contributions are concerned with numerical analysis – for example, stability and convergence of numerical schemes, schemes with special properties such as shock capturing, interface fitting, and high-order approximations to multi-dimensional systems. The third group of articles is orientated towards a wide range of applications, such as non-linear waves in solids, computational fluid dynamics, combustion, relativistic astrophysical problems, multiphase phenomena and geometrical optics.

The Proceedings give an excellent overview of the contemporary state of art in the area of hyperbolic problems. It contains a large amount of material, and will be of interest to researchers and students of applied mathematics, scientists and engineers engaged in applied mathematics and scientific computing. (mf)

J. Fresnel, *Espaces quadratiques, euclidiens, hermitiens,* *Actualités scientifiques et industrielles* ***1445****, Hermann, Paris, 1999, 315 pp., FF 160, ISBN 2-7056-1445-1*

The text of this book is divided into three parts. In the first part, the author gives a detailed introduction to vector spaces endowed with a bilinear form. It contains many results about the orthogonal group (e.g., theorems about its centre, generators and special subgroups). The second part is devoted to real inner product spaces. From its very beginning, the properties of associated orthogonal groups are discussed from many points of view. The third part is treated analogously to the second, but can be viewed as a self-contained introductory text concerning similar questions in the case where the basic field is the field of complex numbers. The author collects together a lot of material, including about 150 well-arranged exercises. The quoted literature has forty items, the majority in French; four items are other books of J.

Fresnel. The book may serve as a very attractive text, not only for students but also for non-specialists. (lbe)

W. Haussmann, K. Jetter and M. Reimer (eds.), ***Advances in Multivariate Approximation,*** *Mathematical Research* ***107,*** *Wiley-VCH, Berlin, 1999, 334 pp., DM 198, ISBN 3-527-40236-5*

This volume is based on lectures presented at the third international conference on multivariate approximation held at Haus Bommerholz, the guest-house of the University of Dortmund, from 27 September to 2 October 1998. It contains 22 articles, the list of conference participants and the scientific programme.

The contributions cover the following topics: Interpolation and approximation on spheres and balls (problems of approximation theory in discrete geometry; spherical polynomial approximations; spherical designs; hyperinterpolation on the sphere; cubature formulas on spheres), Harmonic functions (dense vector spaces of universal harmonic functions; best one-sided L^1-approximation by harmonic and subharmonic functions), Wavelets and splines (multiscale modelling from geopotential data; family of orthogonal wavelets on the quincunx grid; bivariate spline spaces; interpolation by cubic C^1-splines on Clough-Tocher splits; box spline orthogonal projection), Periodic and monotone approximation (monotonic behaviour of Bernstein operators; optimal periodic interpolation in multivariate periodic Hilbert spaces; error estimates for periodic interpolation of functions from Besov spaces), Fekete points (on the asymptotics of points which maximise determinants of the form $\det[g(|x_i - x_j|)]$), Numerical stability of fast Fourier transforms, Best one-sided L^1-approximation by blending functions, Simultaneous approximation in the Dirichlet space, Besov regularity for the Stokes problem, Average case analysis of numerical integration, Weighted K-functionals and moduli of smoothness.

The reviewer is convinced that this book will form an inspiration for further research and so help to establish the links between the various communities working on multivariate approximation. (kn)

J. L. Heilbron: ***Geometry Civilized,*** *Clarendon Press, Oxford, 2000, 309 pp., £25, ISBN 0-19-850078-5 and 0-19-850690-2*

This wonderful book is a combination of mathematics, its history, and the history of civilisation and culture (architecture, painting, measuring, astronomy, etc.). Besides an introduction to plane geometry and trigonometry, it contains some fascinating historical description.

This book helps us to understand the reason why certain geometrical problems were studied and the way they were studied. A lot of effort is spent on increasing our understanding of geometry. The author carefully explains solutions of some geometrical problems, describes the beauty and precision of geometrical methods and proofs (Pythagoras' theorem, the construction of perpendiculars, measuring and constructing angles, constructions for triangles, facts about the square of the hypotenuse, regular polygons – constructions of polygons, tangent, bisector, chords, ovals, etc.).

