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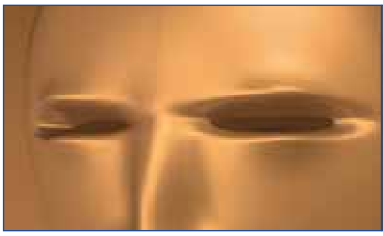

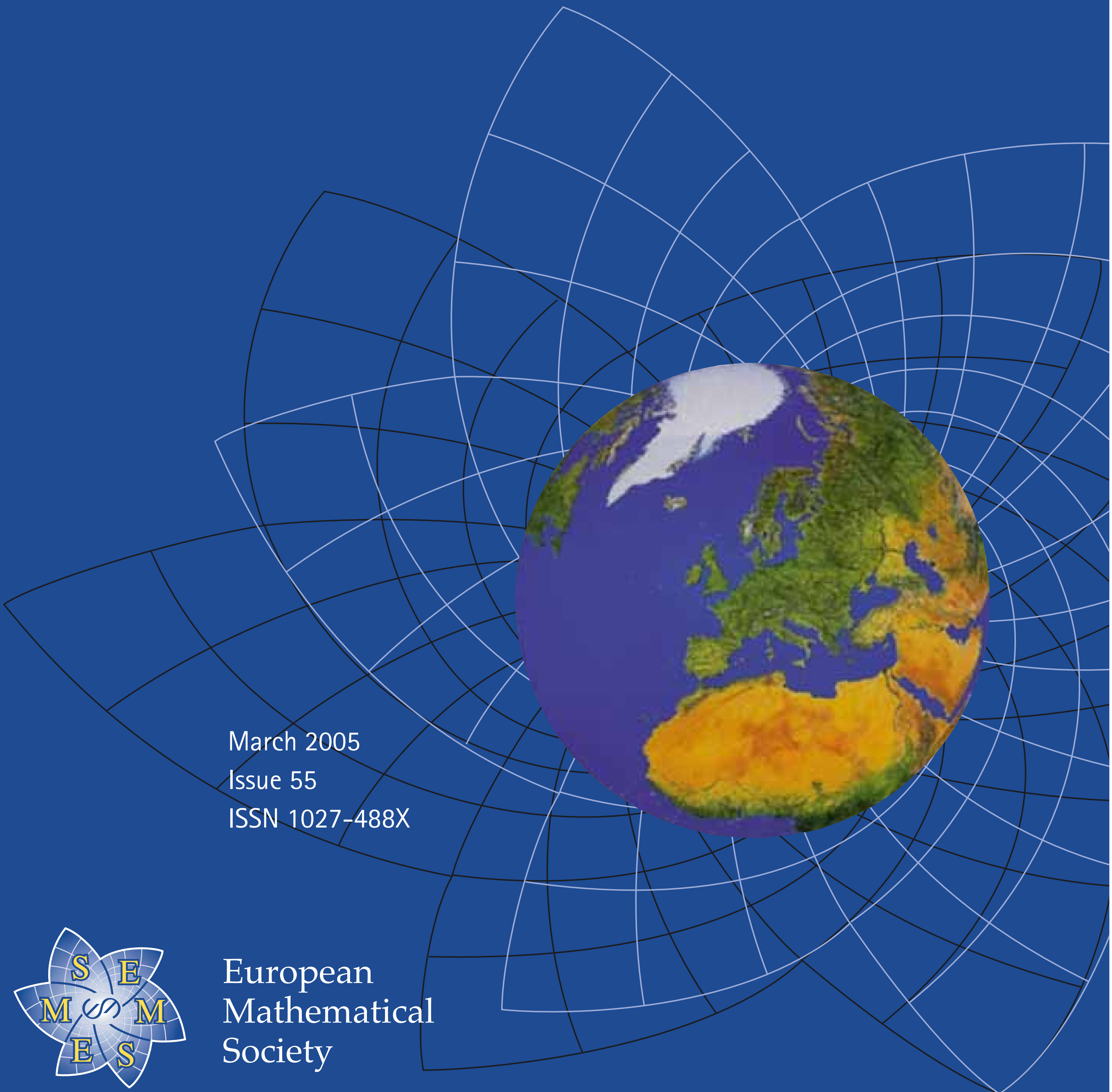

March 2005
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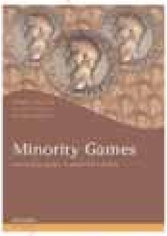

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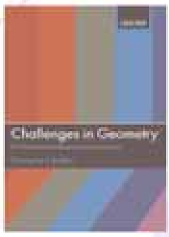

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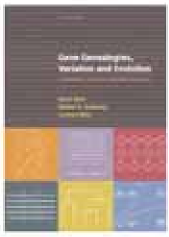

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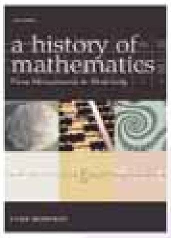

