EUROPEAN MATHEMATICAL SOCIETY

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NOTICE FOR MATHEMATICAL SOCIETIES

Labels for the next issue will be prepared during the second half of May 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: 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 News: Committee and Agenda

EMS Agenda
2000

24-25 March
Executive Committee Meeting, hosted by the Polish Mathematical Society and the Institute of Mathematics of the Polish Academy of Sciences, Bedlevo, near Poz□an (Poland).
15 May
Deadline for submission of material for the June issue of the *EMS Newsletter*
contact: Robin Wilson, *e-mail: r.j.wilson@open.ac.uk*
13-20 June
EMS Lectures by Prof. Dr. George Papanicolaou, (Stanford, USA).
13-16 June: ETH, Zürich (Switzerland): *Financial Mathematics*
18-20 June: University of Crete, Heraklion, Crete (Greece): *Time Reversed Acoustics*
contact: David Brannan, *e-mail: d.a.brannan@open.ac.uk*
17-22 June
EURESCO Conference in Mathematical Analysis at Castelvecchio Pascoli (Italy):
Partial Differential Equations and their Applications to Geometry and Physics
Organiser: J. Eichhorn, Greifswald (Germany), *e-mail: euresco@esf.org*
[This series of conferences is financed by the ESF.]
3-7 July
ALHAMBRA 2000: a joint mathematical European-Arabic conference in Granada (Spain), promoted by the EMS and the Spanish Royal Mathematical Society
contact: Ceferino Ruiz, *e-mail: ruiz@ugr.es website: www.ugr.es/∼alhambra2000*
6 July
Executive Committee Meeting in Barcelona (Spain)
7-8 July
EMS Council Meeting at Institut d'Estudis Catalans, Carrer del Carme 47, E-08001 Barcelona (Spain), starting at 10 a.m. (The agenda will be sent to delegates in April.)
contact: EMS Secretariat, *e-mail: makelain@cc.helsinki.fi*
10-14 July
Third European Congress of Mathematics (3ecm) in Barcelona (Spain)
e-mail: *3ecm@iec.es website: www.iec.es/3ecm/*
24 July-3 August
EMS Summer School, in Edinburgh (Scotland):
New analytic and geometric methods in inverse problems
Organiser: Erkki Somersalo, Otaniemi (Finland), *e-mail: Erkki.Somersalo@hut.fi*
15 August
Deadline for submission of material for the September issue of the *EMS Newsletter*
contact: Robin Wilson, *e-mail: r.j.wilson@open.ac.uk*
17 August-2 September
EMS Summer School at Saint-Flour, Cantal (France): *Probability theory*
Organiser: Pierre Bernard, *Clermont-Ferrand (France), e-mail: bernard@ucfma.univ-bpclermont.fr*
Autumn
Fifth Diderot Mathematical Forum on 'Mathematics and Telecommunications'
Date and programme to be announced.
contact: Jean-Pierre Bourguignon, *e-mail: jpb@ihes.fr*
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*
30 September
Deadline for proposals for 2002 EMS Summer Schools
contact: Renzo Piccinini, *e-mail: renzo@matapp.unimib.it*
14-15 October
Executive Committee Meeting in the UK, hosted by 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

9-20 July
EMS Summer School at St Petersburg, Russia:
Asymptotic combinatorics with application to mathematical physics
Organiser: Anatoly Vershik, *e-mail: vershik@pdmi.ras.ru*
3-6 September
1st EMS-SIAM conference, Berlin
Organiser: Peter Deuflhard, *e-mail: deuflhard@zib.de*

Message from the EMS President

Rolf Jeltsch (Zürich)

The following is adapted from a letter sent to the presidents of all our corporate societies.

We have entered an exciting new year, the World Mathematical Year 2000. I hope that this year we will all encounter a big boost for our science and that we will succeed in making the general public aware of the benefits of mathematics. The EMS poster competition has been very successful; you can find the results at *http://lrc.dtv.dk/ernest/wmy2000/index. html* and further information on the WMY2000 server *http://wmy2000.math. jussieu.fr/*.

The biggest event for the EMS this year will be the third European Congress of Mathematics in Barcelona, from 10-14 July, and of course our Council meeting on 7-8 July. You can now register electronically for the Congress (see our web page, *www.emis.de*) and all information on the Council can be obtained directly from our secretary, Prof. David Brannan.

Let me first recount briefly what happened in 1999. Our journal *JEMS* had a successful start; the first volume is complete and the level of articles has been extremely high. For a journal as young as *JEMS*, the number of subscriptions is already quite large.

Last year the 5th framework programme started and this created a lot of activity for the EMS since we submitted five proposals. I am happy to report that all proposals have been approved. The largest, LIMES, involves partners from seven countries and the EMS and is designed to improve *Zentralblatt MATH* even further. At this point I might add that the EMS has entered contracts with FIZ Karlsruhe and the Zentrum für Didaktik der Mathematik at Karlsruhe University concerning the *Zentralblatt für Didaktik der Mathematik / International Reviews on Mathematical Education*. You can find the electronic version, called MATH-DI, on our web page www.emis.de.

When taking office I promised to strengthen the applied mathematics within the EMS. One change you may have already noticed: the 'Applications Committee' (now called the 'Applied Mathematics Committee') has made great efforts to supply more articles concerning applied mathematics to our *Newsletter*.

In addition, the *Felix Klein Prize* has been created. It will be awarded to a young scientist, or a small group of young scientists (normally under the age of 38), who use sophisticated methods to give an outstanding solution that meets with the complete satisfaction of industry to a concrete and difficult industrial problem. It will be awarded for the first time at the 3ecm in Barcelona this year. The deadline for nominations was 1 March 2000.

Further the EMS has started a cooperation with SIAM, the Society for Industrial and Applied Mathematics. We have agreed to start with the first joint EMS-SIAM conference, to be held in Berlin from 3-6 September 2001. Finally, the number of EMS lectures have been doubled, in the sense that they will take place not biannually but every year. The idea is to try to distribute the topics equally between pure and applied mathematics. This year Prof. George Papanicolaou will give two sets of lectures, one at ETH in Zürich on 'Mathematics in Finance' from 13-16 June, and one at the University of Crete in Heraklion on 'Time Reversed Acoustics' from 18-20 June. We are now seeking proposals for EMS lecturers for the year 2001; the deadline is 30 September 2000. The same deadline applies to proposals for EMS summer schools for the year 2002.

In 1999 the executive committee created a working group to study the possibility of founding EMSph, a European Publishing House run by the EMS. To create such a publishing house has many aspects and is no way a simple enterprise. We therefore would like to get input and support from our corporate societies. We plan to have a meeting at the 3ecm in Barcelona to discuss these plans. We have already contacted a series of journals which may also enter this discussion.

Last year I asked for volunteers to work for the EMS. I am happy to announce that Prof. Volker Merhmann has taken over the position as Editor-in-Chief of the 'left-hand-side' of EMIS. I am convinced that he will do a great job, and if you have information for (or concerning) EMIS, write directly to him (*volker.mehrmann @mathematik.tu-chemnitz.de*). Prof. Jean-Pierre Bourguignon has agreed to be the Chair of the Special Events Committee, and I am looking forward to the fifth Diderot Mathematical Forum on 'Mathematics and Telecommunications', to take place this coming September. Prof. Renzo Piccinini is now the chairman of the Summer School Committee and Prof. Claude Lobry chairs the Committee on Developing Countries. I wish them all success in their positions.

Finally, let me mention that last year was very exciting and exhausting. I would like to apologise to those to whom I was slow in responding. I hope however to meet all of you at the 3ecm in Barcelona in July.

EMS Council for 2000: individual members

The Secretariat received 16 nominations for the 15 delegates of individual members on the EMS Council from 2000-2003. One nomination was invalid. As a consequence, no ballot was needed. The new delegates for the individual members for this four-year period are:

Giuseppe Anichini (Italy), *anichini@dma.unifi.it*
Vasili Berinde (Romania), *vberinde@univer.ubm.ro*
Giorgio Bolondi (Italy), *bolondi@alpha.science.unitn.it*
Alberto Conte (Italy), *conte@dm.unito.it*
C. T. J. Dodson (UK), *dodson@fs1.ma.umist.ac.uk*
Jean-Pierre Françoise (France), *jpf@ccr.jussieu.fr*
Salvador S. Gomis (Spain), *salsegom@fcu.um.es*
Laurent Guillope (France), *Laurent.Guillope@math.univ-nantes.fr*
Klaus Habetha (Germany), *habetha@math2.rwth-aachen.de*
Willi Jäger (Germany), *wjaeger@iwr.uni-heidelberg.de*
Tapani Kuusalo (Finland), *kuusalo@math.jyu.fi*
László Márki (Hungary), *marki@renyi.hu*
Andrzej Pelczar (Poland), *pelczar@im.uj.edu.pl*
Zeév Rudnick (Israel), *rudnick@math.tau.ac.il*
Gerald Tronel (France), *gtronel@fr.packardbell.org*

Editorial

WMY2000

Vagn Lundsgaard Hansen
(Lyngby, Denmark)

When asked what the World Mathematical Year 2000 is about, I answer that it is to make visible to the general public that *mathematics bridges gaps in culture, science and technology*. For technology this is true, even in the very literal sense. For culture and science it is more profound. How this idea dawned upon me, I am about to tell you.

Getting overwhelmed
During holidays in London last summer, I first visited the Science Museum and the next day the British Museum. As many other visitors, I was thoroughly impressed. It is, indeed, fantastic what homo sapiens has created throughout history. Nevertheless, my reflections on the impressions followed an unexpected road.

Suddenly during the visit to the Science Museum, I had a feeling of being completely overwhelmed. Is there really more to be invented? Are the achievements in the natural sciences and technology in the last millennium, and particularly in the last few centuries, so extraordinarily impressive that it can be demoralising for the young and ambitious who think about their future careers? What is there still to be done? What can they do to make a difference? Somehow I felt that here might be one of the reasons for the decline in enrolment at universities in the natural and the technological sciences. I got, admittedly, slightly depressed. But wait, there are hope and encouragement to be found.

Slowly recovering
Where is the red thread connecting all the things in the Science Museum? Where are the great unifying principles? Where is the common language? Suddenly it came to me in a Platonic flash: *the principles of mathematics are behind every single construction in technology*. My adrenalin got a kick. I started talking and talking to my very tolerant and patient wife about this wonderful power of mathematics: "Look at these steam engines, look at these marvellous clocks. And do you think that man would ever have gone to the moon without mathematics?"

Here we go
We went all the way from the philosophy of Plato and Aristotle on the mathematical principles behind the universe, past the work of the ancient Greek mathematicians and philosophers, to Galileo (who died in 1642, the year of the birth of Newton), and then to Maxwell, Einstein and Bohr (excuse me for being patriotic). All the major breakthroughs in physics are written in the language of mathematics. And what about astronomy, chemistry and, in more recent times, biology and geology. I was thrilled and thought proudly to myself: *mathematics stretches back in time to the dawn of civilisation, but its impact is really felt in modern society, and mathematics will continue to be vital in the future*. The only thing that bothered me was that I found this declaration stated nowhere in the Science Museum. There was only a tiny little room with mathematics on display – or so it appeared at first sight. But with hindsight I found the museum filled with realisations of mathematical ideas.

Bring out the message
The purpose of World Mathematical Year 2000 is to bring the power of mathematics to the attention of the general public, pupils in schools, students at the universities, teachers at all levels, politicians,... My goodness, we have a much better case than we think. They cannot do without mathematics. The sad thing is that they do not know about it. We must tell them in every continent of the world that mathematics is a language common to all nations and that its values are eternal and universal.

Greek vases
The next day we visited the British Museum. Same experience. Mathematics behind many things in art, paintings, sculptures, pottery, ornamentation, and marvellous mathematical ideas exploited in the construction of clocks and instruments from the natural sciences. Despite this, there was only one small cabinet devoted to mathematics. But also in the British Museum we found mathematics providing major links throughout the various exhibitions. Again a very happy day on the beaches of the mathematical ocean.

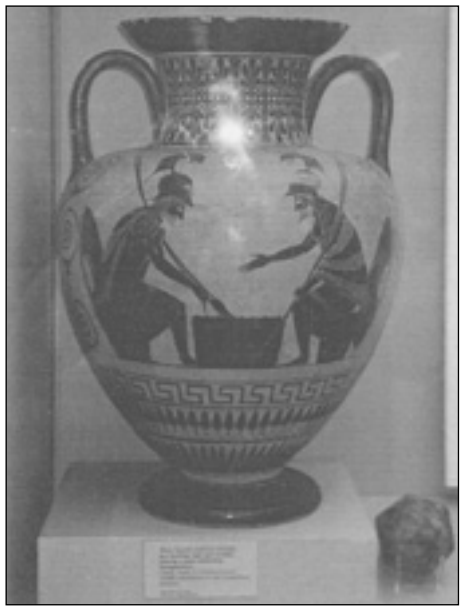
A slight disappointment was that the exhibition of Greek vases was closed on the day of our visit. And my main purpose in this particular visit to the British Museum was to see the Greek vases. I wanted to see the planar reflection symmetry realised by 'umklappung' (a spatial 180-degree rotation) in the famous motif of Ajax and Achilles at a board game.

The tour goes to Spain
This summer the tour goes to Spain – and first to Granada, where a satellite conference to the Third European Congress of Mathematics takes place from 3 to 7 July. The conference in Granada is one of the main projects which the EMS committee of the WMY2000 has worked for. We are extremely grateful to the people in Granada who have realised the project of bringing Europeans and Arabs together in the old city with the famous Alhambra, castle of the Moorish kings. A main part of the conference will discuss the historical perspectives of both cultures to our present mathematical knowledge. A central role is played by the fascinating ornamentation in Alhambra, in which the seventeen planar crystallographic groups are represented. For a long time, I have been eager to see these motifs which form such a beautiful bridge between the Arab and European cultures.

Mathematical posters
The other main project of the EMS committee of the WMY2000 is the campaign for suitable posters to be displayed in subways and other public places. As one way of stimulating the creation of good ideas for posters, the EMS arranged a poster competition in the Spring of 1999, the results of which were announced in the December 1999 *Newsletter*. The poster designers have given permission for their proposals to be included in a web gallery. The gallery is still under construction, but has recently been made public; it can be found at the web address *http://www. mat.dtu.dk/ems-gallery/*. Comments and suggestions for the web gallery are welcome. In particular, the gallery has a supplementary section, where suitable ideas for posters independent of the competition can be included.

Working hard
The main work in connection with the World Mathematical Year has by necessity to be done by all the local committees set up in many countries to organise mathematical events. It is, indeed, hard work to catch the interest of the public media, newspapers and TV, and it is very difficult to make the local postal services issue special stamps with a mathematical theme. The various mathematical societies and teachers' associations will organise competitions and lecture series, which take much thought to be properly prepared. The reward is that the sum of these activities will be to the benefit of mathematics all over the world.

It is fortunate that there is so much to tell about mathematics. For it is indeed true that *mathematics bridges gaps in culture, science and technology*. May I wish you all a very exciting World Mathematical Year 2000.



Greek vase in the British Museum, depicting Ajax and Achilles at a board game.

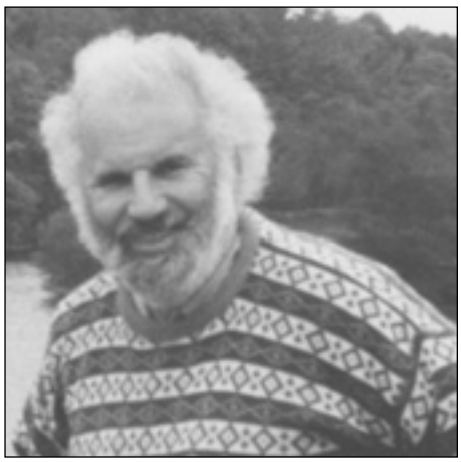
Introducing the WMY2000 team

Below we feature some of the international team for World Mathematical Year 2000.

Vagn Lundsgaard Hansen has been Professor of mathematics at the Technical University of Denmark, Lyngby (Copenhagen), since 1980.
He earned a Masters degree in mathematics and physics from the University of Aarhus, Denmark, in 1966, and a PhD in mathematics from the University of Warwick, England, in 1972. He has held positions as Assistant professor, University of Aarhus, 1966-69; Research fellow, University of Warwick, 1969-72; associate professor, University of Copenhagen, Denmark, 1972-80, and Visiting professor at the University of Maryland, USA, in Fall 1986.

He is fascinated by the interaction between the abstract and the concrete in mathematics, and by finding serious mathematics in the description and explanation of phenomena from the real world. He has written research papers in topology, geometry, and global analysis. Other research interests include mathematical education and the history of mathematics. He is the author of several books, including the general books *Geometry in Nature* and *Shadows of the Circle*.

He is currently President of the Danish Academy of Natural Sciences and has been Vice-chairman of the Danish Natural Science Research Council. He is currently Chairman of the World Mathematical Year committee of the EMS.



Ronnie Brown was an undergraduate and postgraduate at Oxford University, and was supervised by Henry Whitehead (who died suddenly in 1960) and Michael Barratt. He taught at the Universities of Liverpool and Hull, before being appointed in 1970 to the Chair of pure mathematics at the University of Bangor, North Wales, where he has remained ever since.

His first work was on the algebraic and general topology of function spaces, where he initiated the notion of a category adequate and convenient for topology. Later, while writing a book on topology, his attempts to explain the fundamental group led to an exposition that emphasised the use of groupoids as a flexible generalisation of groups, leading to the view that groupoids can be used to define higher-dimensional versions of groups which would reflect some old intuitions in topology and algebra. This has led to a substantial new theory with wide ramifications.

Since 1983 he has become involved in the popularisation of mathematics, and led a team that produced an exhibition 'Mathematics and knots' for the UK 'PopMaths Roadshow' in 1989. This exhibition has since been shown widely and in 1997 was put on the web. The exhibition also led to a collaboration with the sculptor John Robinson (see the website: http://www.bangor.ac.uk/ma/CPM/).

Mireille Chaleyat-Maurel is Professor of mathematics at the Université René Descartes, Paris, France. Her main area of research is probability theory, particularly stochastic differential equations.

She was a member of the Council of the Société Mathématique de France from 1987 to 1994 and in charge of communication and Publicity Officer of the EMS from 1994 to 1998.

She is the Chair of the IMU Committee for WMY2000 and has been Editor-in-chief of the *WMY2000 Newsletter* since 1995.

She is currently the coordinator of the project RPA-MATHS (Raising Public Awareness in Mathematics) which has been selected by the European Commission as a part of the European Science and Technology Week (6-12 November 2000).

José Francisco Rodrigues is Director of the Centro de Matemática e Aplicações Fundamentais of the University of Lisbon, Portugal. He is also Professor of mathematics in the Faculty of Science at the same university, where he received his PhD in 1982, after studying at the Université de Paris VI and lecturing at the ENSM/Université de Nantes. He has visited several universities and Research Institutes in Europe, USA and Asia.
His mathematical interests lie mainly in non-linear partial differential equations and continuuum mechanics, but he is also interested in the history and communication of mathematics, where he has written and edited a few books and articles. He chaired the European Science Foundation scientific programme 'Mathematical treatment of free boundary problems' (1993-97) and he is coordinating the edition of the new Oxford University Press mathematical journal *Interfaces and free boundaries*.
He was Vice-President of the Sociedade Portuguesa de Matemática during the foundation of the European Mathematical Society, and coorganised the Fourth Diderot Mathematical Forum on 'Mathematics and Music'.

Interview with Lars Gårding

interviewers: Karl Gustav Andersson and Anders Melin

You have just passed 80. How are you?
I am well for my age and still able to perform simple tasks.

Where did you go to school?
As a child I went to four schools, I believe. After that it was the local gymnasium in Motala, a small town in Sweden. I left it in 1937.

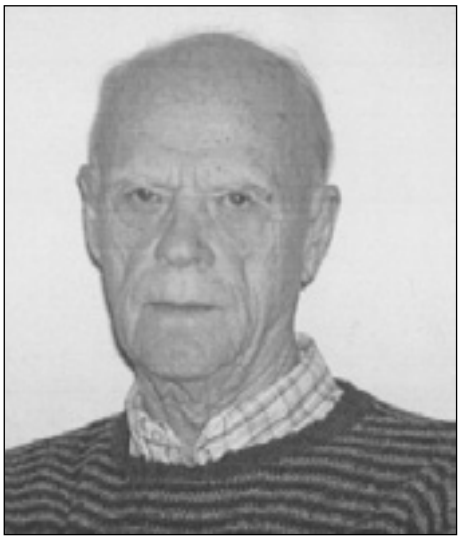
How did you and mathematics meet? Were there any special mathematical questions that occupied your mind?
I was attracted to the subject very early. After reading a simple introduction to infinitesimal analysis I got interested in series. As a special study at school I studied the chapter on series in de la Vallée Poussin's textbook and solved the simple exercises there. Mathematics was my first subject at Lund University when I arrived here in 1937.

How was academic life in your time as a student?
Briefly, the situation in the 1930s and 1940s may be described as follows. Lund was a small, classical university with four faculties and had around 2500 students. All newcomers had passed a centrally organised high school examination in about six subjects. Every subject at the university was taught by just one professor who examined his students at most six times a year. A regular curriculum had three grades each requiring in theory half a year of study. After that there were the higher examinations with a doctor's degree at the top. The university administration employed less than ten people. Students from all faculties lived in rented rooms. For social life they were organised in fraternities based on Swedish regions. They also had an academic society with a house of its own.

Mathematics had two professors and every year received around 30 students. Most of them saw a future in teaching and aimed at a science exam with chemistry, physics and mathematics that took between four and five years.

Now the University is fifteen times larger, teaching is organised in lessons rather than lectures, examinations are frequent and many students refer to the university as 'the school'. I am not saying that things were better before. Student life has lost its unity but the fraternities are still there and many things are as before. In fact, university life for people in their twenties has many time-invariant features.

What did you start with in mathematics?



Lars Gårding

Leonard Eugene Dickson's Elementary theory of equations. It was difficult, especially the proof by induction that symmetric functions of the roots of an equation are polynomials in its coefficients.

Who were your teachers?
Otto Frostman taught elementary analysis. Marcel Riesz had a seminar for semi-advanced students. The problems included difficult elementary inequalities. This seminar was my first encounter with the experience and judgement of a first-class mathematician. Later he became my mentor also outside mathematics.

At the time Riesz was known for his work in summation theory and his convexity theorem. Did he teach you classical function theory?
No, he had acquired other interests. There were two of them: modification of Hadamard's *partie finie* by analytical continuation with respect to a parameter, that gave a kind of fractional integration, and also the nature of Dirac's spinors. These were the constant subjects of conversation. I often met Riesz in a café, alone or together with some members of the regular mathematics seminar. During the war we had very few visitors, but Harald Bohr from Copenhagen lectured once and in 1943 the flight of Jews from Denmark made Werner and Käthe Fenchel stay in Lund for two years.

What did your contacts with Riesz lead to?
To my interest in van der Waerden's *Moderne Algebra* and in group representations. I got a kick out of Herman Weyl's three articles from the 1920s on the characters of the classical groups and a later paper with Brauer on spinors in n dimensions. All this led to my 1944 disputation with Fenchel as the opponent of the faculty. In my now long-forgotten thesis I constructed maps from one representation space to another one on which the two-sided action by a group induces a linear representation of the same group. With this I could construct a lot of wave equations which share with Dirac's equation the property that every component satisfies the wave equation. This was the end of that subject for me, except for a lasting interest in quantum physics.

And after the thesis?
In my first published paper I deduced from its characteristic function the so-called Wishart distribution for the second-order moments in multivariate normal distributions. This gave me an interesting analogue of Riesz's fractional integration. After my thesis I spent a year in Cambridge, England, as a British Council scholar. I spent my time adapting my fractional integration to solve Cauchy's problem for two interesting hyperbolic differential equations and discovered that the supports of their fundamental solutions had large codimensions. In other words they had lacunas – open subsets between the expected conical supports and the actual supports.

In Cambridge I met Hardy, Littlewood, Besicovich and Dirac and other interesting persons, but the university had very little mathematical research in wartime. I and the Polish mathematician Aronszajn started a mathematical seminar of our own. The year ended with a course for British Council Scholars at St Andrews with the title: *The Ideals of the British Empire*. Under this title the local faculty lectured on post-war problems and their young listeners had a wonderful time among themselves.

And then?
A year at home. The year 1946-47 I spent at Princeton University on a stipend from the American-Scandinavian Foundation. Solomon Bochner helped me to rent a cheap room and got me a desk at Fuld Hall, then the mathematics department. My roommate was Raphael M. Robinson, married to the logician Julia Robinson. He gave a course on analytic functions. I felt I had been promoted above my competence level.

What other mathematicians were there at that time?
Many. The mathematicians at the department – for instance, Solomon Lefschetz, Emil Artin and Claude Chevalley, and many others. The main subject at the department was topology. Lefschetz was writing a colloquium treatise on the subject. There were also guest lectures. I remember William Hodge talking about his harmonic integrals and explaining that the topology he got was independent of the metric he used. I was interested in quantum mechanics and had the good fortune to meet a graduate student in physics,

Arthur Wightman. We became friends and a few years later we collaborated on the representations of the commutation and anti-commutation relations.

The department was only a twenty-minute walk away from the Institute for Advanced study. There one could see the permanent members Herman Weyl, John von Neumann, Marston Morse and Carl Ludvig Siegel and, less frequently, Kurt Gödel and James Waddell Alexander. All except Morse and Alexander had left Europe to escape Nazism.

Did you meet them?
I heard von Neumann lecture on functional analysis and Weyl on integral equations. I also met with and talked to most of them. There were plenty of opportunities at the very democratic American afternoon teas and cocktail parties. I can also boast that I was invited to Bochner's dinner parties with von Neumann as a featured guest.

But what did you do?
I wanted to construct fundamental solutions of hyperbolic differential operators, but then I found that this required me to define such operators. In the end I found an intrinsic definition: finite propagation velocity and continuity. But I was also trying to learn modern mathematics. At the time this meant abstract harmonic analysis. My most intimate friends belonged to a group of younger mathematicians who visited the Institute – Irving Segal, Fred Mautner (an ardent admirer of Herman Weyl) and Richard Arens. Their chief ideologue was Segal. The Gods were André Weil, who had written a book about Fourier analysis on commutative locally compact groups, and Israel Gelfand who had invented normed rings a few years earlier. The literature of the field was new but scarce: photoprints of new articles in Russian journals by Gelfand, Rauikov, Naimark and other Russians. Bochner called it the mathematics of photoprints. Both Segal and Mautner were great talkers. The most common phrase in the common room of the Institute used to be 'take a locally compact group' .

Did you write in this field?
I proved that the infinitesimal generators of unitary representations of a Lie group have a common dense domain. This was partly a result of lectures at the department by Jean Delsarte in which he introduced Laurent Schwartz's theory of distributions. In fact, there I learned about infinitely differentiable functions with compact support. Delsarte had only two people in his audience and I was one of them. The students at the department were too busy with topology or homotopy to be interested. I tried topology but found the introductory triangulations uninspiring.

Did you try other things?
My own examples of lacunas in wave propagation made me curious about the lacuna phenomenon. When Irving Segal heard about my interest he said 'Why don't you look at the latest issue of the Sbornik. There are plenty of lacunas.' I found Petrovsky's big article on the subject which was an intriguing mixture of analysis, algebraic geometry and topology. I stayed up all night trying to read it, but I failed to understand even the simplest topological criterion for a lacuna. I tried out some topologists at the department for the simplest parts of the article, but did not get very far. Lefschetz was quoted but I did not dare consult him. It was only twenty years later that I understood enough about fundamental solutions to be able to enlist algebraic and topological help from Atiyah and Bott.

Then what?
I returned to Lund for a year, married Eva, and spent another year at the Institute and applied for a professorship. Lund had then two retiring professors, Marcel Riesz and Nils Zeilon. In 1952 I and Åke Pleijel were nominated professors of mathematics at Lund University. Pleijel had studied with Carleman and worked mostly with the asymptotics of vibration problems.

What about Gårding's inequality?
At the end of the 1940s I realised by reading Herman Weyl that the solution of Dirichlet's problem for high-order elliptic equations just amounted to finding lower bounds for the corresponding Dirichlet integrals. I found the proof one morning after a bad night following a disastrous intervention in a disputation on economics. I am known internationally mostly for this inequality.