The history presented here is not only restricted to the European tradition, but some examples come from the other cultures (in particular, Chinese and Indian). Anyone thinking that Euclidean geometry is something for our great-grandparents would be surprised. The book explains Euclidean geometry in a most accessible way, and is beautifully illustrated. There are diagrams on nearly each page, illustrations from older books, photographs and eight colour plates. (mnem)

N. J. Hitchin, G. B. Segal and R. S. Ward, ***Integrable Systems: Twistors, Loop Groups, and Riemann Surfaces,*** *Oxford Graduate Texts in Mathematics* ***4****, Clarendon Press, Oxford, 1999, 136 pp., £25, ISBN 0-19-850421-7*

In September 1997 there was an instructional conference on integrable systems in Oxford. This book contains lecture series prepared by three experts in the field. A short introduction by N. Hitchin (10 pages) nicely reviews the main features of integrable systems and the principal tools used in their study. The first part of the book (N. Hitchin, 42 pages) describes the importance of algebraic geometry for integrable systems. Starting with a very brief introduction to Riemann surfaces, line bundles, cohomology groups with values in sheaves, vector bundles, and Jacobians of Riemann surfaces, these tools are then used in a study of Lax pairs for matrix-valued polynomials and the corresponding completely integrable Hamiltonian systems. The second part (G. Segal, 68 pages) treats integrable systems using methods of inverse-scattering theory. The most important tools used here are loop groups, restricted Grassmannians and the Birkhoff theorem, and the main examples discussed are Korteweg-de Vries and non-linear Schrödinger equations; relations to the methods of algebraic geometry used in the Hitchin paper are explained here. The last part (R. Ward, 14 pages) is a short summary of the twistor description of self-dual Yang-Mills equations and their various dimensional reductions (which include most of the known integrable systems).

The subject of the book is fascinating and written versions of the lecture series are nicely presented and preserve well the informal spirit of the lectures. This is a very useful book for graduate students and for mathematicians (or physicists) from other fields interested in the topic. (vs)

I. M. James (ed.), ***History of Topology,*** *Elsevier, Amsterdam, 1999, 1056 pp., US$190.50, ISBN 0-444-82375-1*

This book contains forty contributions written by professional mathematicians or historians of mathematics. The title of the book is a little misleading because almost all of the contributions deal with algebraic or differential or geometric topology; most of the topics belonging to general topology by classification schemes are not included.

About ten contributions are devoted to significant mathematicians of the abovementioned fields, and about five others concern special groups or time (e.g., topologists at conferences, in Hitler's Germany, or the Japanese school). The remaining contributions deal with special topics from the parts of topology mentioned above – especially manifolds, shape theory, fixed-point theory, topology and physics, homotopy theory, graph theory, fibre bundles, and several others from algebraic topology. The contributions are written in such a way that non-specialists can read and understand them without difficulty. (mh)

G. R. Krause and T. H. Lenagan, ***Growth of Algebras and Gelfand-Kirillov Dimension,*** *Graduate Studies in Mathematics* ***22****, American Mathematical Society, Providence, 1999, 212 pp., US$39, ISBN 0-8218-0859-1*

This is the second edition of the authors' fundamental monograph on the Gelfand-Kirillov dimension. The first edition was published in 1985 (Research Notes in Mathematics **116**, Pitman). There are practically no changes to the original text, only errors have been corrected. In order to cover the progress of the last fifteen years in this field, the authors have added a chapter that sketches the development and provides the reader with the relevant references. The number of references has doubled with respect to the first edition; they comprise even preprints and papers that were due to appear as the book went to press, and go up to 1999.