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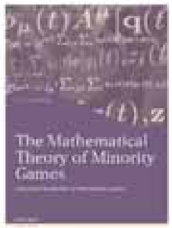

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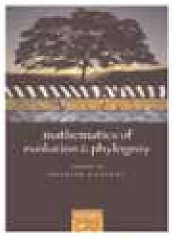

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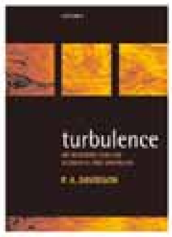

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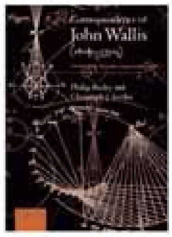

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EMS Calendar

2005

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

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

10–11 June & 14 June
EMS Lectures by Nina Uraltseva, *Regularity of free boundaries in parabolic obstacle type problems.* At the conference on Free Boundary Problems 2005 in Coimbra and at the University of Lisbon (Portugal)
Web site: www.fbp-2005.org

25 June–2 July
EMS Summer School at Pontignano (Italy) *Subdivision schemes in geometric modelling, theory and applications*
Web site: www.subdivision-summerschool.uni-kl.de/

18-23 July
EMS Summer School and European young statisticians' training camp at Oslo (Norway). Web site: www.ems2005.no

11–18 September
EMS Summer School and Séminaire Européen de Statistique at Warwick (UK), *Statistics in Genetics and Molecular Biology*
Web site: www2.warwick.ac.uk/fac/sci/statistics/news/semstat

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

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

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

2006

13–17 March
EMS-SIAM-UMALCA joint meeting in applied mathematics
Centre for Mathematical Modelling, Santiago de Chile

3–7 July
Applied Mathematics and Applications of Mathematics 2006, Torino (Italy)

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

2007

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

2008

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

Editorial


Thomas Hintermann, director of the EMS Publishing House and Martin Raussen, editor-in-chief of the EMS *Newsletter*

A new look

The reader will certainly have discovered that the *Newsletter* has a different look compared to previous issues. The new cover design communicates the European Mathematical Society's focus on mathematics in Europe, while being open to the whole world at the same time. Leafing through the entire *Newsletter*, the reader will also observe certain changes in layout. However, scope and contents of the *Newsletter* have not undergone major changes.

There is a particular reason for the *Newsletter*'s new appearance: From this year on, it will be published under the auspices of the EMS Publishing House, the Society's own publishing operation based in Switzerland. This transition was decided by the executive committee of the society during its meeting in Prague in September 2004. The publishing house had previously enjoyed a fast and positive development. It is now publishing five journals; the first seven books are released and many more will come out during this year and following years. Information on its mission and organization, as well as a complete list of current publications, can be found at www.ems-ph.org. The homepage also sports a bookshop, where EMS members can order at a discount. It is expected and desirable that the EMS Publishing House will grow steadily and attract further journals and many more book authors. The EMS itself approves this development and marks it by the decision to publish its *Newsletter* through its publishing house. While the *Newsletter* is not intended to provide overheads or profits for the publishing house, it will provide a platform for regular information on new publications. In turn, the transition will allow to handle the *Newsletter*'s financial matters, such as advertisement sales, more stringently.

A new editorial team

Starting this year, a new editorial team has taken charge. Let us first of all thank those editors who have chosen to leave the *Newsletter* after several years of (unpaid) services: former associate editor Steen Markvorsen (Denmark), Tony Gardiner, June Barrow-Green and Jeremy Gray (all UK). The new list of editors consists half of editors that continue in office and half of newly appointed members, whom we would like to thank for their willingness to put their efforts into the goal of assembling a stimulating *Newsletter* for several years to come.

You will observe that the new team comprises more members and has gotten a larger spread. The latter is meant in both a geographical sense – with a better representation of members from Mediterranean countries – and with respect to the mathematical areas it represents. Although this is perhaps not fair towards all the others members of the team, we are particularly happy to welcome Chris Budd as an editor with Applied Mathematics and with Applications of Mathematics as his area of responsibility. During this year, all editors will have the opportunity to present themselves in the *Newsletter*: you will find the first four presentations on page 4 of this issue.

Reviews in the *Newsletter*

Some minor changes will also occur to the content of the *Newsletter*. In this issue 55, you will find the first featured book review, incidentally discussing one of the publishing house's first books. In the future, we intend to publish such book reviews on a regular basis – as a supplement to the regular column "Recent Books" with brief reviews. We would like to take this opportunity to ask our readers to submit book reviews to the editorial team. Since its readership has very different backgrounds and interests in mathematics, the *Newsletter* is interested in contributions targeted at the non-specialist mathematician. Reviews dealing with and comparing various books might be particularly interesting and useful.

An appeal

Let us extend this appeal to other areas as well. The *Newsletter* is very interested in submissions, in particular in survey articles of a moderate size, dealing with all sorts of mathematics, its applications, its history and the education of mathematics. We would like to ask our readers to contribute their own articles and/or to suggest somebody else's work. Please contact the editor of your choice; see the list of editors on page 1 of this issue. You can find instructions for authors on the Internet on the *Newsletter*'s own web page www.emis.de/Newsletter. Please note that the *Newsletter*'s language is English; our copy editor, Kelly Ronaldson, sees to it that articles from authors outside the English-speaking community receive a "polish" before they go to print.