What do you consider are your main mathematical achievements?
The intrinsic definition of hyperbolicity, Gårding's inequality, my existence proof by functional analysis alone of Cauchy's problem for hyperbolic equations, my work with lacunas. And, perhaps, my book on mathematics in Sweden before 1950.

How was your time as a professor?
On the whole it was a wonderful time. In the 1950s the department had only three permanent positions, two full professors and one assistant professor, Nils-Erik Fremberg, who taught elementary calculus and analytical geometry. After the war it was also possible to employ young people as assistants. This made the department a lively place. Plenty of gifted young people wanted to study mathematics. I can only mention a few, Carl Hyltén-Cavallius, Lennart Sandgren, Jan-Erik Roos, Jaak Peetre. And, of course, Lars Hörmander. His 1955 thesis was a big event. Very soon afterwards he became a professor in Stockholm.

I enjoyed teaching. My first thesis students, Lennart Sandgren and Gunnar Bergendal, left mathematics for successful careers in politics and administration. My other rather few thesis students stayed in the academic pen. I am the originator of a number of minor theses that were published as papers, but I found it difficult to answer for major theses. As a thesis supervisor one feels the responsibility to give problems or tasks with enough carrying power to give a substantial result. This, by the way, was a relatively new situation. Before the war, one had to write a thesis entirely on one's own with very little outside intervention.

During all my active time we lived under the pressure of swelling crowds of beginners. More and more assistants were employed till the government decided to create new permanent teaching positions called lectorships. This reform came in the middle 1960s and coincided with the 1968 student movement. The tricentennial of Lund University that year had to be cele-

Lars Gårding with Michael Atiyah at the Nordic Summer School of Mathematics, Tjörn, in 1969. (Photograph taken by Christer Bennewitz)

brated under the cover of mounted police. Petrovsky, then Rector of Moscow University and receiver of an honorary degree, was tactfully unimpressed by the police. The minister of education at the time, Olof Palme, decided to pacify the students by letting them into practically every university committee. With time this had a calming effect.

Since the 1960s we have experienced a constant expansion in terms of students and professors. Now with the influx of mathematicians from the east we are getting more and more like an American mathematics department.

Can you tell us, finally, about some important events in your professional life?

My many visits to the States and the many lifelong friendships that I acquired there – for instance with Fritz John, Peter Lax and Louis Nirenberg. Hörmander's 1968 return to Lund from the Institute for Advanced Study was very important. It has been fascinating to see the birth and development of microlocal analysis of distributions. Hörmander dominated mathematics at the department both by his papers and books and his excellent teaching material on various branches of analysis. His four volumes on the analysis of partial differential operators form an impressive masterpiece.

Petrovsky's lacuna paper and the fact that Russian mathematicians were forced to write in Russian made me try to learn this language at the end of the 1940s. I came so far that I could review mathematical papers in Russian for both the *Mathematical Reviews* and *Zentralblatt*. Actually, all of my professional life was marked by the cold war and the restricted access to Russia. The first opening in mathematics came in 1956 when a number of Western mathematicians were invited to a congress in Moscow for mathematicians from the entire Soviet Union. We were the first foreign guests in twenty years. For me this visit was an unforgettable mixture of mathematics, confidences about repression and prisons and my first encounter with some important mathematicians. Olga Ladyzhenskaya, Olga Oleinik, Ivan Petrovsky, Israel Gelfand and many others became my friends. One day Pravda carried an article on the cult of the personality. This was part of the speech that Khruschev had given at the 20th party congress and really dealt with the crimes of the Stalin era. Our interpreters were dumbfounded.

My collaborations with Arthur Wightman and with Michael Atiyah and Raoul Bott were both important and delightful. My collaboration with Jean Leray in the 1960s petered out, but was important for me since I learned a lot from him about Petrovsky's paper.

I have now talked too long, but let me say that my marriage to Eva, my many friendships with mathematicians in Scandinavia and abroad, and the kindness and understanding I have met from mathematicians in Lund – for instance, my two interviewers – have given me a happy life.

Journal of the European Mathematical Society (JEMS)

The Contents lists of the fifth, sixth and seventh issues of the JEMS are as follows:

Volume 2, Number 1:
Charles Pugh and Michael Shub, *Stable ergodicity and julienne quasi-conformality*
Alan Weinstein, *Almost invariant submanifolds for compact group actions*
Fang-Hua Lin and Tristan Rivière, Erratum to *Complex Ginzburg-Landau equations in high dimensions and codimension two area minimizing currents*

Volume 2, Number 2:
Alain-Sol Sznitman, *Slowdown estimates and central limit theorem for random walks in random environment*
Bruno Kahn and R. Sujatha, *Motivic cohomology and unramified cohomology of quadrics*
Birkett Huber, Jörg Rambau and Francisco Santos, *The Cayley trick, lifting subdivisions and the Bohne-Dress theorem on zonotopal tilings*

Volume 2, Number 3:
J. Lindenstrauss and D. Preiss, *A new proof of Fréchet differentiability of Lipschitz functions*
J. Filo and S. Luckhaus, *Homogenization of a boundary condition for the heat equation*
G. van der Geer and T. Katsura, *On a stratification of the moduli of K_3 surfaces*

Correction to Newsletter 34

On page 28 of EMS Newsletter 34 (December 1999), the article on the EMS-WiR Summer School, Numerical Simulation of Flows was written by Jürgen Geiser and Torsten Fischer, members of the research team of Prof. G. Wittum (University of Heidelberg), and not by Rolf Jeltsch. Also, it was not mentioned that support for this summer school was given by UNESCE-ROSTE, the Venice office of UNESCO. We apologise for these errors.

Surveys on Mathematics for Industry

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2000 Anniversaries

Sonya Kovalevskaya (b. 1850)

June Barrow-Green

Sophia (Sonya) Vasilievna Korvin-Krukovsky was born in Moscow on 15 January 1850, the daughter of a general in the Russian artillery. In 1858 her father retired and took his family to live at their large estate in Palibino. As she related in her autobiography, the move had an unexpected consequence with regard to her mathematical development:

When we moved permanently to the country, the whole house had to be redecorated and all the rooms had to be freshly wallpapered. But since there were many rooms, there wasn't enough wallpaper for one of the nursery rooms. Because ordering wallpaper involved sending to St Petersburg it was a very complicated business, and it really wasn't worthwhile to go through all of that for just one room. It was all waiting for a propitious occasion, and in expectation of this the maltreated room just stood there for many years with one of its walls covered with ordinary paper. But by happy chance, the paper for this preparatory covering consisted of the lithographed lectures of Professor Ostrogradsky on differential and integral calculus, which my father had acquired as a young man.

These sheets speckled all over with strange unintelligible formulas, soon attracted my attention. I remember as a child standing for hours on end in front of this mysterious wall, trying to figure out at least some isolated sentences and to find the sequence in which the sheets should follow one another. From this protracted daily contemplation, the outer appearances of many of these formulas imprinted themselves in my memory; indeed their very text left a deep trace in my brain, although they were incomprehensible to me when I was reading them." [**3**, pp.122-123].

Sonya was fortunate that her father, who was well educated and fond of mathematics and science, encouraged her study of mathematics, at least at an elementary level. Her ability was recognised by a family friend, Nikanorovich Tyrtov, professor of physics at the St Petersburg Naval Academy, and in 1867, persuaded by Tyrtov, her father consented to her taking lessons from Alexander Strannolyubsky in St Petersburg. From Strannolyubsky she studied differential and integral calculus, and, as she recalled, her hours of perusing the wallpaper at Palibino finally paid off:

Many years later ... I took my first lesson in differential calculus from the eminent Petersburg professor Alexander Strannolyubsky. He was amazed at the speed at which I grasped the concepts of limit and of derivatives, "exactly as if you knew them in advance". I recall that he expressed himself in just those words. And, as a matter of fact, at the moment when he was explaining these concepts I suddenly had a vivid memory of all this, written on the sheets of Ostrogradsky; and the concept of limit appeared to me as an old friend. [**3**, p.123].

As Sonya began to develop mathematically she also matured politically, becoming increasingly interested in the nihilist philosophy. The nihilists wanted to change

the traditional tsarist society and believed in the power of education to implement social change. They had a strong faith in the natural sciences and unequivocally supported the equality of women. It was a combination of ideas that Sonya found particularly appealing and in September 1868 she married fellow nihilist Vladimir Kovalevsky. The marriage which was initially 'fictitious' – it had been contracted in order to give Sonya the possibility of studying at a university abroad – proved a difficult one.

Initially the couple lived in St Petersburg, but as a woman Kovalevskaya was unable to gain admission to university, and early in 1869 they travelled to Vienna. Unable to find any sympathetic mathematicians in Vienna, they moved on to Heidelberg. In Heidelberg Kovalevskaya, the first woman student at the University, studied physics with Gustav Kirchhoff, physiology with Hermann Helmholtz, and mathematics with Leo Königsberger and Paul DuBois-Raymond.

In the autumn of 1870, with recommendations from Königsberger and DuBois-Raymond, Kovalevskaya journeyed to Berlin to work with Karl Weierstrass. The University was closed to women but Weierstrass agreed to tutor her privately. As Kovalevskaya herself was later to say:

These studies had the deepest possible influence on my mathematical career. They determined finally and irrevocably the direction I was to follow in my later scientific work: all my work has been done precisely in the spirit of Weierstrass. [**3**, p.218]

Under Weierstrass's supervision Kovalevskaya completed three dissertations and in 1874, with recommendations from Lazarus Fuchs and Heinrich Weber, she was granted her doctoral degree *summa cum laude* from the University of Göttingen (*in absentia*). She was the first woman in modern Europe to receive a doctorate in mathematics and one of the first women to receive a doctorate in any field.

The three dissertations were on partial differential equations, Abelian integrals, and Saturn's rings, but it was the one on partial differential equations that had really excited Weierstrass. In it was contained what is today known as the Cauchy-Kovalevskaya theorem, an important tool in establishing the existence or non-existence of analytic solutions of partial differential equations. The paper was published in *Crelle's Journal* in 1875 [**4**] and her work was greatly admired by other mathematicians, including Charles Hermite and Henri Poincaré, both of whom spoke of the result in glowing terms [**2**, p.241; **9**, p.26].

Meanwhile, in 1872, Vladimir had gained a doctorate in geology at Jena. The couple had reconciled in 1873 and they returned to Russia expecting to be appointed immediately to prestigious teaching posts in St. Petersburg. However, Kovalevskaya soon discovered that as a woman she was unable to obtain a position in the Russian system of higher education and the only opening for her in mathematics was to teach in the lower grades of a girls' school. But since, as she sarcastically observed, "she was not strong in the multiplication tables" [**2**, p.127] she did not seriously consider such a position. Instead she turned to other intellectual pursuits – writing fiction, theatre reviews and popular science reports for newspapers. Initially she tried to combine mathematics with her other interests and kept up a mathematical correspondence with Weierstrass. However, in September 1875 her father died. His death came as a shock to her and for reasons possibly associated with his death, her health and the change in her relationship with Vladimir (they had finally consummated their marriage in early 1875), she turned completely away from mathematics. From October that year and for the next three years Weierstrass heard nothing from her. The Kovalevskys immersed themselves in the salon life in the capital, engaging in what was to become a catalogue of ruinous financial speculation.

In early 1876 Kovalevskaya was visited by another of Weierstrass's students, the young Swedish mathematician Gösta Mittag-Leffler. On this occasion he had been sent by their common adviser to try to reawaken her interest in mathematics. He did not succeed, but he left with a glowing impression:

More than anything else in St. Petersburg what I found most interesting was getting to know Kovalevskaya ... As a woman, she is fascinating. She is beautiful and when she speaks, her face lights up with such an expression of feminine kindness and highest intelligence, that it is simply dazzling. Her manner is simple and natural, without the slightest trace of pedantry or pre-

tension. She is in all respects a complete "woman of the world". As a scholar she is characterised by her unusual clarity and precision of expression ... I understand fully why Weierstrass considers her the most gifted of his students. [**8**, p.172].

In the spring of 1878 Kovalevskaya's life turned again. She became pregnant. During the course of what was to be a difficult pregnancy she reflected on the direction of her life, and in August she reopened her correspondence with Weierstrass, writing to him for advice on resuming her mathematics. However her return to mathematics was delayed by the birth of her daughter in October and the

death of her mother in February 1879, followed by the failure of the Kovalevsky investments.

The financial disaster, which culminated in the sale of most of the family possessions, affected Vladimir deeply and he withdrew from society. Kovalevskaya on the other hand responded more positively. She contacted the Russian mathematician Chebyshev who invited her to give a paper at the 6th Congress of Natural Scientists to be held in St Petersburg in January 1880. She dug out her unpublished dissertation on Abelian integrals, translated it from German to Russian in one night, and presented it to the conference. It met with an enthusiastic reception, and Mittag-Leffler, who was in the audience and now a professor at the University of Helsinki, left determined to find her a university position.

In the spring of 1880 the Kovalevskys moved to Moscow, Kovalevskaya intent on participating fully in scientific life. In October she travelled to Berlin to visit Weierstrass. On her return in January 1881 she found that Vladimir was again badly in debt. She was completely exasperated and to all intents and purposes their marriage finally ended. The household was dissolved in March 1881 and she and her daughter left for Berlin where she threw herself totally into mathematics. She saw Weierstrass frequently and devoted her research to the study of two topics: the propagation of light in a crystalline medium – a subject to which she had been led by studying the work of the French physicist Lamé – and the rotation of a solid body about a fixed point, a particularly attractive but elusive problem which had become known by the German mathematicians as the "mathematical mermaid".

Meanwhile she continued to correspond with Mittag-Leffler who had been battling with the university in Helsinki to obtain a position for her. Ironically his efforts had come to grief, not because she was a woman but because she was a known nihilist and the university administrators had feared that her appointment would draw the anger of the tsarist government that occupied Finland at the time. In 1881 Mittag-Leffler became head of the mathematics department at the newly founded university in Stockholm and continued his efforts on her behalf.

Later in 1881 she moved to Paris to work alone on her mathematics. In May, Mittag-Leffler arrived and, surprised to discover that she had not met any French mathematicians, immediately took her to meet Hermite. In July 1882 she became a member of the French Mathematical Society and soon got know several of the best mathematicians, including Hermite, Poincaré, Picard and Darboux. However, while Kovalevskaya was making an impression on mathematicians in Paris, Vladimir, who had completely abandoned palaeontology in favour of financial speculation, was facing complete financial ruin. In April 1883 he committed suicide. When Kovalevskaya heard the news she locked herself into her room, refused to eat or allow a doctor near her, blaming herself for his death. Five days later she lapsed into a coma and the doctor was able to force feed her. She recovered consciousness the following day. She began working intensively and soon completed her research on the light diffraction problem. In the early summer she travelled to Moscow and on the way stopped off in Berlin to show Weierstrass her work. Weierstrass was satisfied and encouraged her to write up her results for presentation. At the end of August she delivered her paper at the 7th Congress of Natural Scientists in Odessa.

Meanwhile, Vladimir's death had caused relief in mathematical circles. As a widow Kovalevskaya would encounter fewer social obstacles to her mathematical career than she would as a single or married woman, and Mittag-Leffler seized the chance provided by her new status. Together with a group of other professors he made a concerted assault on the administration of the new Stockholm University and by skilful manoeuvring managed to obtain for her a temporary post.

In September 1883 Sonya heard the news. The offer – as a *privat-docent* – was a common one given to people on the completion of their doctorate. She was to be on probation for a year, during which time she would receive no salary and no official status. Her pupils would pay by private arrangement and her situation would be reviewed at the end of the academic year. In November she arrived in Stockholm. Her reception was mixed – one of the progressive Stockholm newspapers hailing her as a "princess of science" [**2**, p.179] while the Swedish dramatist Strindberg considered a female professor of mathematics to be a pernicious and useless monstrosity [**1**, p.109]. In January 1884 she gave her first lecture, the beginning of a course on partial differential equations. The lectures were well received, she completed her probationary term successfully, and in the summer Mittag-Leffler secured her appointment as an assistant professor.

In addition to joining the staff of the University, Kovalevskaya became an editor of *Acta Mathematica*, the journal founded by Mittag-Leffler in 1882 – the first woman to join the board of a scientific journal. On behalf of *Acta* she liaised with the mathematicians of Paris, Berlin and her native Russia, providing an important link between Russian mathematicians and their western European counterparts. *Acta* also proved a good vehicle for her own publications. Her doctoral paper on Abelian integrals was published in 1884 [**5**] and her paper on the propagation of light in 1885 [**6**]. (Her paper on the shape of Saturn's rings was also published in 1885, but in *Astronomische Nachrichten* [**7**].)

1885 was a year that was to prove one of the most productive of her mathematical career. She had been working hard at the rotation problem and after four years had finally made a breakthrough. By the spring of 1886 she had solved in principle as much of the problem as she could hope to do, and the rest was a matter of working out the details, although a considerable amount remained to be done. Aware of the importance of her work, she left for Paris in order to communicate her ideas to the mathematicians there. Her visit was to have important consequences.

In the autumn of 1886 the announcement for the *Prix Bordin* of the French Academy of Sciences to be awarded in 1888 was made. The topic: "Improve, in some important point, the theory of the movement of a rigid body" had been chosen specifically with Kovalevskaya in mind. Due to competing concerns in her personal life she was unable to complete her work by the deadline of 1 June 1888, but she sent in a half-finished version and, with the Prize Committee's permission, submitted a revised, although still incomplete, version in the late summer.

In December she went to Paris to hear the result. As she herself later wrote:
Some fifteen papers were presented, but it was mine that was found deserving of the prize. And that was not all: in view of the fact that the same topic had been assigned three times running and remained unsolved each time, and also in view of the significance of the results achieved, the Academy voted to increase the previously announced award of 3,000 francs to 5,000. [**3**, p.227].

Kovalevskaya's memoir was a triumph and earned lavish praise from her contemporaries. She had discovered a special (and complicated) case of the problem that was capable of a closed solution. It was a case in which the body is asymmetric. The particular novelty of her solution lay in her application of the recently developed theory of theta functions to solve hyperelliptic integrals. Prior to her work the problem had only been completely solved for two

cases, in both of which the body is symmetrical. In the first, solved by Euler, the centre of gravity of the moving body coincides with the moving point, and in the second, solved by Lagrange, the centre of gravity and the fixed point lie on the same axis. In the words of the Prize Committee (who, in theory, were not supposed to know the identity of the entrants to the competition):

The author has not merely added a result of very high interest to those that were bequeathed to us by Euler and Lagrange; he has made a profound study of the result due to him, in which all the resources of the modern theory of theta functions of two independent variables allow the complete solution to be given in the most precise and elegant form. One has thereby a new and memorable example of a problem of mechanics in which these transcendental functions figure, whose applications had previously been limited to pure analysis and geometry. [**10**]

In May 1889, with recommendations from Bjerknes, Hermite and Beltrami, the University of Stockholm made Kovalevskaya a full professor – the first woman to achieve such a position. When she returned to Stockholm later in the year she published two variations on the prize-winning memoir. These papers clarified points that had been left obscure in her haste to meet the deadline for the Bordin competition. She had also, on the recommendation of Chebyshev and in opposition to the prevailing academic attitudes towards women, been elected a corresponding member of the Russian Academy of Sciences – the first woman to be so honoured.

In May 1890 she travelled to St Petersburg to discuss with Chebyshev the possibility of filling a recent vacancy in the Russian Academy of Sciences – that is, to become a full member rather than a correspondent. Chebyshev was encouraging but the prejudices were too great and the project fell through. Her case was not helped by the attacks made on her by A. A. Markov, who claimed that her rotation papers were not only incorrect but also incompetent – there was a gap in one of her arguments, but nothing irreparable.

After the autumn term in 1890 Kovalevskaya travelled to Genoa. On the return journey she arrived in Copenhagen in early February without any Danish money and had to carry her bags in pouring rain. When she arrived in Stockholm she was ill but managed to teach her first class of the new term before taking to her bed. Three days later she seemed better and discussed her work plans with Mittag-Leffler. But she had contracted pneumonia and quite suddenly, early the next morning, 10 February 1891, she died.

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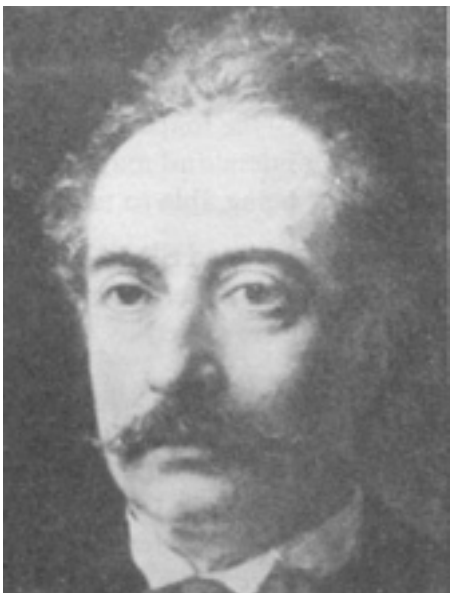
Eugenio Beltrami (d. 1900)

Jeremy Gray

The Italian mathematician Eugenio Beltrami (16 November 1835 – 18 February 1900) is best remembered for his work on non-Euclidean geometry, but he worked for most of his life on different topics in applied mathematics. He first studied mathematics at the University of Pavia, where Brioschi was Professor, but then for a few years financial problems forced him to work as the secretary to a railway engineer, in Verona and Milan after the Austrians had been driven out during the unification of Italy. His fortunes now



improved, and he occupied a succession of professorships in Bologna, Pisa (where he came to know Enrico Betti well), and then Rome, Pavia, and finally Rome again.

His interest in geometry was sharpened by his acquaintance with Cremona, and in the 1860s he studied the representation of curved surfaces on a plane. He published an Italian translation of Gauss's celebrated work on conformal representation, and took up the question of when the geodesics on a surface can be represented as straight lines on the plane. When this can be done the equation for the geodesics takes a special form. Beltrami deduced that geodesics cannot always be represented as straight lines, and then investigated those surfaces for which such a representation can be found, and showed that they are precisely the surfaces of constant curvature.

His celebrated discovery of the representation of a surface of constant negative curvature on the interior of the unit disc followed in 1868. Beltrami, who knew Hoüel's French translation of some of Lobachevskii's work in 1866 (but probably not his translation of Bolyai's the next year) explained clearly how the disc carried non-Euclidean geometry. But publication of his *Saggio* (Essay) was delayed, because Cremona was worried that the paper rested on a vicious circle. It was a thorough-going piece of differential geometry, but the calculus rested on Euclidean geometry: it was not clear that it could be used to describe an alternative geometry. Beltrami laid the paper aside for some time as a result, until he decided that it was 'substantially in agreement with some ideas of Riemann'. Oddly enough, he seems not to have discussed geometry with Riemann, although Riemann had spent a good deal of time in Italy talking to Betti and to have learned of his ideas only through their posthumous publication.

The accounts of non-Euclidean geometry by Bolyai and Lobachevskii were in the last analysis accounts of the consequences of making a new definition of parallels. They did not show that the alternative definition did not lead to a contradiction. So Beltrami's was the first account that was rooted in sound mathematics, and as such it drew its share of criticisms from those to whom a novel geometry was a palpable absurdity. But Beltrami went on to elaborate an n-dimensional version the next year, and among mathematicians at least the battle for non-Euclidean geometry was then steadily won.

In the 1870s Beltrami's interests turned towards physics. He investigated how the theory of the Newton gravitational potential would have to be modified in spaces of negative curvature, and formulated the appropriate generalisation of the Laplace operator (nowadays called the Laplace-Beltrami operator in his honour). His work on differential parameters led to a theory of intrinsic functions and properties of surfaces, later taken up by Ricci and Levi-Civita. He also contributed significantly to the history of mathematics, rescuing Girolamo Saccheri's prescient study of the parallel postulate (published in 1733) from obscurity.

In 1898 he became President of the Accademia dei Lincei and in 1899 a senator of the kingdom of Italy.

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Societies Corner

Societies corner is a column concerning the mathematical societies in European countries. The articles in this column could describe the history of a particular society or discuss some event connected with the society. If you feel that your society would interest others, please contact the column editor, Krzysztof Ciesielski (e-mail: ciesiels@im.uj.edu.pl) in the first instance.

Dutch Mathematical Society

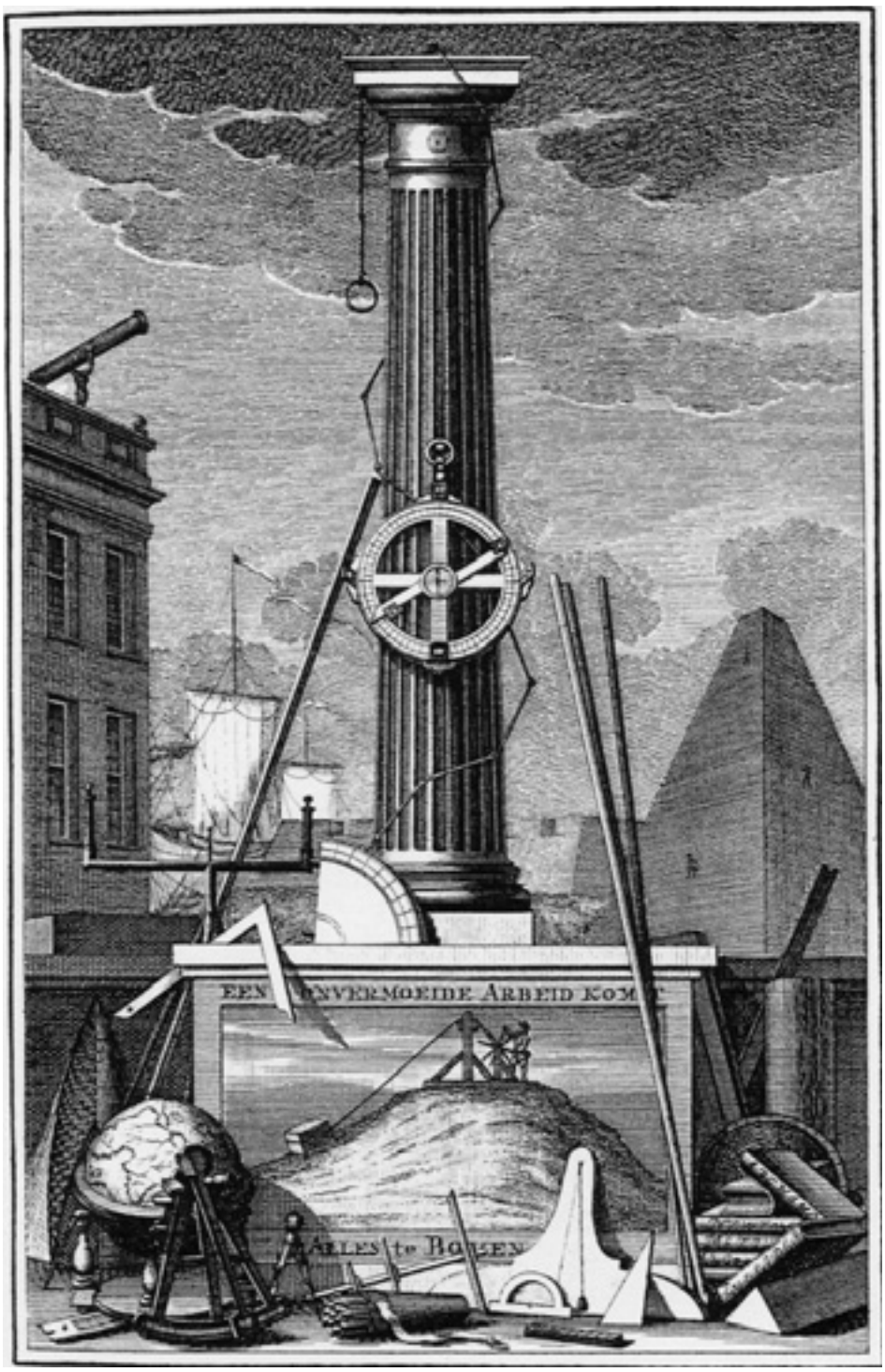
Wiskundig Genootschap

In 1600 the Netherlands were at war. Prince Maurits van Nassau (1567-1625), son of William the Silent (1533-84), led the young republic in its fight for independence from Spain. A military genius who believed in scientific warfare, he counted among his advisers Simon Stevin (1548-1620), a versatile mathematician whose accomplishments ranged from the design of fortifications to the introduction of decimal fractions. At the instigation of Stevin, the Prince attached an engineering school to the newly founded university at Leiden. Its first professor was Ludolph van Ceulen (1540-1610), famous to this day for having computed 35 decimals of π. He taught his courses in the vernacular, using the extensive Dutch mathematical vocabulary that Stevin had zealously devised. Dutch is still the only western language having a word of its own for mathematics: *wiskunde*, which literally translates into 'knowledge'.