In most cases the appearance of a second edition signals that the book is good and interesting. This is certainly the case with the monograph under review. We can say that it is very carefully and clearly written, and can be recommended not only to specialists, but to anybody who either intends to start working in this interesting field or needs some information concerning the Gelfand-Kirillov dimension. For students, it requires only minor prerequisities, mainly from algebra. For specialists in other fields, it is quite easy to find the required information. The book reads well, and the authors often mention the historical development of the subject and provide the text with many interesting examples. They also present various applications, most of them in algebra. There is also a chapter on the growth of groups, a notion that has been applied in differential geometry. (jva)

N. P. Landsman, ***Mathematical Topics between Classical and Quantum Mechanics,*** *Springer Monographs in Mathematics, Springer, New York, 1998, 529 pp., DM 124, ISBN 0-387-98318-X*

The main theme of this book is a discussion of various mathematical tools used for description of classical mechanics (Poisson manifolds, Poisson algebras and their representations, pure states) and quantum mechanics (Jordan algebras, projective Hilbert spaces, C^*-algebras and their representations, pure states, transition proba-

bilities) and a study of the relations among them. In particular, quantisations of classical systems and classical limits of quantum systems are studied systematically.

The first part of the book describes two basic tools for decriptions of classical and quantum mechanics: the algebra of observables and the set of pure states of the theory. It is shown here how these two different descriptions are related. The second part is devoted to various types of quantisation and to classical limits. In the third part, the author describes geometrical constructions of Poisson algebras and C^*-algebras. To cover the cases needed in the theory of elementary particles, the theory of Lie groupoids and Lie algebroids are used (generalising the case of Lie groups and principal fibre bundles). In the last part, an interesting and far-reaching analogy is described between symplectic reduction of symplectic manifolds and the Rieffel induction in the representation theory of C^*-algebras, including typical applications in theoretic physics (for example, the theory of systems with constraints or θ-vacua).

The book has two special features. The first is the introductory chapter (30 pages) where the content of the book and the main notions and ideas are introduced and discussed clearly and with sufficient detail. The second is the last chapter called Notes (50 pages), containing various additions, comments and references. (vs)

S. Lang, *Complex Analysis,* *Graduate Texts in Mathematics* ***103****, Springer, New York, 1999, 485 pp., DM 129, ISBN 0-387-98592-1*

This is the fourth edition of the author's popular book. As said in the Preface, the required prerequisites include a two-year calculus course and ε-δ-techniques. The first part of the book can serve as a basic course in complex function theory and the second part as an advanced undergraduate or a graduate course. Power series dominate at many places in the book. The contents are not essentially changed in this edition, but new exercises and examples are included and many minor improvements are made. The very understandable style of explanation, which is typical for this author, makes the book valuable for both students and teachers. (jve)

S. Lang, *Math Talks for Undergraduates,* *Springer, New York, 1999, 121 pp., DM 59, ISBN 0-387-98749-5*

This new book of its very prolific author is based on talks delivered by him at European and North American universities. It takes the form of simulated discussions: expositions are combined with students' questions and remarks. The material is chosen to be accessible with minimal prerequisites and of interest to a broad mathematically oriented audience. The book can be used by those who have to deliver similar talks, or even by students in student-run seminars. The material includes, for example, prime numbers, approximation theorems in analysis, harmonic polynomials, and other topics. The text is written in a lively light style with an adequate degree of precision. Even for more advanced readers it provides pleasant reading, showing how to popularise mathematics. (jve)

N. Macrae, *John von Neumann,* *American Mathematical Society, Providence, 1999, 405 pp., US$35, ISBN 0-8218-2064-8*

This biography is a study of an exceptionally well-balanced man who – without pushiness or expenditure on public relations – became the most quietly effective mathematical mind of the twentieth century. He was born as Neumann János on 28 December 1903 in Budapest. In 1921, he was sent to become a chemical engineer, first to Berlin and then to Zürich. At that time he was already intensively working on the idea of Cantor's ordinal numbers. His first postgraduate home was in Göttingen, where there were many brilliant mathematicians and physicists around. By the end of 1928, he had published twenty-two major papers on mathematics. He was then invited to the United States, around the time of the 1929 stock market crash. During the period 1931-37, he visited Princeton which had one of the greatest concentrations of brains in mathematics and physics ever to be assembled anywhere. The book also describes his stay at Los Alamos, connected with the history of the A-bomb. John von Neumann died on 8 February 1957 in Washington DC from a tragically early cancer.