Electronic issues

From the *Newsletter*'s web page you can access current and older version of the *Newsletter* online. Several other electronic *Newsletter* projects were described in the editorial in issue 50 more than a year ago. We have to confess with regrets that such projects take more time than first estimated. But we are still working to put the *Newsletter*, and in particular the sections on book reviews and conferences, on an electronic base with appropriate facilities for updating and searching.

Comments? Suggestions?

The editorial team of the *Newsletter* is very interested in receiving comments and suggestions from the readership; please use our mail-addresses! And if you like (most of) the *Newsletter*, why not take the opportunity to convince some of your colleagues to subscribe to it by joining the EMS? This can be done very easily and at a cheap rate (20 Euro per annum) through the national societies; cf. www.emis.de/individuals/membership.html.

Introducing the editorial team

Giuseppe Anichini was born in 1948 in Greve in Chianti, near Firenze, Italy. He was a student of Roberto Conti, head of the Ordinary Differential Equations School in Firenze in the seventies. He was also a researcher for one year at the University of Minneapolis, Minnesota and a visiting professor in several European institutions. In 1985 he became full professor of Mathematical Analysis at the University of Modena, Italy. Since 1997, he has been full professor at the Engineering Faculty in Firenze.

His research interests include: Control problems, Existence for Differential Inclusions; Boundary value problems for Ordinary differential Equations. Concerning these fields, he has organized conferences in Italy and he has been appointed to the editorial board of some journals.

He was a member of the Scientific Council of C.I.M.E. (International Mathematical Summer Centre) from 1993 until 2001. Since 1988, he has been Secretary of the Unione Matematica Italiana and is currently also a member of the C.I.I.M. (Italian Committee for Teaching Mathematics), and a Member of the Committee UMI – Ministry of Education. He is the editor in chief of the *Notiziario UMI*.

Chris Budd (*Editor for Applied Mathematics and Applications of Mathematics*) is a Professor of applied mathematics at the University of Bath and a Professor of Mathematics at the Royal Institution. He is an active research mathematician with interests in differential equations, numerical analysis and industrial mathematics. He is also the director of the Bath Institute for Complex Systems.

He has a strong interest in promoting mathematics to the general public and gives many talks to schools and other bodies as well as running an annual science fair. He is on the education committee of the London Mathematical Society and the Royal Institution, and serves on the council of the London Mathematical Society and of the Institute of Mathematics and its applications. He is currently President of the Mathematics section of the British Association for the advancement of science. He has won awards for research, teaching and the public understanding of science.

Away from mathematics he helps to run a youth club, climbs mountains and is married with two children of school age.

Vasile Berinde (*Associate editor and Conferences editor*) is a Professor in Mathematics and the Head of Department of Mathematics and Informatics at the University of Baia Mare, Romania. He graduated from "Babeș-Bolyai" University of Cluj-Napoca where he also obtained his PhD for a thesis in Fixed Point Theory – his main field of research. His mathematical interests also include iterative methods for solving nonlinear equations, chemical graph theory, mathematics education and the history of mathematics.

He was the coordinator of the National Presentation that Romania gave at ICME-10 in Copenhagen last year and is strongly involved in organizing mathematical olympiads, training gifted students and developing their creative skills in mathematics (see *Exploring, Investigating and Discovering in Mathematics*, Birkhäuser, 2004). He is very fond of any editorial activity: he founded the newsletters of his university and that of the Romanian Mathematical Society (Curier matematic), and he is a member of the Editorial Board of several journals (*Fixed Point Theory*, *Carpathian J. Math.*, *Gazeta Matematică*, *Creative Math.*, *Matematika Plus* etc.).

He is a member of the Executive Committee of the Romanian Mathematical Society and also a delegate to the EMS Council since 2000. He is married and has two daughters. His elder daughter, Mădălina, is presently a junior assistant and PhD student in Mathematics at "Babeș-Bolyai" University.

Maria G. (Mariolina) Bartolini Bussi is a full professor of Didactics of Mathematics at the Faculty of Education of the University of Modena-Reggio Emilia.

She directs the Laboratory of Mathematical Machines at the Department of Mathematics in Modena, with a collection of dozens of geometrical instruments reconstructed from historical sources (see www.mmlab.unimore.it). She is especially interested in teaching and learning processes with the use of both classical and computer-based instruments. The mmlab has prepared several public exhibitions of Mathematical Machines, with thousands of visitors. The mmlab is open to schools for interactive geometry activity.

Two projects directed by her have been shortlisted for international awards in 2004: the Altran award for innovation http://www.fondation-altran.org and the Pirelli INTERNETional awardhttp://www.pirelliaward.com.