The Dutch succeeded in breaking the power of Spain, and their seaborne empire developed into the wealthiest nation of the seventeenth century. Arts and sciences flourished during the Dutch Golden Age. Rembrandt van Rijn (1606-69) and Baruch de Spinoza (1632-77) achieved world fame, as did Christiaan Huygens (1629-95), Europe's greatest mathematician in the period before Isaac Newton (1642-1727).

The *Wiskundig Genootschap* has the distinction of being the oldest of all present-day national mathematical societies. It was founded in 1778 by Arnoldus Bastiaan Strabbe (1741-1805), preceptor of mathematics and astronomy and gauger of wine casks of the City of Amsterdam. In 1770, he had started the *Oeffenschool der Mathematische Wetenschappen* (Training school of mathematical sciences), a periodical that sought to enlighten the many intellectuals who in the Age of Reason solved mathematical problems and puzzles as a pastime. Commercially, the enterprise was a failure, and Strabbe originally founded the Genootschap in order to finance his numerous publications. The society still carries the motto he chose: *Een onvermoeide arbeid komt alles te boven* (Untiring labour overcomes all). It expressed the attitude of a membership that, in addition to the amateurs just mentioned, comprised schoolteachers, surveyors, bookkeepers, engineers, instrument makers, and other practically minded mathematicians. The frontispiece of the *Genootschap*'s earliest publication speaks volumes. One senses the spirit of Stevin and van Ceulen and, maybe, the hope of reviving the glorious seventeenth century.

The Napoleonic era transformed the Dutch republic into a kingdom. A new class of scientists and mathematicians emerged: those who performed research on a professional basis. The *Wiskundig Genootschap* became more tightly organised. Their yearly meetings were replaced by monthly ones, with lectures that, instead of addressing the utility of mathematics and its role in the pursuit of happiness, now had actual mathematical con-



The frontispiece of the first issue of the Wiskundig Genootschap in 1782.

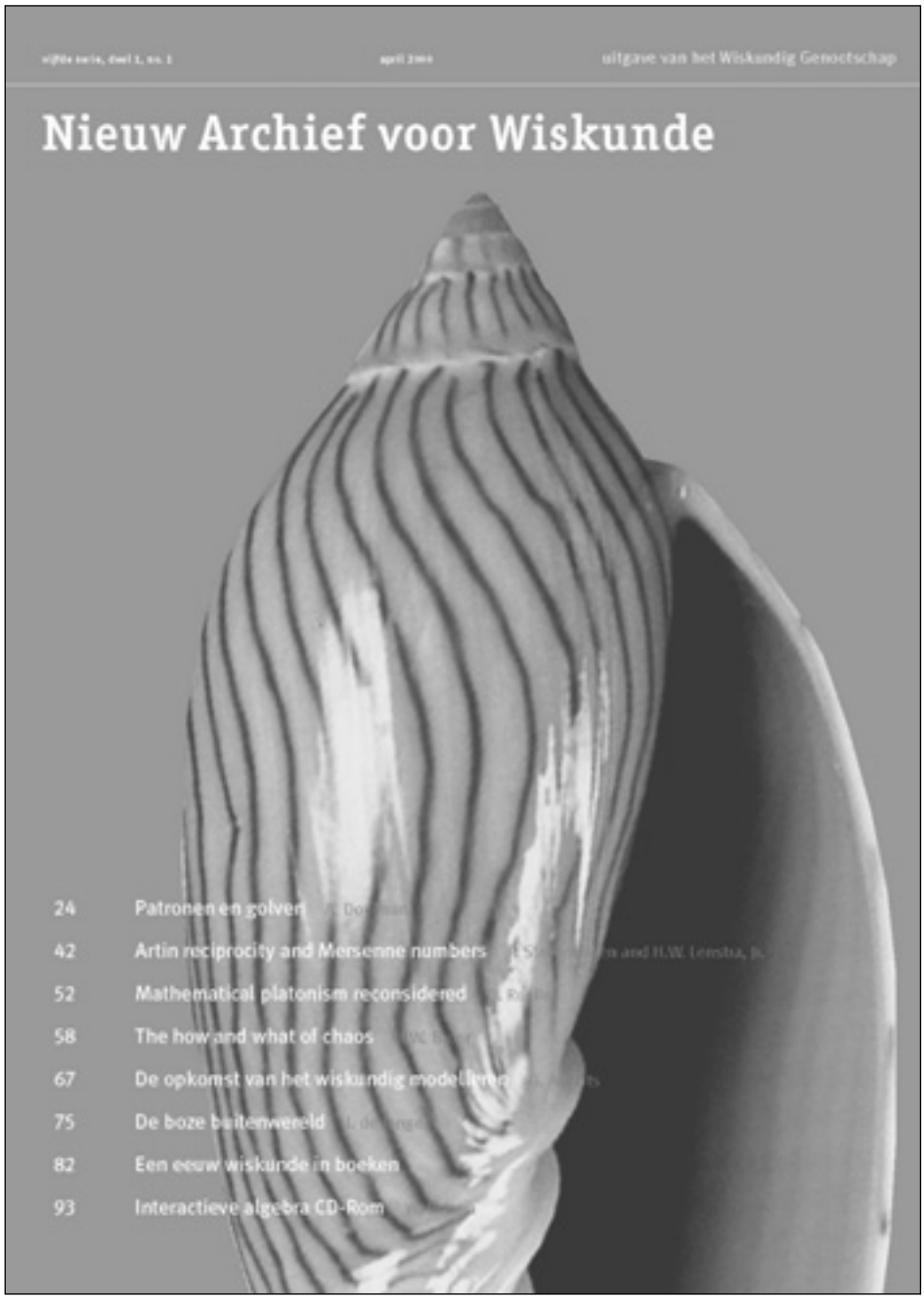
tent. Order was brought into the *Genootschap*'s library, and during the nineteenth century the emphasis in their publications gradually shifted from problems to original work. A prominent and active member was Rehuel Lobatto (1797–1866), an expert in weights and measures and in actuarial sciences, and professor at Delft. Generations of Dutch mathematicians learnt higher algebra from Lobatto's *Lessen over Hoogere Algebra*, which appeared in 1845 and reached its ninth edition in 1921.

During the second half of the nineteenth century, the *Wiskundig Genootschap* established contacts with newly founded national mathematical societies in other European countries. The compilation of bibliographic reference works, necessitated by the growing body of literature, required international cooperation. David Bierens de Haan (1822–95) was the driving force behind the *Revue Semestrielle des Publications Mathématiques*, which the *Genootschap* published from 1893 to 1934. He was a professor at Leiden, whose scholarly reputation rested on voluminous tables of definite integrals (1858). His bibliography of early Dutch scientific publications (1883) is still widely used.

The reader may know several Dutch mathematicians who were active around the turn of the century. Thomas Joannes Stieltjes (1856–94) was too great for the Netherlands. On the recommendation of Charles Hermite (1822–1901) he was appointed to a professorship at Toulouse. The *Wiskundig Genootschap* published his *Oeuvres Complètes* in 1914–18. A central figure in Dutch mathematics was Diederik Johannes Korteweg (1848–1941), who served on the board of the *Genootschap* for 58 years. The Korteweg-de Vries equation first appeared in the thesis (1894) of his student Gustav de Vries (1866–1934). In 1913, Korteweg generously ceded his chair at Amsterdam to his brilliant advisee Luitzen Egbertus Jan Brouwer (1881–1966), whose theorem on the invariance of dimension (1910) and fixed-point theorem (1911) heralded the advent of algebraic topology. Brouwer created intuitionism, and was involved in a famous struggle with David Hilbert (1861–1943) on foundational issues. The *Genootschap* published his *Collected Works* in 1975–76, and instituted in 1970 the Brouwer medal, awarded once every three years to a mathematician of the highest calibre. Its first recipient was René Thom (b. 1923).

Since 1875, all members of the *Wiskundig Genootschap* have received the *Nieuw Archief voor Wiskunde*. Itself a renewed version of the *Archief*, which had started in 1856, the *Nieuw Archief* keeps renewing itself, a fifth series commencing in 2000. The Problem section of this quarterly is as alive as ever. The *Mededelingen* (Notices) *van het Wiskundig Genootschap* are now largely distributed electronically; the printed edition is expected to be discontinued soon. A few years ago, the society assumed responsibility for publishing *Pythagoras*, a magazine for high school students.

The *Wiskundig Genootschap* never did much government advising. In 1918, they were instrumental in increasing the number of mathematicians at the Universiteit van Amsterdam. After World War II, they were indirectly involved in founding the Mathematisch Centrum, a government-funded institution for research in applied mathematics that serves as a meeting point between industry and academia. In 1954 the *Genootschap* hosted the International Congress of Mathematicians in Amsterdam. Queen Juliana (born 1909), another member of the House of Nassau, received the Fields Medallists in her garden, and the Mathematisch Centrum produced table mats, now collectors' items, displaying the Gaussian primes. Soon, the *Wiskundig Genootschap* will coordinate a committee to advise the government on educational issues. The



Cover design of the Nieuw Archief voor Wiskunde – the first issue of the fifth series (2000).

Ludolph van Ceulen in 1596, with 20 decimal places of π.

Mathematisch Centrum celebrates the computer age with a new name: CWI.

In 1965, the *Genootschap*'s monthly meetings, attendance of which had been declining, were replaced by the annual *Nederlands Mathematisch Congres*. This two-day conference, which takes place in April, draws a large part of the Dutch mathematical community, including high school teachers and industrial and applied mathematicians. The annual *Winter Symposium* is specifically aimed at high school teachers.

This summer, the *Wiskundig Genootschap* will organise *Pi in de Pieterskerk*. The 35 decimals of π that Ludolph van Ceulen computed four centuries ago were first published as an inscription on his tombstone in the Pieterskerk (Peter's church) in Leiden. Sometime during the early nineteenth century the stone disappeared. On 6 July, 2000, a reproduction will be unveiled in a ceremony that honours the roots of Dutch mathematics.

The Wiskundig Genootschap gratefully acknowledges the assistance of D. J. Beckers and H. W. Lenstra jr. Consult http://www.wiskgenoot.nl/ for more information on the Wiskundig Genootschap.

Danish Mathematical Society

Dansk Matematisk Forening

Bodil Branner

The Danish Mathematical Society – *Dansk Matematisk Forening* (DMF) – is one of the oldest mathematical societies. It was founded in 1873, eight years after the London Mathematical Society, five years after the Finnish Mathematical Society and one year after Société Mathématique de France.

In the nineteenth century, the possibilities for mathematical studies improved and the mathematical community was growing. The Technical University (Polyteknisk Læreanstalt) had been founded in 1829 and a military school in 1830, after the French model. Moreover, the faculty of mathematics and the natural sciences had been established at Copenhagen University in 1850, making it possible to obtain a degree in mathematics, so there was a need for a common meeting place.

The society was founded on the initiative of Th. N. Thiele. The original rules stated that the goal was to 'promote a vivid cooperation for the benefit of the science of mathematics and its practical applications'; later 'the benefit of teaching in mathematics' was added. The first board of the society consisted of Thiele, H. G. Zeuthen and Julius Petersen. At that time there were two professorships in mathematics, soon after held by Zeuthen and Petersen, while Thiele was professor in astronomy and later mathematical director of the life-insurance company Hafnia.

The early history of the society is intimately connected with the mathematical life in Denmark at the time. The society was responsible for arranging lectures by members, who talked about their own work or introduced new mathematical topics and concepts. The society also subscribed to some journals and established a small library. When the Mathematical Laboratory at Copenhagen University was founded in 1907, the library and the running of literature meetings were moved there.

But the responsibility of organising lectures remained within the society for a long time, with a special obligation to establish and maintain international contacts; the first foreign speaker was G. Mittag-Leffler in 1900. Besides the many individual lectures given since then by foreigners, it is of interest to mention the special invitation to prominent mathematicians to deliver a series of lectures, approximately every other year; this tradition started in 1921 with David Hilbert. The Second World War put a stop to it, but the series was taken up again soon after the war, with the invitation of Hopf in 1949.

The international contacts were built on personal relationships. There was a discussion in 1921 as to whether the society should become a member of L'Union Internationale Mathématique. There were divided opinions, due to the Union's discrimination against mathematicians from countries that had been on the losing side in the First World War. Harald Bohr was strongly against membership, and no action was taken. After the Second World War, the situation was quite different; the international mathematical community was not to repeat the failures from the inter-war period. Børge Jessen served as secretary of the Interim Executive Committee of the IMU from 1950–52, and in September 1951 he could declare the official rebirth of the Union.

As described above, the activities of the society have often originated in, or been supplements to, activities within the mathematical community in the Copenhagen area, a situation which has only changed

H. G. Zeuthen (1839–1920), known for his work on enumerative geometry and the history of mathematics.

Julius Petersen (1839–1910), known in particular for his contributions to graph theory.

Th. N. Thiele (1838–1910), known for his work in astronomy, actuarial science and statistics.

slowly and is still under transformation although the mathematical landscape started to change half a century ago. In 1954, the Department of Mathematics at Aarhus University was founded as the first outside Copenhagen. From the very beginning it had strong international links and many foreign teachers. A colloquium tradition was also started, a tradition which soon spread to Copenhagen, and the other mathematics departments to be. Thus the former important role of the society has diminished. Other changes are due to the creation of societies such as the Danish Society of Theoretical Statistics, the Danish Operations Research Society, the Danish Society of Computer Science and the Danish Center of Applied Mathematics and Mechanics.

The society still arranges lectures in the Copenhagen area, but less frequently than before. During the last ten years regular meetings have been organised once or twice a year, alternating between the different mathematics departments, with lectures and discussions of common interests.

The society has published the *Collected Mathematical Works of Harald Bohr*, edited by E. Følner and B. Jessen in 1952. (They are still sold through the DMF.) Moreover, the society initiated the publication of the *Collected Mathematical Papers of Jakob Nielsen*, edited by Vagn Lundsgaard Hansen and published by Birkhäuser in 1986.

For the last 25 years, a newsletter MATNYT has been published and distributed to all members almost weekly. It consisted mainly of advertisements for lectures and meetings. This service was changed last year by splitting it into an electronic calendar (see *www.matnyt.mathematics.dk/*) and a newsletter with articles (mainly in Danish) printed four times a year and distributed to all members.

Together with other Scandinavian mathematical societies, the DMF is responsible for the publication of *Mathematica Scandinavica* and *Nordisk Matematisk Tidsskrift* (NORMAT). Every fourth year one of the Scandinavian mathematical societies hosts a conference. This year the DMF is the host of the First AMS-Scandinavian International Mathematics Meeting, the XXIII Scandinavian Congress of Mathematicians. It will take place in Odense in June: see *www.imada.sdu.dk/~hjm/AMS.Scand.html/*

The DMF (web address: *www.dmf.mathematics.dk*) has currently about 340 members, of which one-fifth are also individual members of the EMS. A general assembly is held once a year, and in even years members of the Board are elected. Re-election may occur, although the president can be re-elected only once and other members at most three times. Individuals can apply for membership to the Board, which has the power to accept members.

Bodil Branner is currently president of the DMF.

Mathematicians on their way to congratulate Zeuthen on his 80th birthday in 1919. From left to right: T. Bonnesen, J. Mollerup, Chr. Juel, Harald Bohr, Niels Nielsen, C. Crone, J. Hjelmslev and J. L. W. V. Jensen. They were all closely involved in the life of the Society.

Mathematics in English schools

A. D. Gardiner

History of the school system

Until 1988 education in England was a local responsibility – with control vested in around 100 'Local Education Authorities' (LEAs). Each LEA received most of its funding from central government; LEAs were responsible for compulsory education (ages 5-16) and for further education (ages 16-19 and adult vocational training), and raised a percentage of their budget through local taxes. Each LEA provided advice and support to schools and colleges. However, the details of what was taught and how it was taught remained the responsibility of the individual school: there were no national or local curricula.

This apparent recipe for anarchy was constrained by the facts that what was taught at secondary level was strongly influenced by 'public' examinations at ages 16 and 18, and that until the early 1970s what was taught at primary level was influenced by selection tests for entry to 'grammar schools' at ages 10-11. During the late 1960s and 1970s selection at ages 10-11 was largely abandoned, and most of the existing grammar schools were reconstituted as 'comprehensive' (all-ability) schools. Any such change had to be decided at a local level, and so had electoral implications for local politicians; hence some LEAs adopted compromise schemes with the result that we still have 166 selective secondary schools (out of 4000 or so) in England. However, the present government has introduced proposals which are intended to make it easier for LEAs to change the status of the remaining grammar schools.

At neither primary nor secondary level was there any tradition of devising detailed curricula or teaching plans: some schools devised their own teaching plans, but most mathematics departments selected and followed a scheme or textbook series which, in their judgement, matched the abilities of their pupils and which prepared them for the next exam they faced. There was (and is) no official procedure for vetting or 'approving' textbooks: schools are not only free to choose, but are given no official information to assist in that choice.

The examinations which effectively determined the curriculum were not designed or controlled by government agencies. The entry tests for grammar schools were administered by LEAs – often using commercially available tests in English, Mathematics and Reasoning. The 'public' examinations were provided by a large number of 'examination boards' – most of which had historical connections with groups of universities. The main exam boards originally existed to provide 'matriculation tests' for university entrance, but in the 1960s they began to coordinate locally based exams at age 16 for non-academic pupils.

The move away from grammar schools coincided with an increasing concern to provide for the (previously neglected) 'bottom 75%'. The consequences of these changes were often driven as much by local politics and administrative concerns as by educational policy. For example:

(a) The potential market for the examination boards more than doubled, and the desire to generate income from the larger part of this market was sometimes stronger than the demand for educational principles to guide these new developments.

(b) Grammar schools had contained the bulk of highly qualified teachers, and so were the natural focus for academic educational provision at ages 16-19. Abandoning grammar schools created a vacuum at senior high school level. In the political euphoria following 'comprehensivisation', almost all schools were allowed to offer academic courses for pupils aged 16-19. It was clear from the outset that this was unworkable; however, to have allowed a minority of schools to retain academic provision for ages 16-19 would have looked like reinventing grammar schools by the back door. So many LEAs moved towards a new pattern of provision – with secondary schools restricted to ages 11-16, while separate 'colleges' provided academic and vocational courses for those aged 16-19. This led to an outflow of qualified mathematics teachers from 11-16 schools into 16-19 colleges. Official statistics [3] show that in 1992 in maintained (publicly funded) secondary schools only one third of the mathematics lessons for pupils aged 11-14 were taught by teachers whose pre-service training included a degree with mathematics as a main component, while almost two-thirds of mathematics lessons for pupils aged 16-18 were taught by teachers with such a qualification.

The present

Like the British constitution, many English institutions reflect what outsiders must see as an incoherent muddle. However, given a measure of stability (and, in the case of education, a sufficiently large, critical mass of competent teachers), this incoherence has often proved historically valuable by leaving room for innovation, flexibility and compromise.

The dramatic changes in England from 1965 to 1985 made educational change essential, but they also undermined social and political stability. Government introduced a new style of 'radical politics' in which change was imposed through 'permanent revolution' – an endless string of initiatives and 'reforms' which achieved central control by undermining the traditional stability of English life. This style of administration has since been adopted much more widely.

One of the main goals of the (right-wing) government of the 1980s was to restrict the power of (mostly left-wing) urban LEAs. To this end they exploited the language of 'accountability', and used this to justify mechanisms for central control. In education, this led naturally to the idea of a centrally controlled national curriculum, with centrally administered national assessment. As indicated above, some change was needed; but the motivation for what happened was more political and bureaucratic than educational.

England has no tradition of central control in education. Unlike certain other European countries, we had no cadre of officials who understood the conditions under which central control in education can work, who appreciated its limitations, or who knew how to administer a centrally controlled system.

The changes that were eventually made in the late 1980s were strongly influenced by the position of 'mathematics' in the school curriculum. In response to widespread complaints about the mathematical abilities of school leavers, the government established in 1978 an inquiry – which came to be known as the 'Cockcroft Committee', after its Chair, the late Sir Wilfred Cockcroft, a professor of mathematics. This committee was instructed 'to consider the teaching of mathematics ... with particular regard to the mathematics required in further and higher education, employment and adult life generally'. They interpreted this instruction in a strongly utilitarian way: the very limited mathematics which adults actually use was accepted as indicating what really needed to be taught at school level. This had profound consequences. In particular, though the report itself was mostly moderate in tone, it was used by others to persuade a whole generation of English educators and administrators to undervalue the mental 'mathematical world', and to overvalue practical work, 'generic skills' (such as teamwork and problem solving), 'technology', and 'applications' with little mathematical content.

This was the era of plausible slogans. Technology, we were told, had changed completely what schoolchildren needed to learn. They no longer needed to learn facts or algorithms, but should rather be taught 'how to learn'. Multiplication tables and written algorithms were too narrow; instead children needed a 'sense of number'. No-one explained how one could achieve such a 'number sense' without mastering traditional arithmetic, or how one could 'solve problems' without the requisite facts and algorithms. Having woken up to the fact that 'the mathematical world' on its own is not 'sufficient' to ensure that school leavers can use their mathematics, English mathematics educators appeared to conclude that this formal universe was also 'unnecessary' – and even unhelpful. Teachers were encouraged to believe that one could teach pupils to use mathematics directly, without first grappling with the awkward abstractions of traditional school mathematics.

The Cockcroft committee reported in 1982. Its analysis and recommendations were concerned solely with mathematics, but they stemmed from tensions and conflicting demands which affected all subjects. In particular, the report had to address the kind of changes which might provide a better deal for 'the bottom 75%'.

The Cockcroft Report made some important and valuable recommendations, and achieved a remarkable balance between 'progressive' and 'traditional' views of mathematics education, even if those who subsequently used the report to further their own agendas were often less sensitive to this need for balance.

However, the report had two main weaknesses:

(i) It was too concerned to resolve tensions within the mathematics education community, and so failed to notice more telling administrative and political trends, such as the increasing calls for 'accountability' and for central control.

(ii) The report was strongly influenced by emerging evidence of the gulf between the 'intended' and the 'achieved' curriculum. Unfortunately it failed to distinguish between universal facts and local pathology. For example, data from the late 1970s which showed that certain topics appeared to be 'too hard' for most English 14 year-olds was interpreted at face value without looking across the Channel to see whether this was a universal fact or a temporary local aberration – that is, the report did not take account of what was routinely achieved in other European countries.

In the years immediately following the Cockcroft Report, successive Ministers (with orders from the then Prime Minister, Margaret Thatcher) grappled with the problem of how to regain control of an educational system which had lost its traditional contraints – but with limited success.

Some partial improvements were implemented. For example, until 1985 public examinations at age 16 were offered on two levels: the traditional 'O level' exams for the top 25-30%, and an unsatisfactory watered-down version of these exams for the next 30-35%. Both exams officially excluded the bottom 40%.

In line with the purely mathematical recommendations of the Cockcroft Report, the year 1988 saw the introduction of a uniform system of examinations at age 16 for all subjects. The 'system' was uniform, but there were dozens of different exams offered by different agencies – though they all had to observe certain common criteria – which led to the introduction of vetting procedures which marked the beginning of central control!

The new system of exams served a larger fraction of the age group, and the syllabus for weaker students was designed specifically to cater for their needs and abilities. However, since this requirement was interpreted in line with the comments in (ii) above, the resulting syllabuses were partly responsible for institutionalising low expectations.

The detailed history of this period remains to be written. To the casual observer it would appear that modest changes were insufficient for the then Prime Minister, so a new Minister of Education was appointed to introduce wholesale change. The resulting Education Reform Act (1988) promised a compulsory national curriculum in ten subjects, and provided for the subsequent introduction of centrally controlled national testing at ages 7, 11, 14 and 16.

The administration underestimated the difficulties of what was being attempted. To start the process of drafting and implementing an agreed curriculum (in ten subjects) it was thought obvious to start with Mathematics!

The abolition of the grammar schools had created a national taboo: it was no longer possible to discuss the idea of 'selection', or to consider devising different curricula for identifiably different groups before the end of compulsory education at age 16. Hence the National Curriculum had to appear to provide equal opportunities for all.

However, the need to make some provision for different abilities had been highlighted by the Cockcroft report, which had revealed the dramatic gulf between the achievements of the best and the worst English pupils at age 11, a phenomenon which was summarised in the phrase 'the seven-year gap' – meaning that, after removing outliers, the best 11-year-olds were as good as the average 14-year-old, while the weakest were no better than the average 7-year-old. Instead of proposing measures to reduce this 'gap' (as in most countries), it was assumed to be a fact of life. Thus we rejected the idea of a common 'year-by-year' curriculum for all pupils up to an age where divergence made it natural for pupils to attend different kinds of schools – with each type of school having a slightly different curriculum. Rather, we tried to devise the maximal curriculum for ages 5-16 in the form of a single ladder – with ten rungs, which all pupils would climb 'at their own pace'. Schools were expected to accommodate those who progressed very slowly (perhaps reaching only the third or fourth rung by the age of 16) as well as those who could reach the top much more quickly (perhaps by the age of 13). This created an unmanageable diversity within each classroom.

A problem had been recognised, but the curriculum structure which was adopted reflected a refusal to tackle it centrally: instead the buck was passed to individual teachers and schools.

Worse, this 'bottom-up' model of the curriculum as a single ladder meant that the curriculum specification of important topics was determined by the needs and limitations of the slowest pupils. Thus, the details of what was needed at the level of introductory algebra were specified in the same way for those who might proceed to study science and engineering as for those who would struggle to understand the simplest formula.

The resulting mathematics curriculum which was forced through in 1989 was unworkable. Its mathematical and educational shortcomings were denied until relatively recently (and are still not acknowledged openly), but one could not escape the consequences of the contradictions inherent in the structure of this curriculum. However, these consequences could not be effectively addressed as long as their origin was denied. Thus there were repeated attempts (in 1991, 1993 and 1995) to revise the mathematics curriculum – but only 'to make it easier to administer', not to correct its genuine weaknesses.

Notwithstanding the inherent flaws in the curriculum, by the mid-1990s teachers had got used to it and were tired of continual change. Politicians and bureaucrats used this weariness to argue that no further changes were needed.

The subsequent very public struggle – fuelled in late 1995 by the London Mathematical Society report *Tackling the mathematics problem* and by the very poor TIMSS (Population 2) results – led eventually to the most recent revision, which is to be implemented from September 2000. Officially this revision was only allowed to make minor changes of content, so most of the changes made had to be presented as attempts to clarify the 'intention' of the existing (rather vague) curriculum by specifying content in a more detailed and structured way, while still trying to encourage desirable teaching styles.

In parallel with, and perhaps more important than, this recent curriculum review has been the National Numeracy Strategy. This scheme constitutes a radical shift in the way mathematics is taught at primary level. The approach has been piloted over the last 2-3 years and was implemented in all primary schools in September 1999. In contrast to the vague and contradictory guidance of the last fifteen years, the Numeracy Strategy provides a highly structured model for the teaching of elementary mathematics. The approach is pragmatic, has been formulated in great haste, and has many shortcomings, but is generally accepted as a serious – and on the whole sensible – attempt to improve the achievement of 'the bottom 75%' of 11-year-old primary school leavers. The strategy offers schools a very detailed year-by-year curriculum, and incorporates a requirement that each primary school class should devote 45-60 minutes each morning to mathematics.

Though the strategy has many good features – its emphasis on 'numeracy' rather than 'mathematics' – the absence of any similar programme for secondary schools is worrying. Also, the year-by-year structure of the Numeracy Strategy is logically incompatible with the 'level-by-level' ladder structure of the National Curriculum. Rather than confront this issue and make a rational choice, English pragmatism appears content to embrace both – for the time being.