Von Neumann is especially known for his pioneering work on computer design. More than any other individual, he became the creator of the modern digital computer. He believed that Darwin, Faraday, Einstein, etc., followed their own inner light and knew that no organiser, no administrator, and no institution can do more than furnish conditions favourable for research. He wrote a series of fundamental mathematical papers and invented a notion now called a 'von Neumann algebra'.

The book also surveys his substantial contributions to theoretical and applied physics, decision theory, set theory, game theory, meteorology, biology, cybernetics, mathematical economics, and the development of the atomic and hydrogen bombs. The author also presents many facts about John von Neumann's private life. (mk)

P. Mattila, *Geometry of Sets and Measures in Euclidean Spaces,* *Cambridge Studies in Advanced Mathematics* ***44****, Cambridge University Press, 1999, 343 pp., £40, ISBN 0-521-65595-1 and 0-521-46576-1*

This is a new edition of the book published in 1995; for a review, see *EMS Newsletter* **18**, December 1995, p. 38. (vs)

H. Milbrodt and M. Helbig, *Mathematische Methoden der Personenversicherung,* *Walter de Gruyter Co., Berlin, 1999, 654 pp., DM 134, ISBN 3-11-014226-0*

As prerequisities for studying the book, the authors quote a deep knowledge of real analysis and an introductory course of probability theory. The book covers the traditional scope of life insurance and pension mathematics, using continuous-time Markov chains; health insurance and models with random interest rates are not covered.

There are two forms of exposition in the thirteen chapters of this book. In the first, mathematical constructions in the spirit of real analysis are prevalent; in the other discrete-time models are mostly used to provide practical information. The approach to the decrement models is based on the residual lifetime under multiple decrement causes and for joint lives. Information is presented on the life table construction, including recent statistical developments. In the chapters on the insurer's liabilities, the pure and the office premiums, and the technical provisions, the reader finds the standard formulas together with the recursive equations typical for a Markov chain approach. Thiele's equation, Hattendorf's theorem and the theory of Cantelli are dealt with in detail.

A particular feature of the book is its 270 exercises, mostly asking the reader to prove a statement complementing the text material. The book includes actuarial tables from a larger set obtainable on the internet. Some overloading of the text with symbols, formal definitions and proofs may dissuade some readers from a systematic study of this book. (pm)

D. Mumford, *The Red Book of Varieties and Schemes,* *Lecture Notes in Mathematics* ***1358,*** *Springer, Berlin, 1999, 304 pp., DM 79, ISBN 3-540-63293-X*

This is the second edition of a famous and well-known introduction to algebraic geometry, written to show that the language of schemes is fundamentally geometrical and clearly expressing the intuition of algebraic geometry.

There is an appendix on 'Curves and Their Jacobians' which is an expanded version of a series of lectures that the author gave in November 1974 at the University of Michigan. It is a nice introduction to the most beautiful and oldest topics in algebraic geometry – curves and their Jacobians, and is presented here in a form accessible to the general mathematical community. Starting with several possibilities for how to describe curves in projective space, the book continues with the description of the moduli space of curves; Jacobians and theta functions are then introduced in a natural way. At the end, the Torelli theorem and the Schottky problem are discussed. The book ends with notes entitled 'Guide to the literature and references' and 'Supplementary bibliography on the Schottky problem'.

This book can be strongly recommended to anybody interested in algebraic geometry and willing to learn about varieties and schemes and their main properties. (jbu)

G. Nakamura, S. Saitoh, J. K. Seo and M. Yamamoto (eds.), *Inverse Problems and Related Topics,* *Research Notes in Mathematics* ***419****, Chapman & Hall/CRC, Boca Raton, 2000, 233 pp., £42.95, ISBN 1-58488-191-7*

This book contains ten papers on the theoretical aspects of inverse problems and six papers on numerical simulation, including applications to magnetostatics, memory reconstruction, and tomo-electrocardiography.