She is a member of the editorial board of *Educational Studies in Mathematics*, *Recherches en didactique des Mathématiques*, *Journal of Mathematics Teachers Education*; of the International group on the Psychology of Mathematics Education (Vice president 1993–1995), of the IPC of ICME-10 and of the IPC of the ICMI Study 16 (Challenging Mathematics in and beyond the classroom).

She is married and has two married sons and an 18 year-old daughter.

Position paper of the European Mathematical Society on the European Commission's contributions to European research

A letter to the EU Commissioner for Science and Research, Janez Potočnik, January 2005.

The European Mathematical Society acknowledges the action of the European Commission for scientific research, as a key element for European development. It endorses enthusiastically the perspective of a European Research Area, and the central role it very appropriately gives to scientific research in the economic development of our continent. It wishes to contribute to this action, bearing in mind its own European mission and its direct connection with research and training activities throughout the countries of the Union, the Associated States and all other countries of the European continent.

The E.M.S. wants to stress that mathematical research is at this moment pursued at a very high level in Europe, and that this position must be maintained by appropriate actions. It is more cost effective to keep a dominant position than to let it go and have to catch up later. This implies that resolute action has to be taken now in various directions.

The question of human capital is crucial, with a large number of retirements of scientists in the coming years and international competition to attract the best researchers. Europe still produces world class mathematicians, and suitable conditions must be created to keep them here.

The U.S.A. and China are currently investing heavily in research, notably in mathematics, and Europe seems in fact to be lagging behind on its own engagement.

Mathematics has a role to play in most directions of economic and scientific developments, and it is necessary both to develop new fundamental mathematics and to encourage interactions with other sciences and industry.

To best coordinate E.U. actions, it would seem a minimum that advisory boards of the Commission, like EURAB, include mathematicians. Strangely enough compared to the standing of mathematics in Europe, this is not the case.

Contents

0. Summary of recommendations

The European Mathematical Society recommends that

1. the Commission commit itself to the success of a strong initiative, like the projected European Research Council, to develop in Europe a large area of fundamental research, preserving a "bottom-up" approach and leaving the door open for unexpected discoveries that are likely to shape tomorrow's society,
2. more flexibility be introduced in the definition of E.C. programmes, so that sciences with different traditions and formats can be efficiently supported,
3. the Human Capital programme be maintained and amplified, and its shortfalls corrected, in particular by allowing doctoral and post-doctoral researchers on equal footing in the Marie Curie actions,
4. the Commission support the development of European electronic databases and libraries, to allow access to the necessary scientific information all over the continent in scientific and industrial circles,
5. Eastern European mathematicians be integrated rapidly in all the Commission programmes, as equal scientific partners,
6. E.C. programmes include mathematical collaboration with researchers of developing countries, where a good mathematical level has been reached,
7. all Commission procedures be enormously simplified, to avoid possible neglect of the programmes by the best scientists. This applies to all steps of the process, from the initial applications to the final reports,
8. the scientific panels (composed of highly respected scientists) be given more freedom to judge, amend or make suggestions about the proposals that come to them,
9. the Commission include mathematicians on equal footing with other scientists in its advisory boards like EURAB.

Moreover, it would be extremely useful to:
- abandon the idea of evaluating anonymous proposals,
- work on the establishment of easy visa procedures for recognised researchers.

I. Some special features of mathematics

Although the E.M.S. wishes to raise some points relevant to aspects of research in all fields, it feels the need to point to some particular features of mathematical research, notably in Europe.

Some of these characteristics have a bearing on the organisation of the support mathematicians need to find in Europe, in particular in programmes set up by the European Commission. Let it be clear that we do not call for a blind increase in mathematics funding, nor for adopting rules that would unduly favour mathematics, but for an increased flexibility in the definition and the running of the programmes that would leave all opportunities for excellent proposals to be considered in all fields, with the best possible efficiency. Different research traditions indeed require different frameworks, and we believe that our comments do not apply only to mathematics.

Mathematical research in Europe is recognised as among the best in the world: several indicators place it even ahead of that of North America and of Asia.

For instance, a communication of the Commission points out that fewer Nobel prizes go to Europe-based scientists than U.S.-based ones (68 against 154 for the period 1980–2003), but that for the Fields medals (the highest award in our discipline often seen as a "Nobel prize of mathematics") this is not so, since for the same period nine were given on each side of the Atlantic. In particular, the I.H.E.S. (a centre of mathematical excellence near Paris) obtained 7 Fields medal awards (out of 36 awarded since the foundation of this Institute) among the 10 professors appointed there.