Main mathematical objectives

The 1989, 1991, 1993 and 1995 versions of the curriculum all played down the role of 'the mathematical world'. The motivation was understandable, but superficial.

England has no tradition of pedagogy and didactics. There is therefore no accepted formal way of analysing the challenges which confront the mathematics teacher, or of communicating intended modifications to existing or intending teachers. The only vehicles are therefore pragmatic ones: from textbooks, syllabuses and examinations, to personal example and encouragement to 'reflect on one's experience', though without a theoretical framework.

This tradition proved unable to handle the shift in the 1970s from a 'top-down', university-driven agenda to 'education for all'. The new majority were taught and examined in (a watered-down version of) the old minority tradition, with unsatisfactory results. There was also increasing evidence that even the very best pupils understood much less than had been assumed. This led to a reaction against 'formal methods'. This reaction was strengthened by those who (ignoring the lessons of the last 400 years) claimed that traditional disciplines, each with its separate range of techniques and methods, were now less important than 'generic skills' (or general abilities), utility (or applications), and technology.

Instead of reassessing the kind of 'formal mathematics' which had to be taught, and the way it should be taught, to serve the new majority better, there sprang up a belief that informal methods would suffice. The National Curriculum (and the associated assessment) encouraged teachers:
(1) to see school mathematics as being motivated and justified by its uses. ('We believe it should be a fundamental principle that no topic should be included unless it can be developed sufficiently for it to be applied in a way which pupils can understand.' 'Pupils should be given opportunities to use and apply mathematics in practical tasks [and] in real-life problems.')
(2) to concentrate on encouraging pupils to 'use what they know' with confidence, rather than to try to use more formal methods which they do not understand. ('Very many pupils in secondary schools are at present being required to follow mathematics syllabuses whose content is too great and which are not suited to their level of attainment.')
(3) to ensure that pupils are given opportunities to explore, and to investigate, simple situations with some mathematical content, to 'find ways of overcoming difficulties that arise, develop and use their own strategies'.

In this spirit, the 1995 curriculum began – not with the three 'content strands' (*Number and algebra, Shape, space and measures* and *Handling data*) – but with a strand called *Using and applying mathematics*, which emphasised 'making and monitoring decisions to solve problems, communicating mathematically, and developing skills of mathematical reasoning'. While some teachers managed to use this emphasis to improve their teaching, the approach suffered from a failure to analyse the relationship between achieving fluency in mathematical techniques, and being confident in the use of basic techniques.

The most recent revision of the curriculum has made a nominal attempt to incorporate 'using and applying' as part of each content strand. Previous versions of the curriculum emphasised 'general abilities' and 'applications', while failing to specify clearly either which aspects of 'the mathematical world' were most important, or how they should be taught in order to derive the most benefit from pupils' willingness to 'use what they know' with confidence. The most recent revision of the curriculum spells out in much greater detail those aspects of 'the mathematical world' that are felt to be important, and encourages teachers to bring 'using and applying' back into the mainstream, but gives little indication of how this should be done.

Basic contents

In the revised version of the mathematics curriculum, the outline of content covers more than 50 A4 pages, with an additional 25 pages of general requirements.

The content is presented under three main headings: *Number and algebra*, *Shape, space and measures*, and *Handling data*. The additional theme *Using and applying mathematics*, extends across all three content headings.

Since the curriculum is still specified in terms of 'levels', rather than 'grades', it is difficult to infer from what is written what is expected of the average pupil, or of the majority of pupils.

Number and algebra means essentially 'Number' until age 11, after which algebra begins to play an increasing role. The curriculum for ages 11-16 contains most of what one would expect if the top 25% or so are to solve quadratic equations, to handle simple quadratic functions graphically, and perhaps to find the points of intersection of a straight line and a circle. However, the curriculum for the bottom 70% or so suggests that they should not be expected to work with quadratic expressions.

The title *Shape, space and measures* indicates something of the tension which lies scarcely beneath the surface. The reluctance to use the word 'geometry' in the title reflects the earlier distaste for any hint of formal methods. The presentation of content is made more difficult by the need to accommodate the persistent belief that 'transformations' offer a viable approach to 'useful geometry for the majority'. Nevertheless, the strand includes most of the basic material one would expect under the heading 'elementary geometry' – geometry of lines and triangles, approximate and exact constructions, congruence, Pythagoras, and similarity.

The treatment varies from informal (for the majority) to semi-formal (for the top 25% or so, who also meet the basic circle theorems). 'Space' plays a limited role, exploring 3D-shapes, working with cuboids and prisms, with the top 25% required to use Pythagoras in 3D. 'Measures' are included in this strand only because there seemed to be nowhere else to put them.

Handling data focuses on 'collecting data, processing and representing data, interpreting and discussing results', while also trying to convey the unpredictable nature of random processes, the kind of questions that can be addressed using statistical methods, and sources of bias in statistical data. There is an obligation on teachers to involve pupils in designing experiments and surveys so that they have to decide what data to collect in order to answer a simple question.

The only official indication of the relative weighting of the three strands is that *Handling data* does not appear explicitly during the first 2-3 years, but is viewed at that level as a natural part of 'Number'. Unofficially it would seem that during these early years, 'Number' may occupy as much as 80% of the available time, with *Shape, space and measures* occupying 20%. In later years (ages 12-15) *Number and algebra* may occupy 55% of the time, *Shape, space and measures* 30%, and *Handling data* 15%.

World Mathematical Year Stamp

This year several countries are issuing postage stamps to commemorate World Mathematical Year 2000. The first country was Belgium who issued this stamp in February. It features Stokes' theorem and Fermat's last theorem inside a circle, with the normal curve and a representation of the Ishango bone, the earliest known mathematical artefact.

Oberwolfach Programme 2001

Mathematisches Forschungsinstitut Oberwolfach

Lorenzenhof, D-77709 Oberwolfach-Walke, Germany

Names of organisers are in square brackets.

Participants of the meetings at Oberwolfach are invited personally by the director of the institute. Participation is subject to such an invitation. Interested researchers, in particular young mathematicians, can contact the administration of the institute. Since the number of participants is restricted, not all enquiries can be considered.

Information is also available on our website http://www.mfo.de.

7-13 January: Finite Fields: Theory and Applications
[Joachim von zur Gathen (Paderborn), Igor Shparlinski (NSW)]
14-20 January: Combinatorial Convexity and Algebraic Geometry
[Victor Batyrev (Tübingen), Peter McMullen (London), Tadao Oda (Sendai), Bernard Teissier (Paris)]
21-27 January: Berechenbarkeitstheorie
[Klaus Ambos-Spies (Heidelberg), Steffen Lempp (Madison), Ted Slaman (Berkeley)]
28 January-3 February: Topologische Methoden in der Gruppentheorie
[Herbert Abels (Bielefeld), Peter Kropholler (London), Karen Vogtmann (Ithaca)]
4-10 February: Mixed Finite Element Methods and Applications
[Douglas Arnold (University Park), Carsten Carstensen (Kiel), Ronald Hoppe (Augsburg)]
11-17 February: Funktionentheorie
[Kari Astala (Jyväsklyä), Walter Bergeweiler (Kiel), Reiner Kühnau (Halle)]
18-24 February: Geometric Rigidity and Hyperbolic Dynamics
[Werner Ballmann (Bonn), Anatole Katok (University Park), Gerhard Knieper (Bochum)]
25 February-3 March: Mini-Workshops
(Hints for applications: see above)
4-10 March: Algebraische Gruppen
[Michel Brion (Grenoble), Jens Carsten Jantzen (Aarhus), Peter Slodowy (Hamburg)]
11-17 March: Stochastics in the Sciences
[Anton Bovier (Berlin), Richard Gill (Utrecht), Willem van Zwet (Leiden)]
18-24 March: Gewöhnliche Differentialgleichungen
[Jean Mawhin (Louvin-la-Neuve), Klaus Schmitt (Salt Lake City), Hans-Otto Walther (Gießen)]
25-31 March: Representations of Finite Groups
[Michel Broue (Paris), Richard Dipper (Stuttgart), Burkhard Külshammer (Jena), Geoffrey Robinson (Birmingham)]
1-7 April: Arbeitsgemeinschaft mit aktuellem Thema (wird in Heft 1/2001 der DMV-Mitteilungen bekanntgegeben)
8-14 April: Numerical Methods for Singular Perturbation Problems
[Pieter Hemker (Amsterdam), Hans-Görg Roos (Dresden), Martin Stynes (Cork)]
15-21 April: Asymptotic and Numerical Methods for Kinetic Equations
[Pierre Degond (Toulouse), Axel Klar (Darmstadt), Reinhard Illner (Victoria)]
22-28 April: Konvexgeometrie
[Paul Goodey (Norman), Peter M Gruber (Wien)]
29 April-5 May: Phasenübergänge
[Hans Wilhelm Alt (Bonn), Stephan Luckhaus (Leipzig), Errico Presutti (Roma), Ekhard Salje (Cambridge)]
6-12 May: Aperiodic Order
[Michael Baake (Tübingen), Jean Bellissard (Toulouse), Robert Moody (Edmonton)]
13-19 May: Schrödinger Operators
[Volker Enß (Aachen), Christian Gerard (Palaiseau)]
20-26 May: Nonlinear Evolution Problems
[Michael Struwe (Zürich), Sergiu Klainerman (Princeton)]
27 May-2 June: Schnelle Löser für partielle Differentialgleichungen
[Randolph Bank (San Diego) Wolfgang Hackbusch (Leipzig), Gabriel Wittum (Heidelberg)]
3-9 June: Oberwolfach-Seminars
10-16 June: Differentialgeometrie im Großen
[Werner Ballmann (Bonn), Jean-Pierre Bourguignon (Bures-sur-Yvette), Wolfgang Ziller (Philadelphia)]
17-23 June: Numerik von Mikrostrukturen
[Carsten Carstensen (Kiel), Wolfgang Hackbusch (Leipzig), Thomas Hou (Pasadena)]
17-23 June: Two Hundred Years of Number Theory after Carl-Friedrich Gauß's Disquisitiones Arithmeticae
[Catherine Goldstein (Paris), Norbert Schappacher (Strasbourg), Joachim Schwermer (Düsseldorf)]
24-30 June: Algebraische Zahlentheorie
[Christopher Deninger (Münster), Peter Schneider (Münster), Anthony Scholl (Durham)]
1-7 July: 4-dimensional Manifolds
[Stefan Alois Bauer (Bielefeld), Peter Kronheimer (Harvard), Ronald Stern (Irvine)]
8-14 July: Vision and Related Subjects
[Jean-Michel Morel (Paris), Christoph von der Malsburg (Bochum/Los Angeles), David Mumford (Providence)]
15-21 July: Dynamische Systeme
[Helmut Hofer (New York), Jean-Christophe Yoccoz (Orsay), Eduard Zehnder (Zürich)]
22-28 July: Explicit Methods in Number Theory
[Henri Cohen (Talence), Hendrik Lenstra Jr (Berkeley/Leiden), Don Zagier (Bonn/Utrecht)]
29 July-4 August: Computational Group Theory
[Gerhard Hiß (Aachen), Derek Holt (Warwick), Michael Newman (Canberra), Herbert Pahlings (Aachen)]
5-11 August: Partial Differential Equations
[Craig Evans (Berkeley), Ernst Kuwert (Freiburg), Stefan Müller (Leipzig)]
12-18 August: Relativistic Quantum Systems and Quantum Electrodynamics
[Volker Bach (Mainz), Heinz Siedentop (Regensburg), Jan Philip Solovej (Copenhagen)]
19-25 August: Mini-Workshops
(Hints for applications: see above)
26 August-1 September: Complex Geometry: Interactions between Algebraic, Differential and Symplectic Geometry
[Arnaud Beauville (Paris), Fabrizio Catanese (Göttingen), Eduard Looijenga (Utrecht), Christian Okonek (Zürich)]
2-8 September: Singularitäten
[Gert-Martin Greuel (Kaiserslautern), Joseph Steenbrink (Nijmegen), Victor Vassiliev (Moskau)]
9-15 September: Topologie
[Wolfgang Lück (Münster), Cameron Gordon (Austin), Robert Oliver (Villentaneuse)]
16-22 September: Theory of the Riemann Zeta and Allied Functions
[Martin Huxley (Cardiff), Matti Jutila (Turku), Yoichi Motohashi (Tokyo)]
23-29 September: Combinatorics, Probability and Computing
[Bela Bollobas (Memphis), Ingo Wegener (Dortmund)]
30 September-6 October: Stochastic Evolution Equations and Applications
[Guiseppe Da Prato (Pisa), Michael Röckner (Bielefeld), J. Zabczyk (Warszawa)]
7-13 October: Arbeitsgemeinschaft mit aktuellem Thema (wird in Heft 3/2001 der DMV-Mitteilungen bekanntgegeben)
14-20 October: Oberwolfach Seminars
21-27 October: Theoretische und Mathematische Biologie
[Andreas Dress (Bielefeld)]
28 October-3 November: Stable Laws, Processes and Applications
[Werner Linde (Jena), Jan Rosinski (Knoxville), Gennady Samorodnitsky (Ithaca)]
4-10 November: Mini-Workshops
(Hints for applications: see above)
11-17 November: Oberwolfach Seminars
18-24 November: Numerical Integration and its Complexity
[Harald Niederreiter (Wien), Knut Petras (Braunschweig), Henryk Wozniakowski (Warszawa/New York)]
25 November-1 December: Modellierung, Simulation und Optimierung integrierter Schaltkreise
[Kurt Antreich (München), Roland Bulirsch (München), Albert Gilg (München/Perlach), Peter Rentrop (Karlsruhe)]
2-8 December: Finite Geometries
[Aart Blokhuis (Eindhoven), James Hirschfeld (Sussex), Dieter Jungnickel (Augsburg), Joseph Thas (Gent)]
9-15 December: C*-Algebren
[Dietmar Bisch (Santa Barbara), Eberhard Kirchberg (Berlin), Georges Skandalis (Paris)]
16-22 December: Mathematical Methods in Manufacturing and Logistics
[Rainer Burkard (Graz), Horst Hamacher (Kaiserslautern), Hartmut Noltemeier (Würzburg)]

Problem Corner :

Contests from Romania

Paul Jainta

Mathematical competitions have a long tradition in Romania. The first event goes back to 1898, when the Ministry of Public Education advertised a national contest for students at secondary school. Part of this competition was designed to rate the mathematical capability of the participants. Many years later, the *International Mathematics Olympiad* (IMO), the pinnacle of competitions among individuals, was the brainchild of Romania's Tiberiu Roman, an educator of monumental vision, and the first two IMOs were held in Romania, in 1959 and 1960. Roman's pioneering efforts in mathematics were followed by other disciplines, leading to yearly International Olympiads in physics, chemistry and informatics.

Nevertheless, there is a striking disparity between Romania's role in identifying and nourishing mathematically talented youngsters and the way in which these efforts were publicised. I knew nothing of the Romanian groundwork in this field, except for an article that I stumbled over last year in the *Journal of the World Federation of National Mathematics Competitions*.

The author of that account, Vasile Berinde, is Dean of the Faculty of Science and head of the Department of Mathematics and Computer Science at the Northern University of Baia Mare. He is heavily involved in the organisation of local and regional mathematical fixtures in his country, and is assisted by Mircea Becheanu, Associate Professor in the Faculty for Mathematics at the University of Bucharest, a Vice-president of the Romanian Society for Mathematical Sciences who has coached Romanian IMO teams. On inquiry Berinde allowed me to examine data on the rapidly improving mathematical competence among Romanian students, and on the basis of his report I now spotlight the competitions in that country.

In the native country of mathematics competitions, the authors do not understand why this way of matching one's strength against others has lost none of its appeal. They declare openly: 'One extremely difficult question faced us when we began to design the details of this note: how to explain, after almost a century of tradition, the current high rate of interest in mathematics competitions still existing amongst both students and teachers in Romania'. But our initial perplexity soon evaporates. Their review of the contest scene in Romania presents an impressive improvement in the mathematical abilities of young Romanians.

Three ingredients have caused this success.

The Romanian mathematics education system This was established in 1898 under the overall control of the Minister of Education, Spiru Haret, a mathematician. The basic principles of Haret's law proved to be ahead of their time and endured to a great extent in the Romanian education system throughout the 20th century.

The centennial journal Gazeta Mathematica This periodical (founded in 1894) has appeared without a break, and played a crucial role in organising the first mathematical competitions in Romania, as well as in discovering talented young students in mathematics, encouraging interest in mathematics, and directing mathematical education.

The Romanian Mathematics Competition Organisation System The fact that Romania organised the first two International Mathematics Olympiads (IMO) and instigated the idea arises from the above-mentioned enthusiasm for mathematical bouts in this country. So Romania should be appreciated even more nowadays, when similar Olympiads for physics, chemistry, computer science, and so on, have become popular throughout the world.

These international competitions are generally accepted as successful attempts to identify, encourage and challenge gifted youngsters in all countries, and to create opportunities for the exchange of information on school syllabuses and practice throughout the world. The 40th IMO of 1999 was hosted by the Romanian Society for Mathematical Sciences in

Bucharest, yielding excellent results for the Romanian team which came third, after Russia and the People's Republic of China. Incidentally, the only student in the 39-year history of the IMO who achieved three perfect scores in succession was a young Romanian, Ciprian Manolescu (1996-98). These arguments show impressively how organising mathematics competitions open to talented students in Romania arises from a commendable educational system.

The beginnings of the National Mathematics Olympiad

A century ago Haret's law introduced three categories of secondary schools into the educational scene: scientific, modern and classical. The main target was to create new opportunities for young people to develop their natural skills and abilities in an up-and-coming education system. But, due to the antiquated schooling, the level of scientific education was very poor in both the high-school and academic areas. Further, progress in getting teaching shipshape quickly succeeded to universities because of the younger lecturers who, after getting a PhD in Western European countries, returned home in droves. Soon, an alarmingly substandard level of mathematical knowledge was detected amongst the entrance candidates to the *National Technical School* (now the *Polytechnic University of Bucharest*). A group of five young engineers involved in the entrance procedure decided to increase the mathematical level of contestants, instead of decreasing the demands. Their plans gradually matured, and they launched a mathematical magazine intended for high-school students, whose main aim was to identify mathematically-able people and encourage them to study mathematics. The spearhead of this mathematical fostering was the *Gazeta Mathematica*.

The role of this notable journal is unanimously recognised in Romania. It turned out that a most efficient way to entice further high-school students to solve problems posed in the *Gazeta Mathematica* was to create the first mathematics competition in 1902, during the spring holidays. The contestants were selected from the best correspondents of the monthly and handpicked from public and military schools. One criterion for their choice was the degree of excellence of submitted solutions. From 1905 the contestants were examined in certain centres, after preliminary registration, and in 1909 written and oral exams were introduced. From 1910 the competition, now called *The Gazeta Matematica Annual Contest*, was considered almost a national event, due to its large field of entrants.

Over the years *Gazeta Matematica* and its competitions have been helped financially and scientifically by respected Romanian mathematicians. The awards were endowed by the journal itself, and later (1909) funded by a society of the same name. After the Second World War, the *Annual Gazeta Matematical Contest* became the *National Mathematical Olympiad* (NMO), a large-scale competition with financial backing by the state. In the meantime, the education system itself had been given a shake-up through the 'great education reform' of 1948, when mathematics became a centrepiece in both secondary and high-school curricula.

These changes have generated a second flourishing period in the history of mathematics in Romania, which culminated in the first IMO in Bucharest (1959). Two words are apposite to the exceptional contribution of *Gazeta Matematica* during this time: tradition and continuity. Through its prestige, *Gazeta Matematica* quickly won more and more readers. The number of subscriptions increased yearly from 144 in 1895 to 410 in 1912, and more significantly after the Second World War (1964: 25000, 1974: 75000). In the decade 1980-90 it achieved a monthly circulation of 130000-140000 copies; it now has 120000 subscribers.

The astonishing career of mathematics as a refurbished and sporting discipline in Romania will employ us in forthcoming issues of this *Corner*. The following problems come from various Romanian competitions, and illustrate the hundred-year-old tradition that is inherent in the promotion of mathematically talented Romanian youngsters.

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 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.

110 The quadrilateral ABCD has two parallel sides. Let M and N be the midpoints of DC and BC, and let P be the common point of the lines AM and DN. If PM/AP = ¼, prove that ABCD is a parallelogram.

111 Let k be an integer and P(X) be the polynomial $P(X) = X^{1997} - X^{1995} + X^2 - 3kX + 3k + 1$. Prove that:
(i) the polynomial has no integer roots;
(ii) the numbers P(n) and P(n) + 3 are relatively prime, for every integer n.

112 Find the image of the function $f: \mathbf{R} \to \mathbf{R}$, defined by

$$f(x) = (3 + 2\sin x)/[\sqrt{(1 + \cos x)} + \sqrt{(1 - \cos x)}].$$

113 Let $a, b, c, d \in \mathbf{R}$ and $f: \mathbf{R} \to \mathbf{R}$, $f(x) = ax^3 + bx^2 + cx + d$, such that

$$f(2) + f(5) < 7 < f(3) + f(4).$$

Prove that there exist $u, v \in \mathbf{R}$ such that $u + v = 7$ and $f(u) + f(v) = 7$.

114 Let $f: \mathbf{N} \times \mathbf{N} \to \mathbf{N}$ be a function which satisfies the following conditions:
(i) $f(0, y) = y + 1$, for all $y \in \mathbf{N}$
(ii) $f(x + 1, 0) = f(x, 1)$ for all $x \in \mathbf{N}$
(iii) $f(x + 1, y + 1) = f(x, f(x + 1, y))$
Compute f (3, 1997).

115 Let $n \geq 3$ be an integer and x be a real number such that the numbers x, x^2 and x^n have the same fractional parts. Prove that x is an integer.

Solutions to some earlier problems

91 Prove that for any positive number $n \geq 4$ and any positive real numbers $a_1, a_2, \ldots, a_n$, the following inequality holds:

$$1/(a_1 + a_2) + 1/(a_2 + a_3) + \cdots + 1/(a_{n-1} + a_n) + 1/(a_n + a_1)$$
$$> 4/3[1/(a_1 + a_2 + a_3) + 1/(a_2 + a_3 + a_4) + \cdots + 1/(a_{n-1} + a_n + a_1) + 1/(a_n + a_1 + a_2)]$$

Solution *by Ronald van Lujk (Utrecht); also solved by Aldric L. Brown (Chandigarh)*

For $x, y > 0$ we have $4/(x + y) \leq 1/x + 1/y$.
Let $x = a_I + (a_{i+1}/2)$ and $y = (a_{i+1}/2) + a_{i+2}$.
We get $4/(a_I + a_{i+1} + a_{i+2}) \leq 2/(2a_I + a_{i+1}) + 2/(a_{i+1} + 2a_{i+2})$.
But $2/(2x + y) + 2/(x + 2y) < 3/(x + y)$.
Thus, summation over n yields

$$\sum_1^n \frac{4}{a_i + a_{i+1} + a_{i+2}} \leq \sum_1^n \left(\frac{2}{2a_i + a_{i+1}} + \frac{2}{a_{i+1} + 2a_{i+2}}\right) < \sum_1^n \frac{3}{a_i + a_{i+1}}.$$

97 Suppose a, b and c are the lengths of the sides of a triangle with $a \leq b \leq c$.
Let S and T be real numbers.
Find the minimum value S and the maximum value T, satisfying the inequality

$$S \leq (a + b + c)^2/\, b.c \leq T.$$

Determine when there is equality.

Solution *by Niels Bejlegaard (Stavanger); also solved by Dr. J. N. Lillington (Dorchester) and Claude Lamoureux (Paris).*

Since $a \leq b \leq c$ we conclude that

$$(a + b + c)^2/\ bc > (b + c)^2/\ bc = b/c + c/b + 2\ \geq\ 2 + 2\sqrt{(b/c).(c/b)} = 4,$$

by the arithmetic-geometric mean inequality.

Conversely, the following reduction is valid:

$$(a + b + c)^2/\ bc \leq (2b + c)^2/\ bc = 4 + 4b/c + c/b = 4 + k \ \text{ (where } k = 4b/c + c/b).$$

Now we minimise the value of k: we have $4b/c + c/b \leq k$, because $b \leq c$.

We arrive at $4b^2 - kcb + c^2 \leq 0$, giving $b \leq c\{k \pm \sqrt{(k^2 - 16)}\}/8$.

Now $\{k + \sqrt{(k^2 - 16)}\}/8 = 1$ implies that $k = 5$;

we deduce that $4 < (a + b + c)^2/\ bc \leq 9$.

Equality occurs only when the triangle is equilateral.

98 Find all sets of four points in the plane so that the sum of the distances from each of the points to the other three is constant.

Solution *by Pietro Fanciulli (Porto S. Stefano, Italy) and the proposer.*

Let the points be P_i (i = 1, 2, 3, 4), and consider $X_{i,j}$ the distances P_iP_j of the point P_i from P_j (where $i \neq j$ and ij = ji).

We obtain the following equations (where k = constant)

$$X_{12} + X_{13} + X_{14} = k;\ X_{12} + X_{23} + X_{24} = k,\ X_{13} + X_{23} + X_{34} = k,\ X_{14} + X_{24} + X_{34} = k.$$

Subtract each of the last three from the first:

$$X_{13} + X_{14} = X_{23} + X_{24};\ X_{12} + X_{14} = X_{23} + X_{34};\ X_{12} + X_{13} = X_{24} + X_{34}\ .$$

This leads (by adding two of the equations and subtracting the third) to:

$$X_{12} = X_{34}\ ;\quad X_{14} = X_{23}\ ;\quad X_{13} = X_{24}\ ;$$

that is, the distance between any two of the points equals the distance between the other two points. This holds only for the vertices of a (possibly degenerate) rectangle. [*For example, assuming that $P_1P_2P_3P_4$ is a simple (non-crossing) quadrilateral, the first two equations imply that the quadrilateral is a parallelogram, and then the third equation forces it to be a rectangle.*]

99 Let $x_1 > 0$ be any real number. Define the infinite sequence $x_2, x_3, \ldots$ by the recurrence relation $x_{n+1} = x_n^2 + x_n$.

Prove that $\lim_{k\to\infty} \sum_{1}^{k} \frac{1}{1 + x_i}$ exists, and sum the infinite series.

Solution *by Dr. J. N. Lillington and the proposer.*

From $x_1 > 0$ and $x_{n+1} = x_n^2 + x_n$, we have

$$(x_{n+2} - x_{n+1}) - (x_{n+1} - x_n) = (x_n^2 + x_n)^2 + (x_n^2 + x_n) - 2(x_n^2 + x_n) + x_n = x_n^4 + 2x_n^3\ > 0.$$

Thus we have: $x_2 - x_1 = \delta$ (say) and $x_3 - x_2 > \delta, \ldots, x_k - x_{k-1} > \delta$.

Hence $x_k - x_1 > (k - 1)\ \delta$, by adding, and so $x_k \to \infty$ as $k \to \infty$.

Now $1/x_1 - 1/(1 + x_1) = 1/x_2\ ;\ 1/x_2 - 1/(1 + x_2) = 1/x_3\ ; \ldots ,\ 1/x_k - 1/(1 + x_k) = 1/x_{k+1}\ ;$

Adding, we have $1/x_1 - \sum_{1}^{k} \frac{1}{1 + x_i} = 1/x_{k+1}$.

Hence $\lim_{k\to\infty} \sum_{1}^{k} \frac{1}{1 + x_i}$ exists and equals $1/x_1$.

100 Given an arbitrary triangle ABC with circumcircle γ (O, R).

Let AO intersect BC in point A_1, and let points B_1 and C_1 be determined analogously.

Show that $OA_1 + OB_1 + OC_1 \geq 3R/2$.

Solution *by Dr. J. N. Lillington; also solved by Maurice Brémond (Avignon, France), Pietro Fanciulli and the proposer.*

We may assume the angles A, B, C are all acute for otherwise if A (say) is obtuse, then BC is the diameter of the circumcircle and $OA_1 + OB_1 + OC_1 \geq 2$.

Let Δ_A denote the area of triangle BOC, define Δ_B , Δ_C, similarly.