The contributions comprise reviews and highly original results by specialists in applied mathematics, medical engineers, and researchers on inverse problems. It can be strongly recommended to researchers and postgraduate students interested in these fields. (kn)

B. Perrin-Riou, *p-adic L-Functions and p-adic Representations,* *SMF/AMS Texts and Monographs* ***3,*** *American Mathematical Society, Providence, 2000, 150 pp., US$49, ISBN 0-8218-1946-1*

The arithmetical structure of integral values of complex L–functions is fundamental, not only in number theory. Various constructions of p-adic L-functions have appeared since the work of Kubota and Leopoldt on a p-adic analogue of the complex Riemann zeta function by p-adic interpolation. The present volume is devoted to a recent general approach to constructions of p-adic L-functions, starting directly from p-adic Galois representations.

This book was originally published in French (*Astérisque* **225**, 1995), and the present edition mirrors the progress (the Colmez proof of reciprocity law *Rec(V)*, contributions of Benois, etc.) which the field has undergone in the meantime.

The volume consists of four chapters and three appendices: Construction of the module of p-adic L-functions without factor at infinity; Modules of p-adic L-functions of V; Study of values of the module of p-adic L-functions; and p-adic L-functions of a motive. Appendix A contains results in Galois cohomology, Appendix B contains the weak Leopoldt conjecture, and Appendix C (written jointly with J.-M. Fontaine) describes local Tamagawa numbers, the Euler-Poincaré characteristic and applications to functional equations. Each chapter starts with a summary, making orientation in the book more comfortable. The book is written in a concise but readable style, and can be recommended to readers interested in this rapidly growing subject. (šp)

T. J. Rivlin and E. B. Saff (eds.), *Joseph L. Walsh: Selected Papers,* *Springer, New York, 2000, 682 pp., DM 249, ISBN 0-387-98782-7*

In this volume the authors present a selection from the 281 published papers of Joseph Leonard Walsh (1895-1973), a complete list of which follows after the preface. A list of Walsh's books is included, although no excerpts from them appear in this volume; this omission is due to a limitation on the size of the volume. The lists of papers, books and his Ph.D. students is followed by a biography of Walsh and summary of his work by Morris Marden, his first Ph.D. student, and by additional material by D. V. Widder and W. E. Sewell.

The selected papers have been divided into seven broad sections: Zeros and critical points of polynomials and rational functions; Walsh functions; Qualitative approximation; Conformal Mapping; Polynomial approximation, Rational approximation; and Spline functions. The sections are ordered following the evolution of Walsh's work. Appended to these sections are commentaries on his work and a discussion of subsequent developments influenced by it.

One of Walsh's papers has attained an unpredictably remarkable after-life. It made little impact for almost half a century and then, unexpectedly, sparked enormous activity that continues up to the present day. The work referred to is 'A closed set of normal orthogonal functions', Amer. J. Math. **45** (1923), 5-24, which introduced what are now known as 'Walsh Functions'.

The reviewer believes that this book forms an ideal resource for students and researchers involved in function theory, numerical analysis, approximations and Fourier analysis. (kn)

F. Santosa and I. Stakgold (eds.), *Analytical and Computational Methods in Scattering and Applied Mathematics,* *Research Notes in Mathematics* ***417****, Chapman & Hall/CRC, Boca Raton, 2000, 273 pp, £46.99, ISBN 1-58488-159-3*

Most of the papers in this volume were presented at the International Conference in Applied Mathematics, held in memory of Ralph Ellis Kleinman in November 1998 at the University of Delaware; additional papers were solicited from his colleagues. This multidisciplinary collection consists of authoritative overviews and new results from experts in their fields. They feature up-to-date work on scattering, wave propagation, partial differential equations, analytical techniques for partial differential equations and applied mathematics, and practical computational techniques for wave problems.