Other characteristics that distinguish mathematics from sister sciences, and in particular from experimental sciences, are the following:

1) A mathematical research team at a given location is generally smaller, and research on a given subject is geographically more dispersed. That the quality of mathematical research is not necessarily directly dependent on a concentration of heavy resources is certainly an advantage – but requires that this fact be taken into account when setting up programmes or evaluating the quality and impact of the research. This doesn't mean that no support at all is needed for mathematics, and in particular computational mathematics and scientific computations will require significant investments, e.g. as large infrastructures.
2) The unity of mathematics has always made itself felt with considerable force, and at the dawn of this XXIst century the interplay of mathematical ideas between the different sub-domains has probably reached an all-time high in intensity. This phenomenon sets mathematics apart from many other branches of science which have split up into multiple specialities, each with its specific culture and sociology. A direct consequence is that the task of a panel of mathematicians having to evaluate research is much easier, the existence of factions and of schools in conflict with one another remaining exceptional, provided researchers of sufficient breadth and level are recruited as experts.
3) The distance between fundamental mathematics and applications has become in many instances very short and is getting shorter both in time and in contents. In many cases, mathematical subjects developed for reasons purely internal to mathematics have suddenly led to concrete applications, in sharp contrast with the traditional pattern of neighbourhood relationships: pure science – applied science – applications. By way of example, we might mention the use of stochastic processes in finance, or of number theory in cryptography, system security and data compression.
4) In mathematics there is an extremely close relationship between research, teaching and training. In fact, most researchers in mathematics are also teachers and European support for research has an immediate effect on the improvement of mathematical qualifications in the manpower of the future. It is the appropriate moment to point out that the use of people mastering an advanced mathematical training has broadened enormously. Besides finance, we can mention many sectors of industry or services, examples being given by telecommunication as a whole, the pharmaceutical industry, material design and so on.
5) In Central and Eastern Europe and in the Third World the state of research in mathematics is often better than in the other sciences, for relatively low cost initiatives have often led to the creation of centres of excellence – without being exhaustive, we could name some centres that are at the highest world level like the IMPA in Rio de Janeiro or the Tata Institute in Bombay. Some institutes in Vietnam and Africa could also be mentioned. Co-operation in mathematics with such countries should not be seen as a one-way aid to development, but as a true exchange between active centres, from which EU groups can benefit directly.

II. Fundamental research and its role in economic development in industry and services

The European Mathematical Society is happy to see the importance of fundamental research recognised at various levels.

The private sector mostly invests in short-term applied research, and this implies that the public bodies, both national and European, must bear the major responsibility of long-term investment in fundamental research.

All opinions converge on the fact that the time-lag before a discovery can be put to practical use is getting shorter and shorter. But the time before commercialisation is getting short because the numerous (and often cheap) innovations that arise continually from the world of research are more quickly sorted out, and not because the analysis of needs has motivated the discovery. We are in an era where markets are not shaped only by precise demand.

A very significant example illustrates this.

The necessary scientific basis that gave rise to the explosion of the communication society (internet...) is not tied to discoveries that were motivated by that development, but by very theoretical results, obtained without the pursuit of commercial aim and following the initiative of scientists (bottom-up approach).

Indeed, the laser was built as a physical curiosity in the sixties (the production of coherent light). It has become a necessary ingredient of fast transmission along optical fibres – as well as being used every day when we listen to compact discs, use codebars or submit to surgery.

Likewise, number theory was studied for centuries purely for the amusement of mathematicians – yet it led to cryptography and error correcting codes, without which safe transmission on internet and e-commerce would not exist.

Also, developments in non-linear analysis, like wavelets in image processing, have preceded the use of sophisticated non-linear models in high technology industry.

In many commercial developments of the future, we should expect to observe the same pattern: scientific discoveries of different fundamental fields being quite unexpectedly transformed into innovative new tools, creating a new market.

What can the European Commission do in this context?

Naturally, it must support the development of industrial technology in an integrated way, to avoid negative effects of internal competition.

But it must most importantly create a European area of scientific freedom, where the scientists are encouraged to take new initiatives and will create new science following their own approach. Thanks to actions like the NEST programmes, it can then encourage or produce risk capital sufficiently quickly after one has detected that a discovery will lead to unexpected applications.

In short, Europe has to give a chance to the unexpected.

This goes against the long established idea of very close control of programmes and choices made a priori, but is the only way for real progress today.

III. The European Research Council

The project of supporting fundamental research through the proposed European Research Council should become a major realisation of the present Commission, with a long-lasting effect on European development. It should also involve grass-roots organisations, to make sure it takes a form suitable for real scientific involvement.

The EMS supports strongly the idea of a structure that would be funded at a level comparable to that of the Framework Programmes and that would cater for fundamental research.

Following ideas currently discussed, it would give grants and not contracts, would have scientific excellence as the sole criterion of evaluation and would incorporate no notion of juste retour for the various member states. The selection of funded proposals would be made through a system of peer review (as already developed by the Commission).

A scientific governing body would be set up and would act in the interest of scientific development, without other external guidelines.

This project, brought to the right level of success, could become a landmark achievement of this Commission.

IV. Human capital

In this age of science and technology, it is obvious that the future of Europe will depend crucially on the level of its researchers and, more broadly, on the level of all its workforce.

Energetic measures are thus required to encourage the pursuit of science, improve the training of researchers and engineers, and fight the brain drain to other continents.