Then $1 + (OA_1/R) = (R + OA_1) / (R + OA_1 - OA_1) = \Delta/(\Delta - \Delta_A) = \Delta/(\Delta_B + \Delta_C)$

Similarly, $1 + (OB_1/ R) = \Delta/ (\Delta_A + \Delta_C)$

and $1 + (OC_1/ R) = \Delta/ (\Delta_A + \Delta_B)$

Summing these three equations we get

$3 + (1/R)(OA_1 + OB_1 + OC_1) = (\Delta_A + \Delta_B + \Delta_C)/[1/(\Delta_B + \Delta_C) + 1/(\Delta_A + \Delta_C) + 1/(\Delta_A + \Delta_B)]$

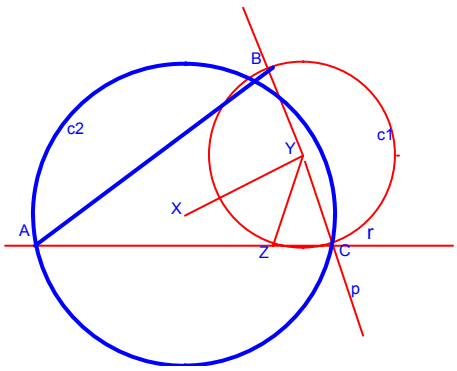
$= [(\Delta_A + \Delta_B) + (\Delta_A + \Delta_C) + (\Delta_B + \Delta_C)][1/(\Delta_B + \Delta_C) + 1/(\Delta_A + \Delta_C) + 1/(\Delta_A + \Delta_B)]/2$

$\geq 9/2$ (by applying the arithmetic-geometric mean inequality to both brackets).

Hence $OA_1 + OB_1 + OC_1 \geq 3R/2$.

103 Three points X, Y, Z are given in the plane, where X is the circumcentre, Y is the midpoint of the side BC, and Z is the foot of the altitude from B to side AC in the triangle ABC. Show how one can construct this triangle.

Solution *by Pietro Fanciulli; also solved by Dr. J. N. Lillington and the proposer.*



Assume that the triangle ABC has been constructed.

Since $\angle BZC = 90^o$, the circle c (Y, R = ZY) intersects the side BC, so ZY = BY = CY. This is the key to the problem; proceed as follows:

1. Join the points X, Y by a straight line, and draw the perpendicular p to XY at Y.
2. Draw the circle c_1 (Y, ZY), which intersects the perpendicular line p in B and C.
3. Join Z and C by the straight line r.
4. Draw the circle c_2 (X, R = BX = CX) which intersects r in points A, C.
5. Join A and B, and the points A, B, C are then defined.

104 A real-valued function f is defined for positive integers, and a positive integer a satisfies

$$f(a) = f(1995),\ f(a + 1) = f(1996),\ f(a + 2) = f(1997),$$

$$\text{and } f(n + a) = [f(n) - 1]/[f(n) + 1] \text{ for any positive integer n.}$$

Prove that $f(n + 4a) = f(n)$ for any positive integer n, and determine the smallest possible value of a.

Composite solution *by Dr. J. N. Lillington and Pietro Fanciulli.*

We have:

$f(n + 4a) = f[(n + 3a) + a] = [f(n + 3a) - 1]/[f(n + 3a) + 1]$

$= \{f[(n + 2a) + a] - 1\} / \{f[(n + 2a) + a] + 1\}$

$= \{[f(n + 2a) - 1] / [f(n + 2a) + 1\}/\{[f(n + 2a) - 1] / [f(n + 2a] + 1]\}$

$= [f(n + a) + 1] / (f(n + a) - 1]$

$= \{[f(n) - 1] / [f(n) + 1] + 1\} / \{[f(n) - 1] / [f(n) + 1] - 1\} = -[-2f(n)] / 2 = f(n)$,

as required.

Now if a is the least value, we have $f(a) = f(5a) = f(9a) = \ldots = f[(4n - 3)a]$, $n \geq 1$. Thus we seek the maximum integer n and the minimum integer a satisfying

$$(4n - 3)a = 1995, \text{ where } a \neq 1 \text{ or } 2.$$

But a = 3 gives $4n - 3 = 665$ and n = 167.

Thus a = 3 is the required solution.

Forthcoming conferences

compiled by Kathleen Quinn

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

April 2000

3-7: Workshop on Ergodic Theory of Zd-actions, Coventry, UK
Information:
e-mail*: peta@maths.warwick.ac.uk*

5-14: ICMS Instructional Conference: Operator Algebras and Operator Spaces, Edinburgh, UK
Information: contact Allan M. Sinclair, Department of Mathematics and Statistics, JCMB, KB, Edinburgh EH9 2DE, UK
e-mail: allan@maths.ed.ac.uk
Web site: http://www.ma.hw.ac.uk/icms/current
[*For details, see EMS Newsletter 34*]

10-14: Summer School and Workshop on Algebraic and Co-Algebraic Methods in the Mathematics of Program Construction, Oxford, UK
Information:
e-mail: acmmpc-info@comlab.ox.ac.uk

10-20: NATO Advanced Study Institute/EC Summer School, New Theoretical Approaches to Strongly Correlated Systems, Cambridge, UK
Information:
Web site: http://www.newton.cam.ac.uk/programs/scew.html

11-14: Workshop on Harmonic Maps and Curvature Properties of Submanifolds 2, Leeds, UK
Information: contact J. C. Wood, School of Mathematics, University of Leeds, Leeds LS2 9JT, UK
e-mail: j.c.wood@leeds.ac.uk
Web site: http://www.amsta.leeds.ac.uk/pure/geometry/leeds2000.html
[*For details, see EMS Newsletter 33*]

12-15: Workshop on Mathematical Methods of Regular Dynamics, Leeds, UK
[satellite meeting of the British Mathematical Colloquium, Leeds, UK, 17-20 April]
Information:
Web page: http://www.amsta.leeds.ac.uk/~vadim/work.html

17-20: 52nd British Mathematical Colloquium, Leeds, UK
Information:
e-mail: h.d.macpherson@leeds.ac.uk
Web site: http://www.amsta.leeds.ac.uk/ bmc/
[*For details, see EMS Newsletter 33*]

23-29: Spring School on Functional Analysis: (Non)smooth Analysis in Banach Spaces, Paseky nad Jizerou, Czech Republic
Information: contact Katedra matematickè analýzy, Matematicko-fyzikàln fakulta UK, Sokolovskà 83, 186 75 Praha 8, Czech Republic, tel./fax: +420-2-232-3390
e-mail: paseky@karlin.mff.cuni.cz
Web site: http://www.karlin.mff.cuni.cz/katedry/kma/ss/
[*For details, see EMS Newsletter 34*]

26-28: Mathematical Education of Engineers, Loughborough, UK
Information:
Web site: http://www.ima.org.uk/mathematics/conferences.htm
[*For details, see EMS Newsletter 33*]

25-6 May: NATO Advanced Study Institute, Nonlinear Dynamics in Life and Social Sciences, Moscow, Russia
Information:
Web site: http://www.cas.mcmaster.ca/~suliswa/asi.html

May 2000

11-15: Theory of Partial Differential Equations and Special Topics of Theory of Ordinary Differential Equations, St Petersburg, Russia
[dedicated to the 150th anniversary of the birthday of Sofia V. Kovalevskaya]
Topics: partial differential equations and their applications, and special topics of ordinary differential equations, preferably connected with Kovalevskaya
Programme: four days devoted to presentations of papers, an excursion and celebration of the anniversary of S. V. Kovalevskaya
Programme committee: L. D. Faddeev (Chairman, St.Petersburg), O. A. Ladyzhenskaya (St Petersburg), V. M. Babich (St Petersburg), E. F. Mischenko (Moscow), P. Van Moerbeke (Louvain), M. A. Semenov-Tyan-Shansky (Russia-France), N. N. Ural'tseva (St Petersburg)
Organisers: St Petersburg Department of Steklov Institute of Mathematics (POMI), Euler International Mathematical Institute
Organising committee: L. D. Faddeev (Chairman), V. M. Babich (Vice-chairman), N. Ya. Kirpichnikova, P. V. Krauklis, L. A. Molotkov, M. A. Semenov-Tyan-Shansky, E. V. Novikova (Secretary)
Language: English
Site: Euler International Mathematical Institute
Support: possibly support from RFBR to cover part of the expenses of participants from Russia; possibly reduced fees for participants from countries in difficult economic situations, and for young mathematicians
Information:
e-mail: sofia@eimi.imi.ras.ru
Web site: http://www.pdmi.ras.ru/EIMI/2000/sofia

20-22: Schloessmann Seminar on Mathematical Models in Biology, Chemistry and Physics, Bad Lausick, Germany
Information:
e-mail: Zeidler@mis.mpg.de

20-25: MaPhySto and StocLab Summer School on Stereology and Geometric Tomography, Sandbjerg Manor, Denmark
Information:
e-mail: maphysto@maphysto.dk
Web site: http://www.maphysto.dk/events/S-and-GT2000/
[*For details, see EMS Newsletter 34*]

26-27: Groups in Galway 2000, Galway, Ireland
Information:
e-mail: Dane.Flannery@nuigalway.ie

28-3 June: Combinatorics 2000, Gaeta, Italy
Information:
e-mail: comb2000@dmmm.uniroma1.it
http://www.mat.uniroma1.it/combinatorics2000

28-3 June: Spring School on Analysis: Some Recent Techniques in Harmonic Analysis, Paseky nad Jizerou, Czech Republic
Information: contact Katedra matematickè analýzy, Matematicko-fyzikàln fakulta UK, Sokolovskà 83, 186 75 Praha 8, Czech Republic, tel./fax: +420 - 2 - 232 3390
e-mail: pasejune@karlin.mff.cuni.cz
Web site: http://www.karlin.mff.cuni.cz/katedry/kma/
[*For details, see EMS Newsletter 34*]

29-2 June: Deuxieme Rencontre Internationale sur les Polynomes a valeurs entieres CIRM, Luminy, France
Information:
e-mail: paul-jean.cahen@math.u-3mrs.fr

29-9 June: Foliations: Geometry and Dynamics Revisited, Banach Centre, Warsaw, Poland
Information:
Web site: http://fol2000.math.uni.lodz.pl/

June 2000

5-9: Advances in Convex Analysis and Global Optimization Honouring the Memory of C. Caratheodory (1873-1950), Samos, Greece
Information:
Web site: http://samos.aegean.gr/math/acago/

5-9: 6th International Conference on Probability, Poraj (near Czestochowa), Poland
[dedicated to Professor Kazimierz Urbanik]
Information:
e-mail: probab@wsh-kielce.edu.pl
[*For details, see EMS Newsletter 34*]

6-10: 8th International Conference on Groups and Group Rings, Wisla, Poland
Theme: groups, group rings, rings and their connections
Aim: to extend the knowledge of algebraists (not only experts) on groups and group rings and to stimulate research contacts between mathematicians in East, West and Central Europe
Main speakers: A. A. Bovdi (Hungary), C. K. Gupta (Manitoba), N. D. Gupta (Manitoba), O. H. Kegel (Freiburg), E. I. Khukhro (Novosibirsk), A. N. Krasilnikov

(Moscow), F. Menegazzo (Padova), D. M. Riley (Western Ontario), A. L. Shmelkin (Moscow), I. Ya. Subbotin (USA), N. A. Vavilov (St Petersburg), J. S. Wilson (Birmingham)
Programme: 1 hour lectures given by the main speakers, 15-30 minute short talks
Programme committee: O. H.Kegel (Freiburg), E. I. Khukhro (Novosibirsk), J. Krempa (Warsaw), O. Macedonska (Gliwice), A. Yu. Olshanskii (Moscow), D. S. Passman (Wisconsin), V. Sushchanski (Gliwice), J. S. Wilson (Birmingham)
Organising committee: C. Baginski (Bialystok), J. Galuszka (Gliwice), W. Holubowski (Gliwice), J. Krempa (Warsaw), O. Macedonska (Gliwice), V. Sushchanski (Gliwice)
Sponsors: the Institutes of Mathematics of the Silesian University of Technology at Gliwice, Warsaw University and Bialystok University
Site: Hotel Beskidy, Wisla, Poland
Grants: there are restricted funds to support participants from East and Central Europe and former Soviet republics. Please contact us if you need financial assistance
Deadlines: for registration, 1 April; for submission of abstracts, 30 April
Information:
e-mail: groups@zeus.polsl.gliwice.pl
Web site: http://www.polsl.gliwice.pl/~groups

7-11: PhD Euroconference on Complex Analysis and Holomorphic Dynamics, Catalonia, Spain
Information:
*e-mai*l: cad2000@crm.es
Web site: http://crm.es/cad2000 (from 1 January 2000)
[*For details, see EMS Newsletter 34*]

11-17: DMV Seminar on Quantum Cohomology, Mathematisches Institut Oberwolfach, Germany
Organisers: Bernd Siebert (Bochum) and Gang Tian (MIT)
Information: Prof. Dr Matthias Kreck, Universität Heidelberg, Mathematisches Institut, Im Neuenheimer Feld 288, 69120 Heidelberg, Germany

11-17: DMV Seminar on Nonparametric Function Estimation, Neural Nets and Risk Asymptotics, Mathematisches Institut Oberwolfach, Germany
Organisers: Andrew Barron (Yale), László Gyröfi (Budapest) and Michael Nussbaum (Cornell)
Information: Prof. Dr Matthias Kreck, Universität Heidelberg, Mathematisches Institut, Im Neuenheimer Feld 288, 69120 Heidelberg, Germany

12-17: 3rd International Conference on Differential Equations and Applications (DIFFEQ 2000), St Petersburg, Russia

13-16: First AMS-Scandinavian International Mathematics Meeting, XXIII Scandinavian Congress of Mathematicians, Odense, Denmark
Information: contact Hans J. Munkholm, Odense University, Campusvej 55, DK 5230 Odense M, Denmark, tel: (+45)65572309/(+45)65932691
e-mail: hjm@imada.ou.dk
Web site: http://www.imada.ou.dk/~hjm/AMS.Scand.2000.html
[*For details, see EMS Newsletter 33*]

14-17: International Workshop for Operator Theory and Applications (IWOTA), Bordeaux, France
Information:
e-mail: iwota@math.u-bordeaux.fr
Web site: http://www.math.u-bordeaux.fr/~iwota/
[*For details, see EMS Newsletter 33*]

15-17: 2nd Croatian Mathematical Congress, Zagreb, Croatia
Topics: all areas of mathematics
Plenary speakers: A. Grossmann (Marseille/Versailles), G. Henniart (Paris), M. Primc (Zagreb), A. Scedrov (Pennsylvania), J. G. Thompson (Florida), Z. Vondracek (Zagreb)
Programme: plenary lectures, parallel sessions including invited lectures and short communications, CMS award lecture
Languages: English and Croatian
Programme and organising committee: I. Aganovic, D. Bakic, D. Butkovic, V. Hari, H. Kraljevic, S. Kurepa, R. Manger, S. Mardesic, P. Pandzic (secretary), M. Polonijo, M. Primc, R. Scitovski, D. Svrtan, H. Sikic (president), Z. Sikic, M. Tadic, Z. Tutek, N. Uglesic, S. Varosanec, D. Veljan, V. Volenec, Z. Vondracek
Sponsors: CVS, Tau d.o.o., Ministry of Science and Technology of Croatia
Site: Department of Mathematics, Bijenicka 30, Zagreb, Croatia
Information:
e-mail: congress@math.hr
Web site: http://www.math.hr/~congress/

17-22: EURESCO Conference on Mathematical Analysis: Partial Differential Equations and their Applications to Geometry and Physics, Castelvecchio Pascoli, Italy
Aim: to bring together some of the leading experts in this very active area of research, to report and exchange information on the most influential and exciting new developments, and to stimulate new ideas and approaches for further advances
Topics: harmonic maps and variational problems; non-linear PDEs for special classes of Riemannian metrics; Seiberg-Witten equations and their applications in geometry; Dirac equations and Killing spinors; spectral theory of Dirac and Laplace operators
Organiser: J. Eichhorn (Greifswald)
Speakers: Uwe Abresch (Bochum), Michael T. Anderson (Stony Brook), Boguslaw Broda (Lodz), Gilles Carron (Lyon), Harold G. Donnelly (Purdue), Tom Ilmanen (Zürich), Thomas Friedrich (Berlin), Dieter Kotschick (Munich), Claude LeBrun (Stony Brook), Joachim Lohkamp (Augsburg), John Lott (Ann Arbor), Matilde Marcolli (MIT), Werner Müller (Bonn) Richard Schoen (Stanford), Stephan Stolz (Notre Dame), Mikhail Shubin (Boston) Michael Struwe (Zürich), Gabriella Tarantello (Rome), Gang Tian (MIT), Andrzej Trautman (Warsaw), Neil S. Trudinger (Canberra), Shing-Tung Yau (Harvard)
Site: International Conference Centre Il Ciocco, Castelvecchio Pascoli (northern Tuscany), Italy
Grants: available for young scientists from European Community countries and associated states
Information:
Web site: http://www.esf.org/euresco/00/pc00094a.htm

18-21: International Conference on Monte Carlo Simulation, Monte Carlo, Monaco
Information:
Web site: http://www.uibk.ac.at/c/c8/c810/conf/mcs_2000.html
[*For details, see EMS Newsletter 33*]

18-24: Perspectives of Mathematics, Goslar, Germany
Information: contact K. Hulek, Institut für Mathematik, Universität Hannover, Postfach 6009, D-30060 Hannover, Germany
e-mail: Hulek@math.uni-hannover.de
Web site: http://www-ifm.math.uni-hannover.de/info/perspectives.html
[*For details, see EMS Newsletter 33*]

20-25: Mathematical Physics in Mathematics and in Physics: Quantum and Operator Algebraic Aspects, Siena, Italy
Information : contact Roberto Longo Dipartimento di Matematica, Università di Roma 'Tor Vergata', I-00133 Roma, Italy, fax: +39.0672594699
e-mail: mp@mat.uniroma2.it
Web site: http://mat.uniroma2.it/~mp/siena2000.html
[*For details, see EMS Newsletter 34*]

24-30: Numerical Methods for Evolution Partial Differential Equations, Anogia, Crete
[part of the series: Euroconferences in Mathematics on Crete]
Main speakers: T. Gallouet (Marseille), R. Nochetto (Maryland), J. Rappaz (Lausanne), V. Thomee (Goeteborg), L. Wahlbin (Cornell)
Organisers: G. Akrivis (Ioannina, Greece), M. Crouzeix (Rennes, France)
Local coordinator: Susanna Papadopoulou (souzana@math.uch.gr)
Grants: contact local coordinator
Information:
e-mail: akrivis@cs.uoi.gr

25-28: IMACS-ACA2000 6th International Conference on Applications of Computer Algebra, St Petersburg, Russia
Scope: actual or possible applications of non-trivial computer algebra techniques to other fields and substantial interactions of computer algebra with other fields
Sessions: the meeting will be run in the standard IMACS format where individuals are invited to organise a special session. Individuals can propose a special session by contacting the programme chairs. All paper submissions must be directed to an organiser of an appropriate special session
General chair: Nikolay Vassiliev (vasiliev@pdmi.ras.ru)
Programme chairs: Victor Edneral (edneral@theory.npi.msu.su), Richard Liska (liska@siduri.fjfi.cvut.cz), Michael Wester (wester@math.unm.edu)
Scientific committee: Bruno Buchberger (RISC-Linz), Jacques Calmet (Univ. of Karlsruhe), Arieh Cohen (Eindhoven Univ. Tech), Rob Corless (Univ. of Western Ontario), Andre Deprit (Ntl. Bureau of Standarts), Sam Dooley (IBM Yorktown Heights), Keith Geddes (Univ. of Waterloo),

Vladimir Gerdt (Inst. of Nuclear Res.), Gaston Gonnet (Zurich), Richard Jenks (IBM Yorktown Heights), Erich Kaltofen (N. Carolina State Univ.), Deepak Kapur (Univ. of New Mexico), Ilias Kotsireas (ORCCA-Univ. of Western Ontario), Wolfgang Kuechlin (Univ. of Tübingen), Bernard Kutzler (BK Techware), Luis Laita (Univ. Politecnica Madrid), Richard Liska (Tech. Univ. Prague), Yuri Matiyasevich (Steklov Inst. of Math. St Petersburg), Alexander Michalev (Moscow State Univ.), Michael Monagan (Simon Fraser Univ.), Matu-Tarow Noda (Ehime Univ.), Mohamed O. Rayes (Texas Instruments Dallas), Tomas Recio (Univ. de Cantabria), Eugenio Roanes-Lozano (Univ. Complutense de Madrid), Tateaki Sasaki (Univ. of Tsukuba), Stanley Steinberg (Univ. of New Mexico), David Stoutemeyer (Soft. Warehouse), Nikolay Vassiliev (Steklov Inst. of Math. St. Petersburg), Anatoli Vershik (Steklov Inst. of Math. St Petersburg), Emil Volcheck (National Security Agency), Volker Weispfenning (Passau), Franz Winkler (J. Kepler Univ. Linz)
Local arrangements: Elena Novikova, Nikolay Mnev, Vyacheslav Nesterov, Sergei Slavyanov
Sponsors: Steklov Institute of Mathematics at St Petersburg, Euler International Mathematical Institute, St Petersburg Mathematical Society, St Petersburg State University
Language: English
Information:
e-mail: aca2000@imi.ras.ru
Web site: http://www.pdmi.ras.ru/EIMI/2000/imacs/

26-28: 5th Workshop on Numerical Ranges and Numerical Radii, Nafplio, Greece
Information:
Web site: http://www.math.uregina.ca/~tsat/nr/nr.html

26-28: 6th International Conference on Advanced Computational Methods in Heat Transfer, Madrid, Spain
Information: contact Conference Secretariat, Heat Transfer 2000, Wessex Institute of Technology, Ashurst Lodge, Ashurst Southampton, SO40 7AA, tel: +44-(0)23-80-293223, fax: +44-(0)23-80-292853
e-mail: wit@wessex.ac.uk
Web site: http://www.wessex.ac.uk/conferences /2000
[*For details, see EMS Newsletter 34*]

26-30: Formal Power Series and Algebraic Combinatorics (FPSAC '00), Moscow, Russia
Information:
Web site: http://www.liafa.jussieu.fr/~fpsac00/
[*For details, see EMS Newsletter 34*]

26-30: POISSON 2000, France
Information:
e-mail: dufourj@darboux.math.univ-montp2.fr

26-1 July: 4th Siberian Congress on Industrial and Applied Mathematics, Novosibirsk, Russia
[dedicated to the memory of M. A. Lavrentév (1900-80)]
Aim: to provide a forum for discussing research in contemporary mathematics and its applications to mechanics and control processes, geophysics, chemistry, mathematical models for processes in the atmosphere, oceans and reservoirs, related problems of conversion, biology, ecology, engineering mathematics, and economics
Topics: differential equations, geometry and analysis, theory of functions, mechanics and control processes, numerical methods, informatics, cubature formulas and solutions of integral equations, informatics in education and teaching methods, mathematical geophysics, mathematical simulation and modelling, mathematical methods in chemistry, mathematical models for processes in the atmosphere, oceans and reservoirs and related problems of conversion, mathematical biology, methods of discovering of the regularities, regional problems of the development of Siberia and the Far East, mathematical problems of ecology, information processing and device control, mathematical models in geodesy, cadastre and optical engineering, mathematical modeling in high technologies, mathematical economics, algebra, computing algebra, mathematical logic
Invited speakers: plenary lectures will be given by a number of invited speakers who are internationally recognised for their contribution to the field
Programme: twenty plenary lectures, sixty interdisciplinary lectures in parallel sessions, a large number of talks in the sections of the Congress, and round table discussions
Languages: English and Russian
Call for papers: it is recommended that abstracts be submitted electronically using the Web site http://www.math.nsc.ru/conference. They may also be e-mailed to inprim@math.nsc.ru, with the subject field containing exclusively the relevant section title (see topics above). They should be written in English or Russian, and prepared in LaTeX2e, using only standard commands and AMS macros, symbols and fonts. They should have the following structure: 1. Title of the talk. 2. Name and affiliation of author(s). 3. Text of the abstract, not exceeding 1500 symbols in hard copy, including references
Programme committee: Prof. M. M. Lavrentév (Novosibirsk, Chairman), Prof. Yu. G. Reshetnyak (Novosibirsk, Vice-Chairman), Prof. P. I. Plotnikov (Novosibirsk, Vice-Chairman), Prof. M. V. Fokin (Novosibirsk, Vice-Chairman), Prof. L. A. Bokut' (Novosibirsk, Vice-Chairman), Prof. V. S. Belonosov (Novosibirsk, Scientific Secretary), Dr V. L. Vaskevich (Novosibirsk, Scientific Secretary), Dr A. I. Rylov (Novosibirsk, Scientific Secretary), and others (see the *Web site*)
Deadlines: for submission of abstracts, 1 April. Decisions on acceptance will be made by 15 April. Acceptance will be confirmed by 1 May. An official invitation will be sent by airmail on request
Information:
Web site: http://www.math.nsc.ru/ conference

27-1 July: 18th International Conference on Operator Theory, Timisoara, Romania
Theme: operator theory, operator algebras and applications
Aim: to contribute to the dissemination of new results in operator theory, operator algebras and applications and to facilitate direct contact between researchers in different countries
Organisers: Institute of Mathematics of the Romanian Academy, University of the West, Timisoara
Programme: 40 minute lectures from invited speakers, 20 or 30 minute communications from other participants
Call for papers: abstracts should be e-mailed to ot@imar.ro, mailed to OT18, Institute of Mathematics, PO box 1-764, Bucharest 70700, Romania, or submitted online at http://at.yorku.ca/cgi-bin/amca/submit/caeo-01. They can be viewed at http://at.yorku.ca/cgi-bin/amca/caeo-01
Languages: English (preferably), French
Programme committee: W. B. Arveson (Berkeley), N. K. Nikolskii (Bordeaux/St Petersburg), N. Salinas (Lawrence), S. Statila (Bucharest), F.-H. Vasilescu (Lille)
Organising committee: D. Gaspar, T. Ceausu, A. Craciunescu, C. Pop, N. Suciu, F. Turcu (all Timisoara), A. Gheondea, R.-N. Gologan, D. Timotin (all Bucharest)
Deadlines: for registration, 30 March 2000; for abstracts, 1 June 2000
Information:
e-mail: ot@imar.ro
Web site: http://www.imar.ro/~ot/conf.html

28-1 July: First World Congress of the Bachelier Finance Society, Paris, France
Information:
e-mail: geman@dauphine.fr

29-3 July: International Workshop on Nonlinear Spectral Theory, Würzburg, Germany
Information: contact Jurgen Appell, Department of Mathematics, University of Würzburg, Am Hubland, D-97074 Würzburg, Germany; tel: +49-931-8885017; fax: +49-931-8885599
e-mail: appell@mathematik.uni-wuerzburg.de
Web site: www.mathematik.uni-wuerzburg.de/~appell/nlst.html
[*For details, see EMS Newsletter 33*]

30-2 July: 2000 Centennial Vranceanu, Bucharest, Romania
Topics: Riemannian and pseudo-Riemannian geometry, submanifold theory, Chen invariants, affine differential geometry, relativity, Lie groups, applications of differential geometry
Information:
e-mail: imihai@geometry.math.unibuc.ro

July 2000

2-7: 6th International Conference on p-Adic Analysis, Ioannina, Greece
Information: contact A. K. Katsaras, Dept. of Math., Univ. of Ioannina, 45110, Ioannina, Greece, tel: +30-651-98289, fax: +30-651-46361
e-mail: akatsar@cc.u0i.gr
Web site: http://www.uoi.gr/conf_sem/p-adic
[*For details, see EMS Newsletter 34*]

2-15: NATO Advanced Study Institute 20th Century Harmonic Analysis-a Celebration, Tuscany, Italy
Information:
Web site: http://www.cs.umb.edu/~asi/

analysis2000

3-7: ALHAMBRA 2000, Granada, Spain
Information: contact ALHAMBRA 2000 Conference eurocongres Avda. Constitución, 18 - Blq.4 E-18012 - Granada, Spain, tel: +34-958-209-361, fax: +34-958-209-400
e-mail: alhambra2000@ugr.es, eurocongres@mx3.redestb.es
Web site: http://www.ugr.es/local/ alhambra 2000
[*For details, see EMS Newsletter 34*]