This book is an ideal resource for engineers working on electromagnetics and wave propagation and for applied mathematicians working on partial differential equations and inverse problems. (kn)

K. Sato, *Lévy Processes and Infinitely Divisible Distributions,* *Cambridge Studies in Advanced Mathematics* ***68****, Cambridge University Press, Cambridge, 1999, 486 pp., £50, ISBN 0-521-55302-4*

This book serves as an introduction to the theory of stochastic processes. In particular, it is intended to provide a comprehensive basic knowledge of Lévy processes, additive processes and infinitely divisible distributions, with detailed proofs. Lévy processes are stochastic processes whose increments in non-overlapping time intervals are independent and their increments are stationary; both Wiener process and Poisson processes are typical Lévy processes. Important classes of stochastic processes, including classes of Markov processes and semi-martingales, are obtained by generalising Lévy processes.

Relaxing the stationary assumption for increments, we get the class of additive processes. The distributions of Lévy and additive processes at any time are infinitely divisible; conversely, additive processes are described by systems of infinitely divisible distributions. Further important processes, such as stable, semi-stable and self-similar additive processes, are obtained after an additional assumption of self-similarity. (vb)

M. Schneider and Y.-T. Siu (eds.), *Several Complex Variables,* *Mathematical Sciences Research Institute Publications* ***37,*** *Cambridge University Press, 2000, 564 pp., £40, ISBN 0-521-77086-6*

This book contains sixteen papers written by participants of the 1995-96 Special Year in Several Complex Variables, held at the Mathematical Sciences Research Institute in Berkeley, California. Most of the contributions are surveys or expository papers describing results and techniques from different parts of the theory of several complex variables, while a few articles are research articles with expository sections.

We now mention some of the papers in more detail. There is an article by M. S. Baouendi and L. P. Rotschild (Local holomorphic equivalence of real analytic submanifolds in C^N), where local biholomorphisms that map one real analytic or real algebraic submanifold of C^N into another are studied; the notion of Segre sets associated with a point of a real analytic CR submanifold of C^N is the main ingredient in this work. In an interesting article by D. Barlet (How to use the cycle space in complex geometry), the topological and analytical properties of the space $C_n(Z)$ of n-cycles in the complex manifold Z are described, and some correspondences defined on the cycle spaces are presented. Among the papers devoted to a study of geometry and toplogy of Kähler manifolds, there are papers by F. Campana and T. Peterneli (Recent developments in the classification theory of compact Kähler manifolds) and D. Toledo (Rigidity theorems in Kähler geometry and fundamental groups of varieties). A survey of the most important results in Seiberg-Witten theory, which are related to algebraic or Kählerian geometry, is given in the contribution by Ch. Okonek and A. Teleman (Recent developments in Seiberg-Witten theory and complex geometry). (jbu)

G. Semenoff and L. Vinet (eds.), *Particles and Fields,* *CRM Series in Mathematical Physics, Springer, New York, 1999, 489 pp., DM 158, ISBN 0-387-98402-X*

This book is based on lectures presented to the CAP-CRM Summer School on Particles and Physics, held in Banff in 1994. They cover the topics of integrable theories, matrix models, statistical systems, field theory and their applications to condensed matter physics, as well as certain aspects of algebra, geometry and topology.

The first contribution, by E. Corrigan, is devoted to integrable Toda field theories associated with affine Dynkin diagrams. The second, written by J. Feldman, H. Knörrer, D. Lehmann and E. Trubowitz, describes a gas of interacting fermions in

the field of a lattice of magnetic ions. The third chapter, by D. S. Fried, explains how quantum groups arise from the path integral in three-dimensional topological quantum field theory. In the next chapter, T. Miwa describes a method for computing correlation functions of solvable lattice models. In Chapter 5, A. Morozov presents matrix models from the point of view of integrable systems. Chapter 6, by A. Niemi, explains the localisation of certain path integrals in equivariant cohomology. Chapter 7, by S. Ruijsenaars, is devoted to systems of Calogero-Moser type. The following chapter, by M. de Wild Propitius and F. A. Bais, addresses planar gauge theories with broken symmetries. Chapter 9, by A. Cappelli, C. A. Trugenberger and G. R. Zemba, describes a characterisation of quantum Hall fluids based on the $W_{1+\infty}$ algebra. The final chapter, by P. I. Etingof, deals with the spectral theory of quantum vertex operators for the quantum algebra $u_1(\mathrm{sl}_2)$. (mm)