1) In mathematics, the crux of the matter is probably the question of availability of post-doctoral and junior positions, and the E.M.S. wants to underline the positive results already achieved by the Framework Programmes at the post-doctoral level through its Marie Curie Network and Fellowship programmes. It calls for a new and substantial increase of funding in these activities, which would prevent having to reject excellent proposals, as is now the case in the network category.

   Why are postdoctoral positions so important for the future of science in Europe?

   We all observe that scientists in Europe are often better trained than those in the U.S. – up to the doctoral level. This considerable investment in education having been made, Europe often offers no good opportunity for further employment, leaving to the U.S. the benefit of hiring highly competent scientists who are left with not much choice.

   As a result, the doctoral and postdoctoral U.S. programmes work with a majority of non U.S. citizens.

   A number of undisputed centres of excellence do exist in Europe, especially in mathematics, but they have less success for the simple and basic reason that they do not have enough positions available at the right competitive level !

   The E.C. can have a strong effect on this problem provided it continues its efforts in the appropriate form. It is in particular extremely important that young researchers after their PhD have the opportunity to enlarge their perspective, by gaining access to centres of high level outside of narrowly defined scientific projects.

   Practically, it would first be important to create and impose an ambitious status for the European post-doctoral researchers in mobility with a non taxable income when they are outside their own countries and paid out of the budget of the Commission, with the hope that States would follow that example with their own fellowships.

From the Commission's point of view, a European tax-free status would overnight increase the number of positions offered.

Secondly, we strongly support the format for post-doctoral fellows in mobility, namely a grant allowing two years in another E.U. country and then one year in their country of origin.

It is indeed important to fill the time gap between completion of the PhD. and the possibility of getting a permanent position in Europe.

2) The networks are also important components of the post doctoral programme - well integrated with the effective development of research.

With their present rules, the rate of success has become too small to make choices optimal, and the lack of flexibility make them less adapted to sciences like mathematics, where at each node groups are usually small.

Thus, for optimal impact, a more flexible rule must allow the inclusion of more small groups, without necessarily increasing the global budget of a network.

Moreover, the panel of experts should be given much more freedom, including the possibility to award less money than requested or intervening to suggest the merger of two applications.

The freedom of action of the panel was abruptly decreased at the beginning of the Fourth Framework Programme, and in mathematics the rules led to a dramatic reduction in the cost-efficiency of the programme and a decline of the interest of the leading scientists in taking part in the panels.

3) The demography of researchers and professors in European universities should be studied in detail for every field, to get a fairly precise estimate of future needs.

For mathematics, this was done a few years ago by the E.M.S. This study should be updated, and would show some strong variations in the number of retirements over different periods (still following the effect of World War 2, of the growth in the sixties, the crisis in the seventies and so on).

An ambitious policy is badly needed. It should insure, by an adequate number of doctoral and post-doctoral positions that future professorial positions in universities will be awarded to high class researchers.

4) A serious problem arises in the definition of most Marie Curie programmes. Indeed, the accent is systematically put on doctoral students and not post-docs. (indeed, a large proportion of early stage fellows is a condition of acceptance). In certain fields, this may correspond to well identified needs, but not in others (like mathematics).

We propose to open the programmes freely to both doctoral and postdoctoral researchers, thus allowing for optimal choices by the proposers in each field.

5) Finally, anyone having invited to Europe a scientist from outside the E.U. knows that the visa problems are a major headache and a huge loss of time. There have been several instances where foreign scientists invited and paid by a government were not able to come, because the same government had not provided them with a visa.

V. Infrastructures and electronic databases

The E.M.S. gratefully acknowledges the fact that the definition of a large infrastructure was enlarged in the Fifth Programme, thereby opening the way to a successful application of support of the comprehensive European database of mathematical literature *Zentralblatt-MATH*.

Further support of electronic databases and libraries will be essential for the development of mathematics, and Europe must reach the level of essential partner in the world competition in this domain.

A special feature of our discipline is that documents are never obsolete: a brilliant proof by Bernhard Riemann (19th century) or Elie Cartan (first half of the 20th century) can be of extreme contemporary importance, because ideas remain valid and the tradition of mathematics publication does not include repetition of past results, unless a new viewpoint has become available.

Thus a present day researcher will effectively need access to the whole of the literature for his or her work.

On the other hand, the price of subscriptions to journals, in particular those published by commercial companies, is rising unreasonably: increases of 10 to 20% per year are the norm, 60% often happens.

Thus, the average university library becomes unable to acquire the basic necessary tools for its mathematics researchers.

As a consequence, a few European governments and some U.S. enterprises have embarked on ambitious programmes of digitising the existing scientific literature, in order to distribute it electronically. The bulk of this effort is funded by private foundations, but access may be restricted to institutes paying a heavy annual fee, likely to remain out of reach for most European universities.

For these reasons, the E.M.S. presses the European Commission to take strong action aiming at developing electronic databases and libraries, including the steps of developing the transfer of the data on electronic support and their distribution.