3-7: ANTS IV Algorithmic Number Theory Symposium, Leiden, the Netherlands
Information:
e-mail: ants4@wins.uva.nl
Web site: http://www.math.leidenuniv.nl /ants4/
[*For details, see EMS Newsletter 34*]

3-7: Functional Analysis Valencia 2000, Valencia, Spain
Information: contact: K.D. Bierstedt or J. Bonet, Univ. Paderborn, FB 17, Math., D-33095 Paderborn, Germany or Universidad Politècnica de Valencia, Departamento de Matemática Aplicada, E-46071 Valencia, Spain
e-mail: VLC2000@uni-paderborn.de
Web site: http://math-www.uni-paderborn.de/VLC2000
[*For details, see EMS Newsletter 32*]

3-9: Euro-Summer School on Mathematical Aspects of Evolving Interfaces, Madeira, Portugal
Information:
e-mail: maei2000@lmc.fc.ul.pt
Web site: http://maei.lmc.fc.ul.pt
[*For details, see EMS Newsletter 34*]

4-6: Catop 2000, Fribourg, Switzerland
Scope: categorical topological methods
Information:
Web site: http://www.unifr.ch/math/catop 2000/
[*For details, see EMS Newsletter 34*]

4-7: 2nd International Conference on Mathematical Methods in Reliability, Bordeaux, France
Information: contact Dr. Valentina Nikoulina, Université Victor Segalen - Bordeaux 2, Statistique Mathematique, UFR MI2S, B.P. 69 33076 Bordeaux Cedex, FRANCE; tel: +33 (0) 5 57 57 10 70 & (0)5 57 57 14 25; fax: +33 (0) 5 56 98 57 36 & +33 (0) 5 57 57 12 63
e-mail: vnikou@mi2s.u-bordeaux2.fr, Nikolaos.Limnios@utc.fr
Web site: http://www.mass.u-bordeaux2.fr /MI2S/MMR2000/
[*For details, see EMS Newsletter 34*]

5-7: Scandinavian Workshop on Algorithm Theory, Bergen, Norway
Information:
e-mail: telle@ii.uib.no
Web site: http://www.ii.uib.no/swat2000

5-8: Ordinal and Symbolic Data Analysis (OSDA 2000), Brussels, Belgium
Aim: the OSDA meetings, of which this is the sixth, are motivated by the fact that ordinal and symbolic data occur quite frequently, but theoretical tools for handling such data require further development
Invited speakers: Michel Chein (Montpellier), Andreas Dress (Bielefeld), Jean-Claude Falmagne (Irvine), Bernhard Ganter (Dresden), Pierre Hansen (Montréal), Itzhak Gilboa (Tel-Aviv), R. Duncan Luce (Irvine), William T. Trotter (Arizona U.), Philippe Vincke (Bruxelles), Uta Wille (Jelmoli Ag)
Sessions: a special session in symbolic data analysis will be organised by Edwin Diday. Other special sessions are under review
Language: English
Call for papers: see the conference *Web site*
Programme committee: Edwin Diday (Paris), Jean-Paul Doignon (Bruxelles), Melvin F. Janowitz (Amherst), Bernard Monjardet (Paris), Marc Pirlot (Mons), Fred S. Roberts (New Brunswick), Rudolf Wille (Darmstadt)
Organising committee: Jean-Paul Doignon (Bruxelles), Samuel Fiorini (Bruxelles), Marc Pirlot (Mons)
Sponsors: F.N.R.S., Belgium, and possibly other granting institutions
Proceedings: the abstracts will appear as a volume in Electronic Notes in Discrete Mathematics. Refereed papers will be published in a special issue of Discrete Applied Mathematics
Site: the campus of the Université Libre de Bruxelles
Information:
Web site: http://www.ulb.ac.be/sciences/ulbmath/osda2000

6-8: 6th Barcelona Logic Meeting, Barcelona, Spain
Information:
e-mail: 6blm@crm.es
Web site: http://www.mat.ub.es/~logica/news.html or http://www.crm.es/
[*For details, see EMS Newsletter 34*]

10-14: IUTAM Symposium on Free Surface Flows, Birmingham, UK
Information:
Web site: http://www.mat.bham.ac.uk/research/iutam.htm
[*For details, see EMS Newsletter 33*]

10-14: ICMS Workshop: Dynamical Systems, Edinburgh, UK
[satellite meeting of the International Congress in Mathematical Physics, 17-22 July, London, UK]
Information:
e-mail: icms@maths.ed.ac.uk

10-14: 3rd European Congress of Mathematics (3ecm), Barcelona, Spain
Information: contact Societat Catalana de Matemátiques, Carrer del Carme 47, E-08001 Barcelona, Spain;
tel: (+34)-270-16-20; fax (+34)-93-270-11-80
e-mail: 3ecm@iec.es
Web site: http://www.iec.es/3ecm/
[*For details, including satellite conferences, see Second Announcement in EMS Newsletter 34*]

13-14: Computational Challenges for the Millennium, Cambridge, UK
Theme: a landmark international conference, organised by the Institute of Mathematics and its Applications in association with the Isaac Newton Institute, to celebrate the new Millennium, which will span a wide range of major computational science areas, which are already, or will become, increasingly more important over the next decades and beyond
Topics: astrophysics and cosmology, chemistry and molecular modelling, computer vision and medical imaging, computer systems, engineering sciences, finance and risk, the humanities, physics and condensed matter, quantum computing, weather forecasting and climatology
Speakers: J. M. Brady (Oxford), R. Catlow (Royal Institution of Great Britain), M. Dempster (Cambridge), P. Embrechts (Zürich), C. Frenk (Durham), R. Horgan (Cambridge), J. C. R. Hunt (London), S. Popescu (Bristol)
Sessions: the format will be based on a series of lectures by the invited speakers, together with refereed poster sessions
Language: English
Scientific and organising committee: H. Liddell (London), J. M. Brady (Oxford), P. Dasgupta (Cambridge), P. Embrechts (Zurich), R. Horgan (Cambridge), J. C. R. Hunt (London), K. Moffatt (Cambridge), D. B. Mumford (USA).
Sponsors: co-sponsored by the Institute of Physics
Site: Cambridge, UK
Grants: not available
Information:
Web site: http://www.ima.org.uk/mathematics/confmillennium.htm

17-20: IUTAM Symposium 2000/10 Diffraction and Scattering in Fluid Mechanics and Elasticity, Manchester, UK
Information: contact Professor David Abrahams, Department of Mathematics, University of Manchester, Oxford Road, Manchester M13 9PL, UK, tel: +44-(0)161-275-5901, fax: +44-(0)161-275-5819
e-mail: i.d.abrahams@ma.man.ac.uk
Web site: http://www.keele.ac.uk/depts/ma/iutam/
[*For details, see EMS Newsletter 33*]

17-21: 9th International Conference on Fibonacci Numbers and their Applications, Luxembourg-City, Luxembourg
Information:
e-mail: howard@mthcsc.wfu.edu

17-22: Colloquium on Lie Theory and Applications, Vigo, Spain
Information: contact I Colloquium on Lie Theory and Applications, E. T. S. I. Telecomunicación, Universidad de Vigo, 36280 Vigo, Spain; tel: +86 81 21 52 // +86 81 24 45; fax: +86 81 21 16 // +86 81 24 01
e-mail: clieta@dma.uvigo.es
Web site: http://www.dma.uvigo.es/~clieta/
[*For details, see EMS Newsletter 33*]

17-22: International Congress on Mathematical Physics, London, UK
Information:
Web site: http://icmp2000.ma.ic.ac.uk/

19-26: 3rd World Congress of Non-linear Analysts (WCNA-2000), Catania, Italy

22-28: New Mathematical Methods in Continuum Mechanics, Anogia, Crete
[part of the series Euroconferences in Mathematics on Crete]
Main speakers: A. Bressan (Trieste), G. Francfort (Paris-Nord), G. Friesecke (Oxford), R. James (Minnesota), V. Sverak (Minnesota)
Organisers: J. Ball (Oxford, UK), S. Mueller (Leipzig, Germany)
Local coordinator: Susanna Papadopoulou (souzana@math.uch.gr)

Grants: contact local coordinator
Information:
e-mail: ball@maths.ox.ac.uk

23-31: ASL European Summer Meeting (Logic Colloquium 2000), Paris, France
Information:
e-mail: asl@math.uiuc.edu
Web site: http://lc2000.logique.jussieu.fr
[*For details, see EMS Newsletter 33*]

24-3 August: EMS Summer School, New Analytic and Geometric Methods in Inverse Problems, Edinburgh, UK
Information: contact Erkki Somersalo, Helsinki University of Technology, Finland
e-mail: esomersa@dopey.hut.fi

29-4 August: Curves and Abelian Varieties over Finite Fields and their Applications, Anogia, Crete
[part of the series Euroconferences in Mathematics on Crete]
Main speakers: N. Elkies (Harvard), G. van der Geer (Amsterdam), R. Pellikaan (Eindhoven), R. Schoof (Rome), M. Tsfasman (Marseille)
Organisers: G. van der Geer (Amsterdam), R. Schoof (Rome)
Local coordinator: Susanna Papadopoulou (souzana@math.uch.gr)
Grants: contact local coordinator
Information:
e-mail: geer@wins.uva.nl

31-3 August: 3rd Conference of Balkan Society of Geometers, Bucharest, Romania
Information: contact V.Balan, University Politehnica of Bucharest, Department Mathematics I, Splaiul Independentei 313, RO-77206, Bucharest, Romania; fax: (401) 411.53.65
e-mail: vbalan@mathem.pub.ro
[*For details, see EMS Newsletter 33*]

31-4 August: Numerical Modelling In Continuum Mechanics (Theory, Algorithms, Applications), Prague, Czech Republic
Aim: to bring together specialists in fluid dynamics, structural mechanics and related areas
Programme: 50-minute invited lectures and 20-minute communications
Topics: fluid dynamics, structural mechanics, material, structures and optimization, environmental problems
Invited plenary speakers: I. Babuska (USA), J. W. Barrett (Great Britain), D. Braess (Germany), L. Demkowicz (USA), P. Fraunie (France) R. Glowinski (USA), T. Hou (USA), K. Kunisch (Austria), Yu. Kuznetsov (USA/Russia), M. A. Leschziner (Great Britain)
Organising committee chairmen: Miloslav Feistauer, Faculty of Mathematics and Physics, Institute of Numerical Mathematics, Charles University, Prague; Karel Kozel, Faculty of Mechanical Engineering, Department of Technical Mathematics, Czech Technical University, Prague; Rolf Rannacher, Institute of Applied Mathematics, Ruprecht-Karls-Universitaet Heidelberg
Proceedings: to be published
Site: Charles University in Prague
Call for papers: abstracts of 15 lines should be sent to the contact address by 30 March
Contact address: Prof. Dr. Miloslav Feistauer, DrSc., Charles University Prague, Faculty of Mathematics and Physics, Institute of Numerical Mathematics, Sokolovska 83, 186 00 Praha 8, Czech Republic, tel: +420 2 21911111, +420 2 21914223, fax: +420 2 535229, +420 2 23233994
Information:
e-mail: nmicm@karlin.mff.cuni.cz
Web site: http://www.karlin.mff.cuni.cz/katedry/knm/nmicm2000

31-4 August: Workshop on Partial Differential Equations: Thermo, Visco and Elasticity, Konstanz, Germany
Topics: partial differential equations related to elasticity, thermoelasticity and viscoelasticity
Invited speakers: H.-D. Alber, D. Andrade, S. Antman, A. Benabdallah, C. Chelminski, C. M. Dafermos, G. Dassios, C. Eck, M. Fabrizio, J. Ferreira, H. Frid Neto, V. Georgiev, J. Gwinner, L. Hsiao, S. Jiang, S. Kawashima, J. U. Kim, H. Koch, I. Lasiecka, Z. Liu, O. Lopes, T. F. Ma, S. A. Messaoudi, M. Nakao, G. Perla Menzala, M. Reissig, M. Renardy, Y. Shibata, M. Slemrod, Y.-G. Wang, S. Zheng
Organisers: J. E. Muñoz Rivera (Petrópolis, Rio de Janeiro), R. Racke (Konstanz)
Site: University of Konstanz
Information: local organiser: reinhard.racke@uni-konstanz.de
Web site: http://www.mathe.uni-konstanz.de/~racke/announ/ws2000.html

August 2000

2-9: Summer School on Mathematical Physics (emphasis on Quantum Field Theory), Sandbjerg Manor, Denmark
Information:
Web site: http://www.maphysto.dk/events/

2-18: Rings, Modules and Representations-Constanta 2000, Constanta, Romania
Scope: A workshop and conference on algebra: 2-12 August, Workshop on Algebra - Representation theory (NATO Advanced Study Institute); 14-18 August, conference on Rings, Modules and Representations
Invited speakers: Henning Andersen (Aarhus, Denmark), Michel van den Bergh (Limburg, Belgium), Jon Carlson (Georgia, USA), Alexandr Kemer (Moscow State University, Simbirsk, Russia), Susan Montgomery (Southern California, USA), Claudio Procesi (Rome, Italy), Idun Reiten (Trondheim, Norway), Jeremy Rickard (Bristol, UK), Wolfgang Soergel (Freiburg, Germany) and Efim Zelmanov (Yale University, USA). The workshop will also include talks by Michel Broué (Paris, France), Steffen König (Bielefeld, Germany), Klaus Roggenkamp (Stuttgart, Germany) and Toby Stafford (Michigan, USA)
Organising committee chairman: Klaus Roggenkamp (Stuttgart, Germany)
Local organiser: Mirela Stefuanescu (Constanta, Romania)
Scientific Committee: László Márki (Budapest, Hungary), Fred van Oystaeyen (Antwerp, Belgium), Klaus Roggenkamp (Stuttgart, Germany)
Registration fee: $50 for the workshop and $50 for the conference ($40 before 31 May); there is a special rate for students
Information:
Address: University of Stuttgart, Mathematisches Institut B/3, Pfaffenwaldring 57, 70550 Stuttgart, Germany
Fax: +49-(0)711-685-5322
e-mail: buro@poolb.mathematik.uni-stuttgart.de
Web site: http://web.mathematik.uni-stuttgart.de/~ovid

3-5: Recent Development in the Wave Field and Diffuse Tomographic Inverse Problems, Edinburgh, UK
Information:
e-mail: icms@maths.ed.ac.uk

8-12: XVIII Nevanlinna Colloquium, Helsinki, Finland
Information:
e-mail: pekka.tukia@helsinki.fi
Web site: http://www.math.helsinki.fi/~analysis/NevanlinnaColloquium/
[*For details, see EMS Newsletter 33*]

17-3 September: EMS Summer School in Probability Theory, Saint-Flour, Cantal, France
Information: contact: P. Bernard, Laboratoire de Mathematiques Appliquees, Univ. Blaise Pascal, F-63177 Aubiere, tel/fax: +33 4 73 40 70 64
e-mail: bernard@ucfma.univ-bpclermint.fr
[*For details, see EMS Newsletter 34*]

19-25: Discrete and Algorithmic Geometry, Anogia, Crete
[part of the series Euroconferences in Mathematics on Crete]
Main speakers: G. Kalai (Jerusalem), R. Seidel (Saarbruecken), J. Snoeyink (Vancouver), E. Welzl (Zürich), G. M. Ziegler (Berlin)
Organisers: G. M. Ziegler (Berlin), E. Welzl (Zurich)
Local coordinator: Susanna Papadopoulou (souzana@math.uch.gr)
Grants: contact local coordinator
Information:
e-mail: ziegler@math.tu-berlin.de

20-23: 3rd International Workshop on Scientific Computing in Electrical Engineering SCEE-2000, Warnemünde, Germany
Information:
Web site: http://www.SCEE-2000.uni-rostock.de

21-25: International Association for Mathematics and Computers World Congress (IMACS 2000), Lausanne, Switzerland
Information: contact Prof. Robert Owens, IMACS Congress 2000, DGM-IMHEF-LMF, Swiss Federal Institute of Technology, CH-1015 Lausanne, Switzerland; tel: +41-21-693.35.89; fax: +41-21-693.36.46
e-mail: robert.owens@epfl.ch
Web site: http://imacs2000.epfl.ch
[*For details, see EMS Newsletter 32*]

27-1 September: 9th Summer St Petersburg Meeting in Mathematical Analysis, St Petersburg, Russia
Information:
Web site: www.pdmi.ras.ru/EIMI/2000/analysis9/index.html

30-2 September: Innovations in Higher Education 2000, Helsinki, Finland
Information:

e-mail: sari.lindblom-ylanne@helsinki.fi
Web site: http://www.helsinki.fi/inno2000

September 2000

1-4: Constantin Caratheodory Congress, Evros, Greece
Scope: measure theory, function theory, partial differential equations and their applications
Information:
e-mail: vougiou@edu.duth.gr

2-9: International Conference on Topology and its Applications, Ohrid, Macedonia
Information:
Web site: http://www.pmf.ukim.edu.mk/mathematics/icta2000.html

3-6: 31st European Mathematical Psychology Group Meeting (EMPG 2000), Graz, Austria
Scope: all areas of mathematical psychology
Topics: measurement theory, psychophysics, psychometrics, statistical theory, response times, perception, cognition, decision theory, memory, learning, knowledge space theory, neural networks, and others
Organising committee: Prof. Dietrich Albert (Graz), Chairman
Site: University of Graz, Austria
Language: English
Deadlines: for submission of abstracts and early registration, 31 May
Information:
e-mail: empg2000@psyserver.kfunigraz.ac.at
Web site: http://psyserver.kfunigraz.ac.at/empg2000/

4-6: Mathematics of Surfaces, Cambridge, UK
Information:
Web site: http://www.ima.org.uk

4-8: FGI2000 French-German-Italian Conference on Optimization, Montpellier, France
Information: contact: Bernard Lemaire, Mathématiques, Université de Montpellier II, Place Eugène Bataillon, 34095 Montpellier cedex 05
e-mail: fgi2000@math.univ-montp2.fr
Web site: http://www.math.univ-montp2.fr/
[*For details, see EMS Newsletter 34*]

4-15: Spatial Structures in Biology and Ecology: Models and Methods, A Biomathematics Summer School, Taranto, Italy
Information:
Web site: http://www.mat.unimi.it/~miriam/ESMTB/MARTINA-SS/summer_school.html

5-7: Quantitative Modelling in the Management of Health Care, Salford, UK
Information:
Web site: http://www.ima.org.uk/mathematics/conferences.htm
[*For details, see EMS Newsletter 34*]

5-16: Advanced Course on Algebraic Quantum Groups, Bellaterra, Spain
Information:
e-mail: quantum@crm.es
Web site: http://crm.es/quantum

10-17: Summer School on Geometry of Quiver-Representations and Preprojective Algebras, Isle of Thorn, UK
Information: contact Karin Erdmann, Mathematical Institute, University of Oxford, Oxford OX1 3LB, UK
e-mail: erdmann@maths.ox.ac.uk
Web site: http://www.mathematik.uni-bielefeld.de/~sek/summerseries.html
[*For details, see EMS Newsletter 34*]

11-14: International Colloquium in Honour of Professor Michel Mendès, Bordeaux, France
[on the occasion of his 65th birthday]
Topics : number theory, combinatorics and physics
Invited Speakers : Alan Baker, Vitaly Bergelson, Michel Dekking, Maurice Dodson, Teturo Kamae, Michael Keane, Hugh Montgomery, Wladyslaw Narkiewicz, Andrew Pollington, Imre Ruzsa, Andrzej Schinzel, Jeffrey Shallit, Chris Smyth, Vera Sós, Alf Van der Poorten, Zhi-Ying Wen, Jia-Yan Yao, Don Zagier, Marie-José Bertin, Anne Bertrand, Paula Cohen, Hédi Daboussi, Bernard Derrida, Etienne Fouvry, Jean-Pierre Kahane, Yves Meyer, Martine Queffélec, Gérard Rauzy, Georges Rhin, Bahman Saffari, Gérald Tenenbaum
Languages : English and French
Advisory committee: Pierre Cartier (chairman), Anne Bertrand, Jean-Marc Deshouillers, Pierre Liardet, Jean-François Méla, Michel Olivier, Jacques Peyrière
Organising committee : Jean-Paul Allouche (chairman), Christophe Doche, Jean-Jacques Ruch
Sponsors : University Bordeaux I, Réseau Diophante, EMS
Site : Université Bordeaux I, 351, cours de la libération 33405 Talence, France
Deadline: for registration, end of June
Information:
Web site: http://www.math.u-bordeaux.fr/~stan/Colloque/MMF.html

11-15: Boundary Integral Methods: Theory and Applications, Bath, UK
Information:
Web site: http://www.ima.org.uk/mathematics/conferences.htm
[*For details, see EMS Newsletter 34*]

12-15: Imaging and Digital Image Processing: Mathematical Methods, Algorithms and Applications, Leicester, UK
Information:
Web site: http://www.ima.org.uk/mathematics/conferences.htm
[*For details, see EMS Newsletter 34*]

12-15: IWOTA -Portugal 2000 International Workshop on Operator Theory and Applications, Faro, Portugal
Main topics: factorization theory, factorization and integrable systems, operator theoretical methods in diffraction theory, algebraic techniques in operator theory, related topics and applications to mathematical physics
Steering committee: T. Ando, H. Bart, H.Bercovici, R. Dijksma, H. Dym, C. Foias, I. Gohberg, J. W. Helton, M. A. Kaashoek, H. Langer, R. Mennicken, L. Rodman, J. G. Stampfli
Organisers: A. F. dos Santos, F.-O. Speck, A. B. Lebre, R. Picken (Lisboa), V. G. Kravchenko, N. Manojlovic (Faro), M. A. Kaashoek (Amsterdam)
Registration: use IWOTA web-page or e-mail to receive second announcement
Information: contact F.-O. Speck, Departamento de Matematica, Instituto Superior Tecnico, U.T.L., 1049-001 Lisboa, Portugal, tel: +351-21-8417095, fax: +351-21-8417598, *e-mail*: fspeck@math.ist.utl.pt
Local organisation: contact N. Manojlovic, U.C.E.H., 8000 Faro, Portugal, tel: +351-28-9800914 ext 7637, fax; +351-289 818560, *e-mail*: nmanoj@ualg.pt
Web site: http://www.ualg.pt/cma/iwota

13-15: International Conference of the Royal Statistical Society, Reading, UK
Information:
e-mail: rss2000@reading.ac.uk

15-18: Physical Interpretations of Relativity Theory, London, UK
Information:
e-mail: michael.duffy@sunderland.ac.uk

18-22: International Data Analysis Conference, Innsbruck, Austria
Information:
e-mail: viertl@tuwien.ac.at
Web site: http://www.statistik.tuwien.ac.at/ida2000/

18-23: International Congress on Differential Geometry, Bilbao, Spain
[in memory of Alfred Gray (1939-98)]
Theme: differential geometry
Topics: special Riemannian manifolds, homogeneous spaces, complex structures, symplectic manifolds, geometry of geodesic spheres and tubes and related problems, geometry of surfaces, computer graphics in differential geometry and Mathematica(
Main speakers: T. Banchoff (USA), R. Bryant (USA), H. Ferguson (USA), T. Friedrich (Germany), K. Grove (USA), S. Gindikin (USA), A. Huckleberry (Germany), D. Joyce (England), M. Mezzino (USA), V. Miquel (Spain), E. Musso (Italy), R. Palais (USA), M. Pinsky (USA), A. Ros (Spain), D. Sullivan (USA), I. Taimanov (Russia), J. Wolf (USA)
Language: English
Call for papers: we are using the facilities of Atlas Mathematical Conference Abstracts. If you wish to present an oral communication or a poster, please submit before 31 May 2000 an extended (up to two pages) abstract (either plain ASCII or TeX) via http://at.yorku.ca/cgi-bin/amca/submit/cadq-01. Abstracts accepted by the organising committee will become available at http://at.yorku.ca/cgi-bin/amca/cadq-01
Programme committee: T. Banchoff (USA), J. P. Bourguignon (France), S. Donaldson (England), J. Eells (England), S. Gindikin (USA), M. Gromov (France), O. Kowalski (Czech Republic), M. Mezzino (USA), S. Novikov (USA), M. Pinsky (USA), A. Ros (Spain), S. Salamon (England), L. Vanhecke (Belgium), J. Wolf (USA)
Organising committee: M. Fernández (chairman, Spain), L.C. de Andrés (Spain), L.A. Cordero (Spain), A. Ferrández (Spain), R. Ibáñez (Spain), M. de León (Spain), M. Macho-Stadler (Spain), A. Martinez Naveira (Spain), L. Ugarte (Spain)
Sponsors (provisional): Universidad del País Vasco-Euskal Herriko Unibertsitatea, Bilbao Iniciativas Turisticas, Casco Viejo, Codorniu, Colegio Mayor Miguel Unamuno, El Correo, Deia, Europen Mathematical Society, Iberia, Iparlat-Kaiku, Laboratorios Kodak, Metro Bilbao, El Mundo, Panda Software, Real Sociedad

Bascongada de Amigos del Pais, Staedtler, Wolfram Research Inc
Proceedings: to be published
Site: the buildings of Facultad de Ciencias Economicas y Empresariales (Avenida Lehendakari Agirre 83, Bilbao)
Grants: probably support for participants from countries in a difficult economic situation and young mathematicians
Deadlines: for registration, 30 June; for abstracts, 31 May
Information:
e-mail: gray@lg.ehu.es
Web site: www.ehu.es/Gray

18-27: 8th Workshop on Stochastic and Related Fields, Famagusta, North Cyprus
Information:
Web site: http://mozart.emu.edu.tr/workshop

19-22: Fractal Geometry: Mathematical Techniques, Algorithms and Applications, Leicester, UK
Information:
Web site: http://www.ima.org.uk/mathematics/confractalgeometry.htm
[*For details, see EMS Newsletter 34*]

19-22 SCAN 2000: 9th GAMM-IMACS International Symposium on Scientific Computing, Computer Arithmetic and Validated Numerics, Karlsruhe, Germany
Information:
Web site: http://www.scan2000.de/

22-27: EURESCO Conference on Geometry, Analysis and Mathematical Physics: Analysis and Spectral Theory, San Feliu de Guixols, Spain
Aim: the interaction between physics and mathematics has become ever more important in recent years. This meeting aims to bring together mathematicians and some physicists working in areas related to quantum physics and mathematical analysis
Scope: recent progress in non-linear scattering theory and evolution equations, solitons, quantum many body problems, resonances (scattering poles), field theory, quantum chaos, and also some related topics such as control theory, spectral theory on manifolds, semi-classical problems. These areas are closely related to each other and many modern mathematical tools, such as for instance microlocal (or phase space) analysis have been successfully applied and developed. The purpose of the conference is to promote the interaction between these themes in a unifying effort
Speakers: Boris Altshuler (Princeton), V. Bach (Mainz), Nicolas Burq (Orsay), Vladimir Buslaev (St. Petersburg), Jan Derezinski (Warshaw), Bruno Eckhart (Marburg), Maria Esteban (Paris), Jean Ginibre (Orsay), Bernard Helffer (Orsay), Victor Ivrii (Toronto), Vojkan Jaksic (Ottawa), Andreas Knauf (Erlangen), Alexander Komech (Moscow), Gilles Lebeau (Palaiseau), Galina Perelman (Palaiseau) Claude-Alain Pillet (Toulon), Israel Sigal (Toronto), Uzy Smilanski (Rehovot), Jan-Philip Solovej (Copenhagen), T. Tao (Los Angeles), Andras Vasy (Berkeley-Boston), Giorgio Velo (Bologna), Giorgi Vodev (Nantes), Steven Zelditch (Baltimore), Maciej Zworski (Berkeley)
Site: Hotel Eden Roc, San Feliu de Guixols (Costa Brava), Spain
Grants: available for young scientists, in particular those from less favoured regions of European Community countries, and for participants from Central and Eastern Europe
Deadline: for applications, 2 May
Information:
http://www.esf.org/euresco/00/pc00127a.htm

22-27: EURESCO Conference on Number Theory and Arithmetical Geometry: Motives and Arithmetic, Obernai (near Strasbourg), France
Organiser: U. Jannsen (Regensburg)
Information: available soon at
Web site: http://www.esf.org/euresco

22-28: 4th International Conference on Functional Analysis and Approximation Theory (4th FAAT), Acquafredda di Maratea , Potenza, Italy
Aim: to bring together mathematicians and specialists working in functional analysis and approximation theory, in order to promote interdisciplinary collaborations and to enhance exchanges of results, techniques and applications
Main topics: Banach spaces, Banach lattices, function spaces, (positive) linear operators, semigroups of (positive) linear operators, evolution equations, approximate quadratures and integral equations, approximation methods in abstract spaces and in function spaces, approximation by (positive) operators, interpolation, polynomial approximation, constructive approximation, orthogonal polynomials
Confirmed invited speakers: P. Aiena (Palermo), H. Berens (Erlangen), P. Clément (Delft), T. Erdelyi (College Station), C. Franchetti (Firenze), G. Godefroy (Paris), D. S. Lubinsky (Johannesbourg), G. Milovanovic (Nis), G. Monegato (Torino), M. Neumann (Mississippi), P. L. Papini (Bologna), I. Rasa (Cluj-Napoca), B. Silbermann (Chemnitz), V. Totik (Szeged), P. Vertesi (Budapest), L. Weiss (Karlsruhe)
Scientific programme: survey talks by invited speakers (45 minutes) and short communications (20 minutes)
Sponsors: Center for Studies on Functional Analysis and Approximation Theory of the University of Basilicata (Potenza, Italy), Department of Mathematics of the University of Basilicata (Potenza, Italy), Department of Mathematics of the University and of the Polytechnic of Bari (Italy), University of Basilicata (Italy), University of Bari (Italy), Polytechnic of Bari (Italy), National Group of Functional Analysis and Applications (G.N.A.F.A.), Progetti di Ricerca di Interesse Nazionale: Analisi Funzionale (M.U.R.S.T.)
Organising committee: F. Altomare (altomare@pascal.dm.uniba.it), Attalienti (attalienti@matfin.uniba.it), M. Campiti (campiti@pascal.dm.uniba.it), Della Vecchia (dellavecchia@iamna.iam.na.cnr.it), G. Mastroianni (mastroianni@unibas.it), M. R. Occorsio (occorsio@iamna.iam.na.cnr.it)
Site: Hotel Villa del Mare, Acquafredda di Maratea, Potenza, Italy
Information: contact any of the organising committee or visit the website
Web site:
http://www.dm.uniba.it/maratea/FAAT2000.htm

October 2000

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

15-21: DMV Seminar on The Riemann Zeta Function and Random Matrix Theory, Mathematisches Institut Oberwolfach, Germany
Organisers: Jon Keating (Bristol), Zeév Rudnick (Tel Aviv) and Kannan Soundararajan (Princeton)
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
Organisers: Gerhard Huisken (Tübingen) and Tom Ilmanen (ETH Zürich)
Information: Prof. Dr Matthias Kreck, Universität Heidelberg, Mathematisches Institut, Im Neuenheimer Feld 288, 69120 Heidelberg, Germany

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

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

December 2000

18-20: 5th International Conference on Mathematics in Signal Processing, Coventry, 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, fax: +44 (0)1702 354111
e-mail: conferences@ima.org.ac.uk
[*For details, see EMS Newsletter 34*]

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.