M. Stern, *Semimodular Lattices: Theory and Applications*, *Encyclopedia of Mathematics and its Applications* **73,** *Cambridge University Press, 1999, 370 pp., £50, ISBN 0-521-46105-7*
This monograph develops the theory of those lattices which are, in some sense or other, close to modular lattices. The first chapter is an ingenious outline of the related parts from lattice theory and introduces the notion of a semimodular lattice as a lattice L where, for any $a, b \in L$, the fact that $[a \wedge b, a]$ is a prime interval implies that the transposed interval $[b, a \vee b]$ is also prime. In the following chapters, the author presents modular pairs, modular, distributive, standard and neutral elements, and M-symmetric lattices; you will hardly find a better exposition or source for supersolvable, strong or balanced lattices.

To complete the picture, let us mention that you will also find here semimodular lattices of finite length, local distributivity and modularity (with the Kurosh-Ore replacement property), and many other interesting and recent topics. The whole book makes very nice reading, and the text is very carefully arranged, including comments on the history of the subject as well as indications of papers and books for further study. It will be useful to anyone interested in lattice theory. (lbe)

D. Stirzaker, *Probability and Random Variables: A beginner's guide*, *Cambridge University Press, 1999, 368 pp., £45, ISBN 0-521-64297-3 and 0-521-64445-3*
This textbook on probability theory is written in a tutorial style, oriented towards beginners. The author does not assume a deep knowledge of, or skills in, mathematics.

The basic concepts of probability and chance are first described and explained at an intuitive level. Motivations based on proportions, as well as on relative frequencies, are mentioned. After that, there follows a rigorous definition of probability, both in discrete and continuous case. The text then proceeds to an explanation of the crucial notions of probability theory: random variables, probability distributions, independence, conditional distributions, etc. The last chapter introduces generating functions, the most powerful tool for handling independent random variables.

The basic topics of mathematical statistics are touched on, as well as Bayes' rule, the (weak) law of large numbers, the central limit theorem and ordered statistics. The text is written in an informal tutorial style with an emphasis on motivation and with a number of illustrative examples. It is appropriate for beginners and readers interested in the basic ideas of probability theory. (pl)

J. J. Tattersall, *Elementary Number Theory in Nine Chapters*, *Cambridge University Press, 1999, 407 pp., £16.95, ISBN 0-521-58503-1 and 0-521-58531-7*
Despite the fact that this book has more than 400 pages, it is intended for a one-semester introduction to basic number theory, at the level of prospective secondary school teachers. The topics covered are divisibility, prime numbers, perfect and amicable numbers, modular arithmetic, congruences of higher degree, partitions, the Pell equation, binary quadratic forms, continued fractions, p–adic analysis, and applications in cryptology.

The book is very readable, containing a wealth of historical comments that make the reading of it very interesting, even for more experienced readers. Although some comments are a bit inaccurate (e.g., the term 'Davenport covering' was never used in the literature, or the claim that the rule for Easter was definitely settled at the Council of Nicaea), such banal trifles do not affect the positive impression accompanying the reading of this book. The author writes in the introduction that "historical vignettes are included to humanize the mathematics involved"; this is certainly true for novices trying to enter a new field. The sections are accompanied by exercises, and answers to selected exercises, together with a satisfactory index and bibliography, can be found at the end of the book. It can be recommended to anybody who wants to learn about elementary number theory and its historical background. (šp)

Sundaram Thangavelu, *Harmonic Analysis on the Heisenberg Group*, *Progress in Mathematics* **159,** *Birkhäuser, Boston, 1998, 191 pp., ISBN 0-8176-4050-9 and 3-7643-4050-9*
This is a well-written exposition of the recent progress in harmonic analysis on Heisenberg groups, stemming from the beautiful known results in a Euclidean setting. The material in this book is due to the author and his collaborators, and other fundamental work is also included. For a full understanding of the theory and its motivations, the reader should be familiar with Euclidean harmonic analysis.