A more precise analysis would show whether Europe should best catch up with the digitising initiated on a large scale in the U.S. by competition or by partnership. In the latter case, a sufficiently strong position must be reached before hoping for a real partnership.

By strong action, we mean in particular that the Commission support be granted not only for access to infrastructure, or for research related to its development, but for direct funding of its development and upgrading.

This does not contradict any principle of subsidiarity once it is acknowledged that the infrastructure is a truly European one, and could just not be conceived at the scale of one or a small number of states.

VI. Centres of excellence

The E.M.S. strongly supports the Commission's view that centres of excellence are an important component of European research, and that they should be well-positioned for efficient and justified E.U. support.

As mentioned above, centres of excellence in mathematics exist in Europe at the highest level, and are by no means inferior to U.S. centres like the Institute for Advanced Study at Princeton and the Mathematical Sciences Research Institute at Berkeley.

Nine of these centres have constituted a network of European dimension, tailored for the scope of a European Research Area. The European Post-Doctoral Institute (E.P.D.I.) is composed of the Institut des Hautes Etudes Scientifiques (Bures-sur-Yvette, France), the Isaac Newton Institute for Mathematical Sciences (Cambridge, UK), the Max-Planck Institut für Mathematik (Bonn, Germany), the Max-Planck Institut für Mathematik in den Naturwissenschaften (Leipzig, Germany), the Erwin Schrödinger Institut (Vienna, Austria), the Institut Mittag-Leffler (Djursholm, Sweden), the Banach Center (Warsaw, Poland), the Centre de Recerca Matemàtica (Barcelona) and the Forschungsinstitut für Mathematik (Zürich).

The aim and function of this E.P.D.I. is so much in line with the E.U. programme that its case should be examined by the appropriate scientific panels. In the past, strict rules on different E.U. programmes made the E.P.D.I. repeatedly ineligible- usually to the regret of scientific panels who rated it as excellent.

Other networks in mathematics have also established themselves at the highest level, either in the E.U. programmes or outside, and we wish to mention here the Network MACSI

(Mathematics, computing, simulation in Industry), initiated by ECMI and ECCOMAS.

In order to allow for choice of optimal centres and networks, the E.M.S. stresses once more the importance of flexibility in the rules: a network of centres of excellence need not be very large, need not be founded on a very specialised topic, need not consist of large laboratories, although of course it can.

Finally, all calls for proposals should be widely open to competition - science in Europe is not limited to a list of centres fixed once and for all.

VII. Eastern Europe and Third World

As indicated above, very high level mathematical research is pursued both in Eastern Europe and in various developing countries.

In Eastern Europe, a high mathematical level has been achieved and maintained as part of a tradition, using the fact that restricted access to expensive material over a short period of time did not bring irreversible damage.

This tradition is under threat in some countries, simply because economic problems have brought down the salaries of university teachers below a minimal level - thus producing a massive exodus to the west and serious concern about the ability of attracting or keeping talented young people in the future. Let us note for instance that over the period 1980–2003 studied above, four Fields medals were awarded to Russian mathematicians, but that only one has remained in Russia.

It is in the interest of the whole of Europe to preserve the high and long-lasting tradition of mathematical research in all countries.

To disrupt it in the East would irreversibly damage a remarkable reservoir of talent, that Europe will need in the near future.

Thus we advocate strong relations with scientific centres in Eastern Europe, on the basis of scientific partnership at high level. The very low cost of living there can be used as an advantage to organise activities more cost-efficiently.

Concerning the countries of Latin America, Asia and Africa, Europe could at this stage develop strong scientific relations, which would be beneficial on the long run.

Indeed, these countries do not usually cherish the idea of being absorbed under the umbrella of powerful neighbours (U.S.A. for Brazil and many other countries, Japan for Korea,…). Mathematically, some centres in these countries are at the highest level, and a specific programme of co-operation would be very efficient. Currently, co-operation is only funded on specific themes defined by the Commission (pollution, forest, health…), missing the necessity for these countries to be integrated in the future society of knowledge.

Various European states have strong historical and cultural links with developing countries, and these links could form the basis of this future co-operation.

VIII. E.U. programmes and procedures

Some rules currently enforced by the Commission do not allow for maximal efficiency of the programmes. It is essential to identify and modify them.

1) The E.C. procedures, applications and contracts are absurdly complicated, notably because they aim at covering in extreme details many different situations in the same format. It seems all documents were drawn up by wary lawyers, and not scientists. The smallest application is the object of 50 to 80 pages of instructions on the Cordis website.

Quite often, the questions asked in the application form constitute a barrier between the proposer and the scientific panel.

This is in part due to a very restrictive view of subsidiarity: instead of simply saying what research is planned for the panel to read, the proposer will have to answer a series of questions, distinguishing training, research, added European value, externalities and so on.

It has gone so far that some high level scientists do not apply anymore, whereas others hire the (paid) service of consulting agencies, which specialise in knowing how to transform a scientific project into a "viable" application to the Framework Programme.