M. S. Agranovich, B. Z. Katsenelenbaum, A. N. Sivov and N. N. Voitovich, ***Generalized Method of Eigenoscillations in Diffraction Theory,*** *Wiley-VCH, Berlin, 1999, 377 pp., DM298, ISBN 3-527-40092-3*

This book presents a new method for solving various diffraction and scattering problems in acoustics, electrodynamics, and quantum mechanics. This method is based on the representation of the solution of a stationary diffraction problem by a series with respect to some orthogonal system of functions. These functions are the eigenfunctions of the auxiliary homogeneous problem in which the spectral parameter is some electrodynamic parameter (not necessarily frequency). The choice of the specific electrodynamic variable used as the spectral parameter depends on the form of the diffraction problem. The book presents several versions of the method. The main part of the book contains the exposition of the formal technique of various versions of the generalised method of eigenoscillations (Chapters 1-2), the construction of stationary functionals (Chapter 3), and examples of applications to specific problems (Chapter 4). Chapter 5 deals with a mathematically rigorous treatment and justification of the technique constructed in Chapters 1-2 and connected with the use of non-self-adjoint operators. (dmed)

M. Aigner and G. M. Ziegler, ***Proofs from THE BOOK,*** *Springer, Berlin, 1998, 199 pp., DM49.90, ISBN 3-540-63698-6*

This is an international bestseller which presents 30 problems in less than 200 pages which can be solved by means of pleasing tricks. No previous knowledge is needed, and yet the problems are taken from number theory, geometry, analysis, combinatorics and graph theory (of course, and perhaps naturally, most of the solutions have a combinatorial flavour). Paul Erdös, who invented the mythology of 'The Book', was reluctant to assign 'Book' status to any particular proof, but he would probably not protest against the balanced (and in a way expected) choice of the authors. This is a useful book for motivating students and to stimulate mature minds. (jnes)

S. Axler, J. E. McCarthy and D. Sarason (eds), ***Holomorphic Spaces,*** *Mathematical Sciences Research Institute Publications 33, Cambridge University Press, Cambridge, 1998, 476 pp., £35, ISBN 0-521-63193-9*

The term 'holomorphic spaces' is used here as short for 'spaces of holomorphic functions', and this book consists of several expository articles based on lecture courses given at the MSRI semester on this subject in the fall of 1995. A range of topics is addressed, focusing primarily on operator–theoretic aspects.

The opening paper by D. Sarason gives a beautiful overview of the area. The next two papers are concerned with Bergman spaces: factorisation, invariant subspaces and Beurling's theorem (H. Hedenmalm) and the harmonic Bergman spaces on the disc (K. Stroethoff). Four papers are devoted to Hankel operators and their generalisations, by V. Peller (a survey of the classical Hankel operators), P. Gorkin, S. Saccone (both dealing with Hankel-type operators on uniform algebras), and R. Rochberg (Hankel forms of higher order). The papers by Z. Wu and by J. B. Conway and L. Yang concern operator theory in the Dirichlet space and subnormal operators, respectively. Six papers that follow address the field of operator models, systems theory and interpolation; namely, a coordinate-free function model approach to spectral theory (N. Nikolski and V. Vasyunin), scattering systems (C. Sadosky), feedback stabilization (N. Young), an abstract interpolation problem (A. Kheifets), a unified approach to the classical interpolation problems and their generalizations (H. Dym), and the reproducing kernel Pontryagin spaces (D. Alpay, A. Dijksma, J. Rovnyak and H. S. V. de Snoo). The concluding article by Vinnikov exhibits an interesting relationship between the theory of commuting families of non-self-adjoint operators and function theory on Riemann surfaces.

Though the papers vary both in length (10 to 92 pages) and in the degree of specialisation (for instance, Peller's paper may well serve as an introductory tutorial on Hankel operators for a newcomer), for the most part they are accessible even to a non-expert. In my opinion, this is a very nice collection of articles and it is extremely unlikely to disappoint any reader interested in the subject. (me)

R. Berndt and R. Schmidt, ***Elements of the Representation Theory of the Jacobi Group,*** *Progress in Mathematics 163, Birkhäuser, Basel, 1998, 213 pp., DM108, ISBN 3-7643-5922-6*

Parabolic groups and their representations nowadays play a very important role in many parts of mathematics. One of the simplest and most important examples is the Jacobi group. It is a semidirect product of the symplectic group $Sp(2n)$ with the corresponding Heisenberg group.

In the book, the authors restrict themselves to the case $n = 1$. They describe a classification of the irreducible representations of the Jacobi group in the case of real, complex, p-adic and adelic coefficients. Explicit models for these representations (including Whittaker and Kirillov models) are constructed here and a connection with holomorphic Jacobi forms and their generalisations is discussed. The book complements well the book *Automorphic forms and representations* by D. Bump (see *EMS Newsletter* **29,** p.39) and *The Theory of Jacobi Forms* by M. Eichler and D. Zagier.

This book is a very useful addition to the literature on the topic and can be recommended to readers interested in representation theory, the theory of algebraic groups and number theory. (vs)

A. Beutelspacher, N. Henze, U. Kulisch and H. Wussing (eds), ***Überblicke Mathematik 1998,*** *Friedrich Vieweg & Sohn, Braunschweig, 1997, 148 pp., ISBN 3-528-06944-9*

Following a positive reaction to the first volume, the Wiesbaden publishing house Vieweg has already published the second volume of *Überblicke der Mathematik* which summarises the development and the contemporary state of some mathematical disciplines and, above all, their application in the fine arts, natural sciences and other scientific disciplines. All essays are well and attractively arranged and written and give a reliable survey that is fairly accurate from the professional point of view and readable for mathematicians active in other disciplines.

The survey contains contributions by P. Schreiber (Mathematics and fine arts), U. Kulisch (Computer, arithmetic and numeric), R. Weiss (Mathematics and mathematical tools: advice from history), P. Brass (Distances of finite point sets), G. Strang (Mathematics in satellite navigation), E. Gauss (Fractals and fun – a programme of variants of classic fractals), L. Rüschendorf (Stochastics – an interdisciplinary science), B. Polster and A. E. Schroth (Models of semibiplanes), and R. Schreckenberg (Mathematics of transport flows). (efu)

B. Blackadar, ***K-Theory for Operator Algebras,*** *Mathematical Sciences Research Institute Publications 5, Cambridge University Press, Cambridge, 1998, 300 pp., £19.95, ISBN 0-521-63532-2*

This is the second edition of a famous book, the first edition of which appeared in 1986. For the second edition the author has made only minor changes. He has corrected some errors, and added new comments and references. The references now contain 250 items and go up to 1998. The only substantial addition is a new section (at the very end) on E-theory.

K-theory first appeared first in topology as a device for the study of vector bundles. Later on, it was realised that instead of a vector bundle one can consider continuous sections of this bundle as a module over the algebra of continuous functions on the base space. This idea was at the beginning of the K-theoretical investigations of operator algebras (as well as at the beginning of algebraic K-theory). This K-theoretic approach has brought a revolution into the study of operator algebras and has led to many interesting applications.

To understand these parts of mathematics is not very easy. At the time of its first edition Blackadar's book was the only comprehensive introduction to the *K*-theory of operator algebras. Since then several very good books on this subject have appeared, but for a comprehensive one we would most probably again choose this one.

According to the author, the reader of the book should be familiar with the rudiments of the theory of Banach algebras and *C**-algebras, such as can be found in the first part of J. Dixmier's *Les C*-algebras et leurs représentations*, or G. K. Pedersen's *C*-algebras and their automorphism group*, or M. Takesaki's *Theory of operator algebras*, but sometimes must know more.

The book is well written, with a great number of examples, exercises and problems that help one to understand the theory, and the reader can find a good survey of the theory as well as many references to more detailed or more advanced reading. Section 24 outlines the nice applications of the theory in geometry and topology. The book will be interesting for specialists in operator algebras, in topology, in group representations, and for anybody who wishes to appreciate the very nice interplay between operator algebras and topology. For postgraduate students the book may not be easy reading, but will be very helpful. (jiva)

I. Blake, G. Seroussi and N. Smart, *Elliptic Curves in Cryptography*, *London Mathematical Society Lecture Note Series 265, Cambridge University Press, Cambridge, 1999, 204 pp., £24.95, ISBN 0-521-65374-6*

This book summarises the latest knowledge on the theoretical aspects and practical implementation related to public key cryptography based on elliptic curves. The authors start with the discussion of issues about basic arithmetic operations on curves and finite fields.

The first chapter surveys some standard protocols of public key cryptography based on groups and discusses some practical implications of using groups. The second chapter addresses problems connected with implementation of the underlying field arithmetic; the material is treated separately for fields of odd characteristic and fields of characteristic 2. Chapter 3 introduces the basic concepts from the theory of elliptic curves needed for the rest of the book. Besides the basic notions, the reader will find notions like the division and modular polynomials and the Weil pairing. The fourth chapter is devoted to efficient algorithms for computation of point addition, their doubling, and of integer multiples of points on an elliptic curve. Chapter 5 deals with various attacks (e.g. MOV, baby step/giant step, time and wild kangaroos, etc.) on the converse question of the elliptic curve discrete logarithm problem. Chapter 6 introduces the problem of determining the order of the groups of rational points. More advanced methods are then presented in two chapters entitled 'School's algorithm and extensions' and 'Generating curves using complex multiplication'. The penultimate chapter discusses some additional applications of elliptic curves, such as factoring, primality proving or the equivalence between the discrete logarithm problem and a problem connected to a Diffie-Helman key exchange. The final chapter discusses a generalisation to hyperelliptic systems. The book closes with an appendix presenting examples of elliptic curves whose groups of rational points contain large prime subgroups.

The book is written in a very readable form and thus can be consulted and used both by mathematicians and by anybody wishing to learn more about the mathematics behind the implementations of elliptic curve cryptosystems. Though the book is written for a wide audience, familiarity with the main principles of the involved public key cryptography and number theory would be useful. The book can also be of great help also for those who want a quick survey of the main and new results of elliptic curve cryptography.

D. A. Brannan, M. F. Esplen and J. J. Gray, *Geometry*, *Cambridge University Press, Cambridge, 1999, 497 pp., £18.95, ISBN 0-521-59193-7 and 0-521-59787-0*

The topic discussed in this book is geometry in its most classical sense. The authors' aim was to create a text addressing students in a way that shows the beauty of the classical geometrical ideas concerning conics, affine and projective geometries, inversive and spherical geometries, and non-Euclidean geometries. The Kleinian philosophy of geometry is used through the book, but is discussed explicitly only in the last chapter, when most of the previous treatments are revisited.

The book is designed for a student working without further help, and the text is produced very carefully from the point of view of contents, splitting of the material into individual blocks (each one evening's work) and the excellent graphical design. Many historical comments and links are added. All expositions are accompanied by several solved and unsolved problems and exercises, whose solutions may be found at the end of the text. The book will be helpful for all students of mathematics, as well as for their teachers. (jslo)

W. Bruns and J. Herzog, *Cohen-Macaulay Rings*, *Cambridge Studies in Advanced Mathematics 39, Cambridge University Press, Cambridge, 1998, 453 pp., £24.95, ISBN 0-521-56674-6 and 0-521-41068-1*

This is a revised edition of a monograph first published under the same title in 1993. Its topic, Cohen-Macaulay rings and modules, is central to modern commutative algebra. As important particular cases, it includes the regular local rings (those of finite global dimension), complete intersections, and Gorenstein local rings (those of finite injective dimension). So the focus is naturally on homological methods, but the more recent combinatorial aspects due to Hochster and Stanley are also presented.

The main revisions concern Part III, now called 'Characteristic p methods'. There is a new Chapter 10 dealing with tight closures and their applications; for example, the Hochster-Huneke theorem, that equicharacteristic direct summands of regular rings are Cohen-Macaulay, is proved. To cover the applications, other extensions were needed. For example, a section developing techniques for reduction to characteristic p, has been rewritten.

Chapter 4, dealing with Hilbert functions and multiplicities, has been extended by a new section containing Gotzman's regularity and persistence theorem. Chapter 5, dealing with Stanley-Reisner rings of simplicial complexes, now includes a new section where Hochster's formula for Betti numbers of Stanley-Reisner rings is proved.

The authors present the classical material together with quite recent developments, avoiding more complex structures such as derived categories or spectral sequences. This makes the book valuable not only for experts, but also for beginners equipped only with a basic knowledge of commutative and homological algebra. (jtrl)

F. Buekenhout, M. Dehon and D. Leemans, *An Atlas of Residually Weakly Primitive Geometries for Small Groups*, *Mémoire de la Classe des Sciences, Tome XIV, Académie Royale de Belgique, Brussel, 1999, 175 pp., ISBN 2-8031-0161-0*

This atlas analyses geometries induced by 32 small groups. The groups can be divided into three families: S_n and A_n for $n \geq 7$; $PSL_2(q)$, $PGL^2(q)$ and $P\Gamma L_2(q)$ for $q \geq 8$; and affine-type groups which include (among others) the groups $AGL^1(q)$ for $q \geq 13$.

For each of these groups G, the authors list geometries $\Gamma = \Gamma(G, (G_i)_{i\in I})$, where G_i are subgroups of G, and the incidence relation is given by non-empty intersection of left cosets of G_i, $i\in I$. Only those geometries Γ are included that satisfy at least one of the properties F, RC, FT, $(IP)_2$ and RWPRI; the property F (firm) means that every flag of rank $|I|-1$ is contained in at least two chambers, RC stands for residually connected, FT for flag transitive, $(IP)_2$ refers to the 2 intersection property and RWPRI stands for residually weakly primitive (each residue of a flag is weakly primitive: the group acts primitively on the set of i-elements for at least one $i\in I$.)

For each group the authors give the list of subgroup conjugacy classes, together with the inclusion relations. For each geometry (with some restrictions pertaining to geometries of higher rank), the authors draw the diagram, the incidence graph and the collinearity graph, and compute groups of automorphisms and corellations. The graphs are equipped with various numerical and symbolic data, in order to convey as much information as possible.

The atlas also contains a list of geometry diagrams that have been induced by the investigated groups. One can thus get from a group to geometries and from a geometry to groups. (ad)

S. C. Coutinho, *The Mathematics of Ciphers: Number Theory and RSA Cryptography*, *A. K. Peters, Ltd., Natick, 1999, 196 pp., £19, ISBN 1-56881-082-2*

From a background of the RSA cryptosys-

tem, the author develops various elementary algorithmic aspects of number theory and algebra. The book is centred more around mathematics than cryptography, which makes the book suitable to all novices interested in number theory. Thus the reader can find here a description of the principle of finite induction, introduced by the well-known puzzle called the Tower of Hanoi. As this example shows, the author avoids the 'dry' theorem-proof style, and devotes a lot of space to historical comments.

The topics covered by the book are the sieve of Erathosthenes, modular arithmetic, pseudoprimes, the Chinese remainder theorem, the basic theory of groups (including Lagrange's theorem), Mersenne and Fermat primes with the Lucas-Lehmer test, primitive roots, Carmichael numbers, and the cumulative applications to the RSA cryptosystem with a discussion of its various elementary aspects. The book is easy to read, and is suitable also forthose studying independently. The book contains no answers to the exercises closing each chapter.

R. Curtis and R. Wilson (eds), ***The Atlas of Finite Groups: Ten Years On****, London Mathematical Society Lecture Note Series 249, Cambridge University Press, Cambridge, 1998, 293 pp., £27.95, ISBN 0-521-57587-7*
This book is the proceedings of a conference organised in Birmingham in July 1995, to mark the tenth anniversary of the *Atlas of Finite Groups*. It contains twenty articles by leading experts in the field. Besides research papers, we note a historical article on the development of the Atlas project since 1970 by three of its authors, J. H. Conway, R. T. Curtis and R. A. Wilson. Of particular interest are survey papers on applications of character theory to surfaces by G. A. Jones, on recent advances in the representation theory by G. Hiss, and on Zassenhaus conjectures on integral group rings by W. Kimmerle. (jtu)

H.-H. Dai and P. L. Sachdev (eds), ***Recent Advances in Differential Equations****, Pitman Research Notes in Mathematics Series 386, Addison Wesley Longman Ltd, Harlow, 1998, 243 pp., £35, ISBN 0-582-32219-7*
This volume of the Pitman Research Notes in Mathematics Series contains eighteen lectures from the first Pan-China Conference on Differential Equations, held in Kunming in May-June 1997. The aim of the editors was to present recent research in China in the area of ordinary and partial differential equations.

The papers can be split into the following topics: large-time behaviour, including exponential stability, the existence of global attractors and further qualitative properties; asymptotic theory of linear ordinary differential equations, including a construction of hyperasymptotic expansions and error bounds (with a contribution by F. W. J. Olwer); bifurcation theory, including the conditions for existence and non-existence of limit and heteroclinic cycles; global existence theory, providing a unified approach to the study of a general class of non-linear parabolic equations (a paper by Yuan-Wei Qi) and Boltzmann-Poisson systems; singular perturbation methods; and numerical analysis. (jmal)

H. G. Dales and G. Oliveri (eds), ***Truth in Mathematics****, Clarendon Press, Oxford, 1998, 376 pp., ISBN 0-19-851476-X*
This book contains the lectures given at a conference on this theme, held in Sicily in September 1995; the book is dedicated to the memory of Dr. R. O. Gandy.

Many branches of mathematics (foundations) are discussed in these papers. Besides the history of development of mathematical truth, we mention constructivism, computability and algorithms, and set theory and natural numbers.

One of the papers is an excellent contribution on foundations of the theory of algorithms by Y. N. Moschovakis which can be understood as to be written quite formalistically without considering such peculiar things as mathematical truth. On the other hand, in another excellent paper on mathematical evidence by D. A. Martin, the notion of mathematical truth is used to convince the reader that it is reasonable to accept projective determination as a new valid statement of set theory.

This book can be especially recommended to those who do not want to use only the safe formalism created by others, but want also to consider the area of mathematical truth, which cannot be fully formalised, such as by the Tarski theorem. (k^3)

B. Davies and Y. Safarov (eds), ***Spectral Theory and Geometry****, London Mathematical Society Lecture Note Series 273, Cambridge University Press, Cambridge, 1999, 328 pp., £27.95, ISBN 0-521-77749-6*
This Lecture Note appeared as the final product of the ICMS Instructional Conference, held in Edinburgh in 1998. The volume contains most of the (extended) lectures of the invited speakers.

It is organised according to the level of the courses: Introductory courses (F. E. Burstall, I. Chavel and E. B. Davies); Medium-level courses (M. Ashbaugh, A. Grigor'yan and M. Shubin); and Advanced courses (only the lecture by S. Zelditch is included). The titles of the lectures are: Basic Riemannian geometry, The Laplacian on Riemannian manifolds, Computational spectral theory, Isoperimetric and universal inequalities for eigenvalues, Estimates of heat kernels on Riemannian manifolds, and Spectral theory of wave invariants.

The first two chapters, by F. E. Burstall and I. Chavel, start practically from zero, and introduce the reader to elements of Riemannian geometry and the basic properties of the Riemannian Laplace operator. They are self-contained and can be recommended as an excellent short text for those who need only basic information about the topic. (ok)

P. G. L. Dirichlet, ***Lectures on Number Theory****, History of Mathematics 16, American Mathematical Society, Providence, 1999, 275 pp., $49, ISBN 0-8218-2017-6*
This is a nice English edition of Dirichlet's famous *Vorlesungen über Zahlentheorie*, including the nine Supplements by Dedekind, translated by John Stillwell. The book opens with an introduction by the translator. As one of the most important number-theoretical and mathematical books of the 19th century this book needs no further description, and can be recommended to those who have problems with the German language, or to those who cannot find the German original in the library. This book should certainly have a permanent place on every mathematical bookshelf. (šp)

C. Dorschfeldt, ***Algebras of Pseudodifferential Operators near Edge and Corner Singularities****, Mathematical Research 102, Wiley-VCH, Berlin, 1998, 202 pp., DM128, ISBN 3-527-40118-0*
The general theory of elliptic operators on manifolds has a long history, and was recently extended to manifolds with singularities of certain types. The simplest and best-understood is the case of conical singularities, modelled by a cone whose base is a closed smooth manifold. This research monograph treats more general types of singularities. Two recent monographs by B.-W. Schulze described a pseudodifferential calculus of operators on manifolds with cone and edge singularities.

The first part of the book (Chapters 2 and 3) contains a parameter-dependent version of elliptic edge operators; the main tool used here is the Mellin transform. Another type of singularity is the so-called 'corner singularity'; a model example is a cone over a close compact manifold with conical singularities. The last chapter of the book treats the Mellin-type operators on manifolds with corner singularities.

This book presents material that has previously been available only in papers or PhD dissertations. (vs)

L. van den Dries, ***Tame Topology and O-Minimal Structures****, London Mathematical Society Lecture Note Series 248, Cambridge University Press, Cambridge, 1998, 180 pp., £24.95,*
The study of properties of sets $A \subseteq \mathbf{R}^n$ given by a finite set of inequalities $A = \cap_i \{x \mid f_i(x) \geq 0\}$ (where f_i belongs to a given class of functions) has a long tradition. Typical examples are the theory of semi-algebraic or subanalytic sets. Grothendieck has indicated in his 'Esquisse d'un programme' a definition of 'tame topology' (topologie modérée) which would be a generalisation of these important examples.

The main aims of the book are to show that a simple set of axioms (defining the so-called o-minimal structures on $\mathbf{R}$) gives such a generalisation and to prove basic properties of sets in an o-minimal structure. Every semi-algebraic or subanalytic set can be stratified into a union of submanifolds. An analogue for o-minimal structures is a 'Cell decomposition theorem', which leads to a definition of dimension and Euler characteristic of a set in the structure. If new axioms (related to addition and multiplication) are added to the

definition of an o-minimal structure, it is possible to prove a suitable triangulation theorem. The book offers a systematic and self-contained treatment of o-minimal structures which needs almost no prerequisities. It is a nicely written summary of interesting results. (vs)

L. C. Evans, *Partial Differential Equations*, *Graduate Studies in Mathematics 19, American Mathematical Society, Providence, 1998, 662 pp., ISBN 0-821-80772-2*
This excellent textbook is meant as an introduction to mathematical analysis of partial differential equations. The book is split into three parts. It starts with the classical theory, with the emphasis on model (prototype) equations. While in many textbooks this means a study of the Laplace, heat and wave equations and their generalisations, but here model cases include also the transport Hamilton-Jacobi equations and equations of hyperbolic conservation laws. The representation formulas are given, which makes it possible to obtain qualitative properties of solutions, as well as to introduce the notion of a weak solution.

The second part is then devoted to the theory of linear second-order elliptic, parabolic and hyperbolic equations, based on energy methods and linear functional analysis. Questions of the existence of weak solutions, their uniqueness, regularity, or blow-up are systematically discussed. The introductory chapter to the second part contains a very well written description of properties of functions from the Sobolev spaces, not restricted only to the case $p = 2$. The third, main part of the book is devoted to the modern theory of non-linear second-order elliptic and evolutionary equations, Hamilton-Jacobi equations and equations of hyperbolic conservation laws.

Throughout the book the reader is acquainted with various approaches and techniques to initial and boundary-value problems. In particular, in the final part the methods of variational calculus, including the mountain pass theorem, the theory of monotone operators, the techniques of sub- and super-solution, fixed-point methods, the method of non-linear semigroup, and viscosity solutions, are outlined and applied to specific problems. The necessary knowledge of linear functional analysis and measure theory is surveyed in an Appendix. I recommend this book as the first textbook for anyone who wants to learn the theory of partial differential equations. (jmal)

B. S. Everitt, Chance Rules. *An Informal Guide to Probability, Risk and Statistics*, *Springer, New York, 1999, 202 pp., DM49, ISBN 0-387-98776-2*
Statistics and probability theory are scientific disciplines describing effects caused by chance. It is known that people have used chance for amusement for a long time. Board games involving chance were perhaps known in Egypt some 5000 years ago.

The first part of this book describes the history of chance. The author points out that even in the Bible lots were used to ensure a fair division of property. Later on, dice games and playing cards led to many interesting problems, the solution of which originated probability theory. Today, we have more opportunities for gambling. The book describes lotteries, football pools, roulette, and horse racing. Elements of probability theory are demonstrated by interesting examples concerning balls and urns, birthdays, coincidences, conditional probabilities, and Bayes' theorem. Further, the author shows that people cannot always make rational choices about the differing risks. The last part of the book is devoted to statistics in medicine. The role of randomisation is explained and a description of experiments is given. It is demonstrated that this scientific approach is usually missing in alternative therapies.

This easily understood book can be recommended to everybody. The mathematics is kept to a minimum and the author stresses the philosophical features of uncertainty. If you read this book, you will better understand the impact of chance on your life. (ja)

P. Eymard and J.-P. Lafon, *Autour du nombre π*, *Actualités scientifiques et industrielles 1443, Hermann, Paris, 1999, 318 pp., FF148, ISBN 2-7056-1443-5*
This is an interesting book on mathematics and history surrounding the number π. Five chapters dealing with π are ordered according to decreasing difficulty. Whereas Chapter 1 is accessible to students starting their university studies, Chapter 5 requires a substantial knowledge of advanced courses in mathematical analysis.