Chapter 1 contains basic material, such as the definition of H^n, its various representations, the operator-valued Fourier and Weyl transforms on H^n, the functions of Hermite and Laguerre type, and includes theorems of Paley-Wiener type and the Hardy-type uncertainty principle in the non-commutative setting of H^n. The first two sections of Chapter 2 are based on fundamental Strichartz' results on the spectral analysis of the sub-Laplacian. The expansion into eigenfunctions is given and an Abel summability theorem is proved. Further, the Paley-Wiener theorem and some restriction theorem are proved for spectral projections, Bochner-Riesz means are considered and, with help from the Littlewood-Paley-Stein theory of g-functions, a Mikhlin-Hörmander multiplier theorem for the group Fourier transform on H^n is obtained. Chapter 3 focuses on the Heisenberg group H^n and the unitary group $U(n)$ as a Gelfand pair, and studies the Gelfand transform on the (commutative) algebra $L^1(H^n/U(n))$. The Gelfand spectrum is given here by bounded $U(n)$-spherical functions, and a Wiener-Tauberian theorem and a maximal theorem for spherical means are then proved. Chapter 4 gives a sharper maximal theorem and a theorem of Tauberian type for spherical means, in the case of the reduced Heisenberg group H^n/Γ, where $\Gamma = \{(0, 2\pi k): k \in \mathbf{Z}\}$. Related results on mean periodic functions are also included. (mkr)

C. Voisin, *Mirror Symmetry*, *SMF/AMS Texts and Monographs* **1,** *American Mathematical Society, Société Mathématique de France, Providence, 1999, 120 pp., US$27, ISBN 0-8218-1947-X*
Mirror symmetry is a conjectural duality predicting, for a complex manifold X, the existence of its 'mirror image', a manifold X^t for which the moduli spaces M_X and M_{X^t} of deformations of complex structures decorated with 'complexified Kähler parameters' are isomorphic, with an isomorphism preserving, in a specific sense, the local product structures.

The mirror conjecture is based on experimental evidence, stemming from calculations in physics and geometry; a rigorous proof is known only for a very narrow class of examples. This book gives an overview of various manifestations of the mirror symmetry phenomena.

The first chapter introduces the main source of examples: Calabi-Yau manifolds (compact Kähler manifolds with trivial canonical bundle). The second chapter explains the physical origins of the conjecture, formulated as a duality between A- and B-models of the $N = 2$ supersymmetric σ-model. In the next chapter, a correspondence between deformations of the Hodge structure of a Calabi-Yau threefold and Gromov-Witten invariants of its mirror is constructed.

In Chapter 4, an involution $\Delta \to \Delta^*$on the set of toric Fano varieties is constructed. Mirror symmetry can be then observed as a certain correspondence between hypersurfaces of a toric Fano variety corresponding to the polyhedron Δ and hypersurfaces of the variety corresponding to Δ^*.

The central theme of Chapter 5 is the theory of Gromov-Witte invariants and its applications to variations of Hodge struc-

tures. The last chapter shows how counting rational curves on a quintic of the four-dimensional projective space leads to solutions of the Picard-Fuchs equation of the mirror family.

This book is far from being elementary and self-contained. Although it assumes a broad preliminary knowledge of algebraic and differential geometry, it might yet give, even to a non-specialist, some basic orientation in the complicated and rapidly developing world of mirror symmetry. (mm)

Contributions wanted

Contributions are needed for future issues of the EMS Newsletter. These can be feature articles, interviews, information about your mathematical society, letters to the Editor, historical notes, or anything else that you think will be of interest to Newsletter readers. Contributions from Eastern European countries, or form countries rarely represented in this Newsletter, are particularly welcome.

Please e-mail or send your contribution to the Editor-in-Chief, Robin Wilson, at the address given on page 1.