Chapter 1 is devoted to the Archimedean method of approximating π, volumes and areas involving the number π, the asymptotic Gauss formula for number of lattice points contained in large circles, Buffon's needle problem, and curves of constant width. Chapter 2 presents various expressions of π in terms of infinite series and products. The results presented go back to Viète, Stirling, Gregory, Leibniz, Euler, Machin, etc.; however, new formulas, such as those of Bailey, Borwein and Plouffe from 1997, are also discussed. Chapter 3 reveals the position of (in analysis (Fourier series, Euler formulas, the Gamma function, Bernoulli numbers, and the behaviour of certain arithmetic functions). Chapter 4 deals with squaring the circle, classical geometric constructions, irrational numbers, algebraic numbers, the irrationality and transcendence of π, and Liouville numbers. Chapter 5 is on (and elliptic integrals: arithmetic-geometric mean, algorithms for calculating elliptic integrals, and algorithms of Brent and Salamin, as well as of J. M. and P. B. Borwein for the calculation of π, theta functions, Abel's function, modular functions, Ramanujan's formulas, and so on. Solutions of the exercises in individual chapters are included in Chapter 6.

Students and teachers of mathematics on various levels will find the book interesting and useful. (in)

D. M. Gabbay, *Fibring Logics*, *Oxford Logic Guides 38, Clarendon Press, Oxford, 1998, 471 pp., ISBN 0-19-850381-4*
This book is based on extended versions of papers of the author. The fibring is a method of how to combine two or more logic systems or, more precisely, how to establish axioms and semantics of an appropriate combination of such systems. The basic idea of fibring can be presented by the following example:

Let *S1*, *S2* be systems, where *S1* is modal logic *K1* with the modality *M1* and *S2* is modal logic *S4* with the modality *M2*, and assume that the logics are presented via classes *C1*, the class of all Kripke models of the form $m = (S, R, a, h)$ with R transitive and *aRa*, and *C2*, the class of all Kripke models of the form $m' = (S', R', a', h')$ with R' transitive and reflexive. Assume that $A = M1M2q$ is a mixed formula with an atom q of *S2*; then $A = M1p$ with an atom p of *S1*, since *S1*, where $p = M2q$. We see now this relation as $sat2(a', M2q)$ with $F(t) = (S', R', a', h')$. A generalisation of this idea and applications of results obtained are presented in twenty-one (slightly independent) chapters. (jmlc)

N. Guicciardini, *Reading the Principia. The Debate on Newton's Mathematical Methods for Natural Philosophy from 1687 to 1736*, *Cambridge University Press, Cambridge, 1999, 285 pp., £50.00, ISBN 0-521-64066-0*
This book is divided into three parts (Newton's methods, Three readers, Two schools).

The first part (82 pp.) is an introduction to Newton's *Principia*. In the second chapter we find a concise presentation of Newton's methods of series and fluxions. The author's aim is to give an idea of mathematical method, the 'new analysis' that Newton had already developed before writing the *Principia*. The third chapter of the first part is devoted to the mathematical methods employed by Newton in the *Principia*; it is not an easy chapter. This part is not to be taken as an introduction to the *Principia* or a critical analysis of the *Principia*, but as a work devoted to the reception of Newton's magnum opus.

The second part (70 pp.) explains the reactions to the *Principia* of three giant readers: Newton himself, Huygens and Leibniz. This part is divided into three chapters. The first one describes Newton's evaluation of his own published masterpiece, the worries of the calculus priority dispute with Leibniz, Newton's attempt to defend the mathematical methods of the *Principia* against the criticism of the Leibnizians. The second chapter discusses Huygens' reaction and the third describes Leibniz's reaction to the *Principia*; for example, Huygens was dissatisfied with Newton's use of proportion theory, and criticised the use there of this classic ingredient of ancient geometry. The author also explains the important differences between Leibniz and Newton.

The third part (94 pp.) pays attention to the two schools that divided Europe, the so-called British Newtonian school and the Continental Leibnizian school. The author shows their different mathematical practices, their mathematical methods, the pri-

ority dispute on the invention of the calculus, etc. The third part concludes with a short characterisation of Euler's Mechanica and new edition of the *Principia* enriched by an extensive commentary, because after Euler the *Principia*'s mathematical methods became obsolete. (mbec)

V. P. Havin and N. K. Nikolski (eds), *Commutative Harmonic Analysis II*, *Encyclopaedia of Mathematical Sciences 23, Springer, Berlin, 1998, 325 pp., DM158, ISBN 3-540-51998-X*
This part of the *Encyclopedia* is written by V. P. Gurarii and is a translation of the 1988 Russian edition. Its subtitle, 'Group Methods in Commutative Harmonic Analysis', gives a true picture of its contents.

The first part of the book consists of twelve paragraphs, devoted to 'classical' harmonic analysis (integral transforms in $\mathbf{R}^n$. The emphasis in Sections 1-7 is mainly on L^2-theory. Positive definite functions and kernels and their connections with functional analysis and probability theory are discussed in Sections 8-10. The rest of the first part contains deeper results on Tauberian theorems and spectra of bounded functions. Applications to number theory and information theory are also given.

The second part of the book deals with general locally compact abelian groups and special examples of them. Integration theory, invariant means, characters and abstract Fourier transforms, duality, and structural theorems are described here. The paragraph on duality also contains Bohr compactification and the abstract Poisson formula, together with applications to number theory via numerical characters. There is also a paragraph on commutative Banach algebras, where basic information on the Gelfand representation, analytic functions of elements, spectral synthesis of ideals, and involutions are presented.

The book covers a rather large part of commutative harmonic analysis and can therefore serve as a good source of information for non-experts. Unfortunately, the book contains few references to recent results (obtained since the Russian 1988 edition). (jmil)

J. Jost and X. Li-Jost, *Calculus of Variations*, *Cambridge Studies in Advanced Mathematics 64, Cambridge University Press, Cambridge, 1998, 323 pp., £37.50, ISBN 0-521-64203-5*
This textbook guides the reader through various areas of the calculus of variations. The first part, split into five chapters, is of an introductory nature and covers the classical Euler-Lagrange theory, symmetries, the saddle-point constructions, the theory of Hamilton and Jacobi, and some links to control theory; all of this is developed very carefully in less than 120 pages.

The rest of the book is more advanced. After three chapters on the background (Lebesgue integration and functional analysis), the show goes on with standard and abstract methods for the existence of the minimisers, and the next two chapters are devoted to the Γ-convergence and some applications, such as the so-called homogenisation. Chapter 8 is independent of the preceding ones, and deals with bifurcation phenomena and minimal surfaces of revolution. The last section discusses the unstable critical points of variational problems, and is also independent of Chapters 4-8.

The reader should enjoy the straightforward exposition, with clean and exact arguments. The whole book is nearly completely self-contained, the prerequisites involving only the basic calculus of one and several variables. Many relevant links to other textbooks or research monographs are given throughout the text. The book is warmly recommended to a wide class of mathematicians. (jslo)

E. I. Khukhro, *P-Automorphisms of Finite P-Groups*, *London Mathematical Society Lecture Note Series 246, Cambridge University Press, Cambridge, 1998, 204 pp., £24.95, ISBN 0-521-59717-X*
The aim of this book is to expose the interplay of nilpotent groups and Lie rings in the modular case, and to deduce results about p-groups that admit p-automorphisms with few fixed points.

The first half of the book presents standard material, ranging from definitions and basic properties of groups, nilpotent and soluble groups, Lie rings, nilpotent and soluble Lie rings, free Lie rings and associated Lie rings, to their connections by the Three-Subgroup Theorem and to some more advanced features such as the characterisation of soluble varieties as varieties where $M' \neq M$ for all non-trivial members M, or certain estimates of the nilpotency class and of the factor orders, or some starting observations concerning automorphisms and their fixed points.

While the style is relaxed, it gives sufficient amount of detail, and, generally speaking, the ease with which the author has introduced so many different concepts coherently in a relatively small space is quite admirable. As in most books, slips of the pen were not completely avoided, and a few of them could mislead a beginner; for example, Lemma 1.13 does not hold in the stated form.

The core of the book lies in its second half, which starts with Kreknin's and Higman's theorems about Lie rings that possess an automorphism of a finite order. From Higman's theorem the author proves that any finite p-group that admits an automorphism of order p fixing p^m points contains a characteristic subgroup of (p, m)-bounded index and of nilpotency class not exceeding $h(p)$, where h denotes Higman's function. After presenting several topics, such as the Baker-Hausdorff formula for free nilpotent groups, nilpotent Q-powered groups, the Mal'cev and Lazard correspondence, and the basic properties of powerful p-groups, the above-mentioned theorem on automorphisms of order p serves as one of the ingredients for the two theorems in which the book culminates:
1. If a finite p-group P admits an automorphism of order p^n and if the number of fixed points equals p, then P has a subgroup of (p, n)-bounded index which is nilpotent of class at most 2, and abelian if $p = 2$.
2. If a finite p-group P admits an automorphism of order p with exactly p^m points, then P has a subgroup of (p, m)-bounded index which is nilpotent of an m-bounded class.

The style has a textbook character to the end, and each of the fourteen chapters is supplemented by exercises. There are also many remarks pointing towards generalisations, related results, open problems and authorships of various theorems and proofs. (ad)

Y. Kitaoka, *Arithmetic of Quadratic Forms*, *Cambridge Tracts in Mathematics 106, Cambridge University Press, Cambridge, 1999, 270 pp., £18.95, ISBN 0-521-40475-4 and 0-521-64996-X*
The aim of this book is to provide an introduction to the arithmetic theory of quadratic forms. The book starts from the basics and proceeds to some very recent results. It covers many aspects of the subject, including lattice theory, Siegel's formula, and tensor products of positive definite quadratic forms. Quadratic forms are mainly considered over the rationals or the ring of rational integers and their completions.

The reader is required to have only an elementary knowledge of algebraic number fields. This makes the book ideal for graduate students and researchers from other fields interested in quadratic forms. (jtu)

V. F. Kolchin, *Random Graphs*, *Encyclopedia of Mathematics and its Applications 53, Cambridge University Press, Cambridge, 1999, 252 pp., £50, ISBN 0-521-44081-5*
The random graphs discussed in this book are very sparse: for example, random forests, random graphs with unicyclic components, and random graphs with average degree close to 1; further topics include random systems of linear equations over GF(2) and random permutations. Graph-theoretical considerations seldom play a role in their investigation; rather, the central technique is the generalised allocation scheme. This method, whose theory is elaborated in the first chapter, deals with situations where the joint distribution of N random variables can be described as the distribution of N independent random variables conditioned on the sum of these variables being a given number n. The book covers almost exclusively the work of Russian mathematicians (with some references to alternative approaches by other authors), mostly from the last twenty years. The material is well presented and offers a new perspective to readers interested in the above topics. (jmat)

S. Konyagin and I. Sharplinski, *Character Sums with Exponential Functions and their Applications*, *Cambridge Tracts in Mathematics 136, Cambridge University Press, Cambridge, 1999, 163 pp., £30, ISBN 0-521-64263-9*
The book covers various aspects related to

the distribution problem for integer powers gx of some positive integers g modulo a power of a prime p with p and g coprime. The authors also consider applications of this problem to problems from algebraic number theory, the theory of function fields over finite fields, and linear congruential pseudorandom number generators, including cryptography and coding theory.

After two short preparatory chapters forming the first part of the book, the first 'mathematical' chapter is devoted to estimates of characters sums with sufficiently large number of terms; the main result of the chapter gives bounds for Gauss sums proved recently by Heath-Brown and Konyagin. The next chapter gives an upper estimate for maximal absolute value of short exponential sums proved by the first author. These chapters, together with chapters containing bounds of character sums for almost all moduli and bounds for maximal absolute values of Gaussian sums with general non-prime denominator, form the second part of the book. The third part is devoted to multiplicative translations of subgroups of F_p^* and of arbitrary subsets of F_p by an element $a \in F_p^*$ modulo p. The rest of the book contains the above-mentioned applications.

The book is written in a concise, but good readable manner. The exposition contains references to related problems and can therefore also be useful to those who want an insight in the further developments of the presented and related ideas. (šp)

S. G. Krantz, *How to Teach Mathematics*, *American Mathematical Society, Providence, 1993, 76 pp., £11.95, ISBN 0-8218-0197-X*
Unlike secondary school teachers, college and university teachers usually have no preliminary theoretical background in the teaching of mathematics. Not only those who feel such a gap in their education should read this booklet, which presents a personal perspective. However, the reader will find much more than a particular personal opinion.

The booklet is a practical guide to the teaching of mathematics, with an emphasis on specifics. What Chapter I (Guiding Principles) includes can be seen from the following selected keywords: Respect, Prepare, Speak up, Inductive vs. deductive method, Time, Why do we need mathematics teachers?, Math anxiety, How the students learn, Computers, Applications. Chapter II contains practical matters (voice, eye contact, blackboard technique, handouts, exams, transparencies, etc.). Chapter III (Sticky Wickets) touches sensitive subjects, from problems caused by nonnative English speakers, through difficult questions and mistakes in the lecture, to cheating, bribery and sexual harassment.

The booklet is written in a lively and humorous style, even though the points discussed are entirely serious and sensible. The author succeeds in elucidating the fine points of excellent teaching and offers a lot of important practical advice. The book is strongly recommended to everybody who teaches mathematics. (in)

W. Krawcewicz and J. Wu, *Theory of Degrees with Applications to Bifurcations and Differential Equations*, *John Wiley & Sons, 1997*
This book is devoted to the theory and applications of the degree of non-linear mappings in finite- (Brouwer degree) and infinite-dimensional spaces (Leray-Schauder degree and its generalisations to condensing maps, including the coincidence degree). Attention is paid to maps with symmetries for which the S^1-degree and the Dold-Ulrich equivariant degree are defined.

The explanation in the book is self-contained, and chapters on algebraic and differential topology and transformation groups are included. The degree theory is applied to local and global bifurcation, including the Hopf bifurcation. The second type of application is towards ordinary, delay and neutral differential equations (boundary value and eigenvalue problems, periodic solutions). This part of the book is closely related to the authors' investigations. The book is clearly written and can be recommended to graduate students interested in differential equations. There are more than 170 exercises of medium difficulty. (jmil)

J. Madore, *An Introduction to Noncommutative Differential Geometry and its Physical Applications*, *London Mathematical Society Lecture Note Series 257, Cambridge University Press, Cambridge, 1999, 321 pp., £24.95, ISBN 0-521-65991-4 and 0-521-59838-9*
The first edition of this book appeared in 1995. This is the second edition, in which some errors have been corrected and a few recent results included. The second edition appearing so soon after the first suggests that the book is of particular interest.

The book is built on examples that comprise more than half of the text; this is probably its most interesting feature. The reader has a good feeling that the noncommutative generalisation of differential geometry makes sense and finds reasonable applications. The book is designed for beginners but takes the reader rather far. Moreover, at the end of each chapter we find Notes with many interesting comments and hints for further reading.

It requires from the reader some knowledge from several branches of mathematics such as differential geometry, the theory of Hilbert and Banach spaces, the theory of rings and algebras, and also some knowledge of physics, especially of classical field theory. But in all these areas it requires only very basic knowledge. It seems that according to its style and language the book was written more for physicists, and that mathematicians accustomed to a high level of abstraction will have slight problems in understanding some points. Nevertheless, I strongly recommend the book to mathematicians. It represents an ideal opportunity to familiarise oneself with physical language, to learn a new branch of mathematics, and to see some nice physical applications. (jiva)

J. Matoušek and J. Nešetøil, *Invitation to Discrete Mathematics*, *Clarendon Press, Oxford, 1998, 410 pp., £19.50, ISBN 0-198-50207-9 and 0-198-50208-7*
This is more than a textbook for undergraduates. The book stems from the authors' long experience with teaching a beginners' course of discrete mathematics at Charles University. They cover selected topics in considerable depth and often from several points of view. The authors aim at cultivating mathematical and logical reasoning by the reader rather than merely teaching facts. It really is an invitation worth accepting. The book is suitable for virtually everyone – beginners will learn the basics of discrete mathematics, graduate students will find interesting applications and connections with other branches of mathematics, and everybody will enjoy the authors' lively style and subtle humour. (jkrat)

M. Overbeck-Larisch and W. Dolejsky, *Stochastik mit Mathematica*, *Vieweg, Braunschweig, 1998, 370 pp., ISBN 3-528-06921-X (paperback)*
This book is an introductory course in probability theory and mathematical statistics. The style of presentation is somewhat different from the classical textbooks on the subject, however. The reader equipped with the Computer Algebra System *Mathematica* can download the corresponding *Mathematica* notebooks (free) from the Vieweg web site and see almost all of the concepts and methods throughout the book in the working environment of *Mathematica*.
The book consists of six chapters. Chapter 0 is a brief introduction into sets and functions under *Mathematica*. Chapters 1 and 2 deal with the elements of probability. Chapter 3 introduces random samples. The basic methods of estimation (principle of maximum likelihood and least squares method) are presented in Chapter 4; the construction of confidence intervals for the binomial and normal distribution is also given here. Chapter 5 is devoted to hypothesis testing. Besides the classical parametric tests, tests of goodness of fit and non-parametric tests are mentioned here. In the Appendix, the reader will find the solutions to selected exercises.

The book is clearly written and easily readable with plenty of carefully selected examples. It seems that this way of presentation is a prospective method of teaching the subject. The book is recommended to lecturers and students and to all with an interest in computer-aided theory of probability and statistics. (jh)

A. Quarteroni and A. Valli, *Domain Decomposition Methods for Partial Differential Equations*, *Numerical Mathematics and Scientific Computation, Cambridge University Press, Cambridge, 1999, 360 pp., £55, ISBN 0-19-850178-1*
This book is concerned with the underlying mathematical concepts of domain decomposition methods. For any given partial differential equation, the authors derive its

multidomain formulation, describe suitable transmission conditions and investigate the corresponding Steklov-Poincaré operators. A large variety of boundary value problems are addressed: symmetric elliptic equations, convection-diffusion equations, elasticity problems, Stokes problems of incompressible and compressible fluids, the time-harmonic Maxwell equations, parabolic and hyperbolic problems, and suitable couplings of heterogeneous equations. In the discretisation of the problem, the finite element method is used, but the analysis presented can be adapted to any Galerkin-type approximation, as spectral method or hp-version of the FEM. Both overlapping and non-overlapping subdomain decompositions are treated, and special attention is paid to the analysis of the convergence of several iterative procedures among subdomains. The algebraic part of algorithms is also explained.

The book contains a number of various approaches, techniques and results presented in a very nice style. It will be of interest to researchers and students of applied and numerical mathematics, specialists in partial differential equations, scientists and engineers engaged in applied mathematics and scientific computing. (mf)

P. Rife, *Lise Meitner and the Dawn of the Nuclear Age,* *Birkhäuser, Boston, 1999, 432 pp., DM78, ISBN 0-8176-3732-X and 3-7643-3732-X*

Lise Meitner (1878-1968) is one of the most fascinating figures in the early history of nuclear physics. In this book, Patricia Rife presents a very readable and very thorough picture of her life and personality. During her life, Meitner witnessed enormous changes both in society and in science. In 1906, she was awarded a PhD in Physics, the second woman in the history of Vienna University to do so. In 1907, she went to the Chemistry Institute of the Berlin University (and later to the Kaiser Wilhelm Institute for Chemistry) to work on radioactivity with the radiochemist Otto Hahn.

By the early 1930s, she was an established and respected expert in nuclear physics. Jointly with Hahn, she was repeatedly nominated for the Nobel prize in chemistry. Unfortunately, in 1933, the attacks on non-Aryans like Lise Meitner started. In August 1938, she fled to Stockholm, and in December she received a letter from Hahn reporting the mysterious behaviour of uranium after it had been bombarded by neutrons. In discussions with her physicist nephew Otto Frisch, she concluded that the neutrons had penetrated into the uranium nucleus and split it into two parts. Meitner and Frisch called this process 'fissioning', calculated the associated energy release, and published their results in a letter to Nature. This experiment and its interpretation marked the birth of the nuclear age. In recognition of the discovery, Otto Hahn was awarded the 1944 Nobel prize in chemistry.

During and after the Second World War, Lise Meitner worked in Sweden. She was remembered and repeatedly honoured by the international scientific community. In 1960, she moved to Cambridge, and passed away shortly before her 90th birthday. In 1992, the element 109 of the periodic table was named 'Meitnerium'.

This book is pleasure to read. The chronological presentation of Lise Meitner's life is given in fourteen main chapters. There are also numerous notes to the chapters, the personal chronology of Lise Meitner, the list of her awards and honours, the list of her publications, and a rich bibliography. Still, to my eyes, one important topic is not covered thoroughly enough in the book: the question of why only Otto Hahn was honoured with the Nobel prize. After the usual 50-year delay, the records of the Nobel prize deliberations of the Royal Swedish Academy of Sciences are released to scholars. It is a pity that these records are not discussed in the book in more detail. (zpl)

S. M. Ross, *An Introduction to Mathematical Finance: Options and Other Topics,* *Cambridge University Press, Cambridge, 1999, 184 pp., £21.95, ISBN 0-521-77043-2*

This book provides an accessible and relatively deep insight into basic and advanced topics of mathematical finance. No prior knowledge of probability is assumed. Instead, the first two introductory chapters present all the necessary preliminary material in an understandable and rigorous way. This in turn allows the author to treat the Brownian and geometric Brownian motion as a limit of a binomial process. The basics of mathematical finance that are included contain an explanation of interest rates and present value and two well-elaborated chapters on arbitrage pricing and the arbitrage theorem. Also included are valuation by expected utility, the capital assets pricing model (CAPM) and the portfolio selection problem; these are all explained in a concise and precise way.

The presented method of option pricing is based on the assumption of geometric Brownian motion of security prices and on no-arbitrage reasoning. The results cover the Black-Scholes formula for European options and its extension to American ones and no-arbitrage pricing of exotic (barrier, lookback, Asian) options, and simulation methods for their valuation are discussed. The last two chapters explain limitations of the geometric Brownian motion model and suggest two alternatives: the log ratios viewed as a Markov chain and log prices as an autoregressive scheme. The situation is illustrated on an extensive set of crude oil data.

The text is accompanied by elaborate examples and each chapter is augmented by numerous original exercises. Throughout the book, the author points out the limitations and shortcomings of the presented methods and presents suggestions for improvements and extensions. He discusses the validity of assumptions, and is concerned with the properties of the time series of input data, with statistical methods for estimation of parameters. The lucid style of the exposition will be appreciated by readers interested in the topic, and by researchers, students and practitioners.

G. Royer, *Une initiation aux inégalités de Sobolev logarithmiques,* *Course Spécialisés 5, Société Mathématique de France, Paris, 1999, 114 pp., FF120, ISBN 2-85629-075-2*

This course is a quick (114 pages) introduction to logarithmic Sobolev inequalities (especially the Gross inequality) and their application to ergodicity for a stochastic differential equation (the equation of Langevin). As an illustrative example the unbounded spin system with weak interactions is studied. The main notions of functional analysis (self-adjoint operators and semigroups) needed in the text are introduced. The reader is supposed to be familiar with basic objects of probability theory; however, the notions of Kolmogorov process, Gibbs measure and Markov kernel are revisited. The book is prepared as a one-semester course for graduate students, but would be also of interest to scientists interested in probability theory. (efas)

J.-P. Schneiders, *Quasi-Abelian Categories and Sheaves,* *Mémoires de la Société Mathématique de France 76, Société Mathématique de France, Paris, 1999, 134 pp., FF 150, ISBN 2-85629-074-4*

In this memoir, quasi-abelian categories are introduced in order to extend classical homological and sheaf-theoretic methods from abelian categories to other exact categories occurring in algebraic analysis.

Chapter 1 develops a general theory of quasi-abelian categories. For E quasi-abelian, an abelian envelope $LH(E)$ of E is constructed. Among other things, it is proved that the derived categories of E and of $LH(E)$ are equivalent. Chapter 2 deals with sheaves with values in quasi-abelian categories, in particular in the so-called elementary ones (the cocomplete ones with a small strictly generating set of tiny objects. The chapter culminates with a proof of the Poincaré-Verdier duality and the projection formula in this general setting. Chapter 3 is dedicated to applications of the general theory to sheaves of $\mathbf{Z}$-filtered abelian groups, and of locally convex topological vector spaces. (jtrl)

B.-W. Schulze, B. Sternin and V. Shatalov, *Differential Equations on Singular Manifolds,* *Mathematical Topics 15, Wiley-VCH, Berlin, 1998, 376 pp., DM198.00, ISBN 3-527-40086-9*

The theory of differential equations on manifolds with singularities has a long history. The best-studied case is that of manifolds with conical singularities. In this book, singularities of more general types are covered. The main problems addressed are a description of the asymptotic behaviour of solutions and finiteness theorems (that the corresponding differential operators are Fredholm operators). The study of singularities more general than conical ones brings new effects and needs new tools. The so-called 'resurgent analysis' used in the book deals with a problem of re-summation of divergent series appearing in the theory. The Maslov non-commutative analysis (a construction of algebra of functions of non-

commuting operators) is needed for finiteness theorems. The main part of the book (Chapters 4-8) is devoted to a study of elliptic operators. Chapter 9 covers a special case of hyperbolic equations and Chapter 10 contains a discussion of the evolution equations for thin elastic shells. Two appendices offer a brief summary of facts needed from other monographs of the authors.

The book is very well organised and clearly written with a lot of commentary and motivating examples showing main features of the theory. (vs)

P. K. Suetin, *Orthogonal Polynomials in Two Variables, Analytical Methods and Special Functions, Vol. 3*, *Gordon and Breach Publishers, Amsterdam, 1999, 348 pp., $130, ISBN 90-5699-167-1*

This monograph presents a comprehensive theory of orthogonal polynomials in two real variables and properties of Fourier series in these polynomials. Cases of orthogonality over a region and a contour are presented, and much attention is paid to the relationship between orthogonal polynomials in two variables and differential equations. The volume includes the classification of differential equations that admit orthogonal polynomials as eigenfunctions, and several two-dimensional analogies of classical orthogonal polynomials.

The monograph consists of 11 chapters, comments and supplements, and a list of 174 references. To read this book knowledge of the main properties of orthogonal polynomials in one variable is necessary. Also used are the main concepts and methods from the theory of functions of a real or complex variable and the theory of differential equations.

The volume represents an extensive survey of the area, and contains new results. It will doubtless be very valuable, not only for specialists but for a general audience interested in mathematics. (kn)

Y. C. de Verdière, *Spectres de Graphes*, *Cours Spécialisés 4, Société Mathématique de France, Paris, 1998, 114 pp., ISBN 2-85629-068-X*

This book develops for finite graphs some analogues of the spectral theory of Schrödinger operators on compact manifolds. It covers some spectacular recent developments, including the second-smallest eigenvalue method (Cheeger and Fiedler), expanders of Ramanujan graphs, minor theory (geometric view) and a famous invariant (Colin de Verdière). The book is self-contained and has a lucid mature style. This is a great book which should be translated into English. (jnes)

H. Völklein, P. Müller, D. Harbater and J. G. Thompson (eds), *Aspects of Galois Theory*, *London Mathematical Society Lecture Note Series 256, Cambridge University Press, Cambridge, 1999, 282 pp., £27.95, ISBN 0-521-63747-3*

This book is an outcome of the conference 'UF Galois Theory Week', held at the University of Florida in October 1996. The main highlight of the meeting was the Inverse Galois Problem, one of the most exciting questions of contemporary mathematics. Among the different aspects of this matter one can find here new methods for determining explicit classes of polynomials with positive characteristic among whose Galois groups appear entire families of groups of Lie type. Further, a recent result on the realisation of series of Lie type groups as Galois groups in characteristic 0 is presented; in particular the realisation of the projective symplectic groups PSp(n, q) under a restriction on n and q is obtained. The study of the entire world of Galois extensions of a given field may lead to the structure of certain profinite fundamental groups. Here the finite quotients of the fundamental group of an affine curve in positive characteristic are determined. Some other topics of this volume, such as the comparisons between the absolute Galois group of the rationals and the Grothendieck-Teichmueller group, and between the fundamental group of the punctured line in characteristic 0 and in positive characteristic, should be mentioned. (rb)