2) The scientific panels play and must play an essential role in the peer reviewing of proposals. They must examine the proposals and have an actual physical meeting, to exchange informations and opinions. To ask for separate marks out of 100 and then to make a mere average (a process unfortunately used by INTAS) transforms the choice into a lottery, different experts having different scales for their marks. Needless to say, the choice of experts in the panels must be of such quality that they command undisputed respect in the scientific community.
3) As already mentioned, panels should be given more freedom by allowing added flexibility to the rules.
4) In some programmes organised by the Commission, part of the first applications must be anonymous, in the sense that the scientific programme must be described but the name of scientists in charge must be deleted. This procedure may give an impression of impartiality, but in fact it is absurd. The level of expertise of the researchers is the main factor in the success of a programme, and to delete that information is to deprive the assessor of a major element of judgement.

   Moreover, if an assessor is suspected of helping his or her friends, it is clear that these friends will tell him or her that they are behind the application. So nothing is gained but very much is lost in that process.
5) As summary of this section, we could reduce our recommendations to simple mottoes: more flexibility, fewer rules, less paperwork.

EMS Lectures in Portugal

The EMS (European Mathematical Society) LECTURE on REGULARITY of FREE BOUNDARIES in PARABOLIC OBSTACLE TYPE PROBLEMS, by N. Uraltseva (St. Petersburg, Russia), will take place 10–11 June 2005 during the conference FBP 2005 (Free Boundary Problems) at the University of Coimbra, and on 14 June 2005 at the University of Lisbon, Portugal.

Nina Uraltseva

Programme

1. Introduction and formulations of the parabolic obstacle problems
2. Monotonicity formulas
3. Optimal regularity of solutions: interior and boundary estimates; two-phase problem
4. Lebesgue measure of the free boundary
5. Balanced energy
6. Classification of global solutions
7. Properties of the free boundaries: regularity and behaviour near the given boundary
8. Generalizations

Notice

Professor Uraltseva, currently the head of Mathematical Physics at St. Petersburg State University, is a well-known specialist in the field of nonlinear PDE's. Her fundamental results in elliptic and parabolic PDE's have influenced and continue to influence generations of mathematicians working within the field.

Nina Uraltseva's work ranges over classical problems such as the theory of quasi-linear equations, variational inequalities, the Signorini problem, p-harmonic functions, quasi-conformal maps, extremal problems for area minimizing functionals, mean curvature flows, and free boundary problems of obstacle type. During the last decade, she has been working on regularity for free boundary problems in the vicinity of contact points between free and fixed boundaries.

The EMS Lecture takes place in Portugal in collaboration with the conference 'Free Boundary Problems: Theory and Applications – 2005', organized by the Centro de Matemática of the University of Coimbra in collaboration with CMAF/University of Lisbon, (see http://www.fbp-2005.org/). It follows the meeting 'Classics in PDE's', organized in Professor Uraltseva's honour at KTH in Stockholm, Sweden (see http://www.math.kth.se/classicsinPDE/).

EMS-SCM Joint Mathematical Weekend

Barcelona, September 16–18, 2005

Marta Sanz-Solé (Barcelona, Chair of the Organising Committee)

Four years after the organisation of the Third European Congress of Mathematics, the Catalan Mathematical Society decided to actively contribute again to the scientific events promoted by the European Mathematical Society. Indeed, we are happy to announce the celebration of the next Joint Mathematical Weekend in Barcelona next September, 16-18. This shall be the third edition of a series of annual meetings following Lisbon 2003 and Prague 2004.

Programme

After a successful open call for organisers of special sessions, the Scientific Committee of the Catalan Mathematical Society chose five topics among the proposals, mostly representing strong areas of the local mathematical community, aiming to conceive an attractive and varied programme. Combinatorics and Graph Theory, Dynamical Systems, Evolution PDEs and Calculus of Variations, Module Theory and Representations of Algebras, and Non-commutative Geometry constitute the core of the activity, with Béla Bollobás, Jean-Christophe Yoccoz, Henri Berestycki, Henning Krause and Alexey Bondal respectively, as plenary speakers.

The organisation of each session has both local and international representation. By now, most of the invited speakers of the sessions are already fixed.

You can follow the progress of the organisation by visiting the home page at

http://www.iecat.net/scm/emsweekend .

The congress is organised with the support of the universities of Barcelona, Autònoma de Barcelona, Politècnica de Catalunya, EMS and the financial backing of the Catalan Mathematical Society. Financial support from research funding public institutions is also expected. There is no registration fee.

The venue

The historical building of the Universitat de Barcelona, inaugurated in the academic year 1879-80, will host the conference. The Faculty of Mathematics is located inside. Following the trends of post-romantic cultural renaissance, its architect, Elias Rogent, integrated elements of Roman, Byzantine and early Florencian architecture in a very personal and particular style. Rooms, corridors, cloisters and the garden offer a pleasant, inspiring atmosphere for any intellectual activity and are specially appreciated by peripatetic practitioners.

You should not miss this opportunity to visit Barcelona. You will surely enjoy a strong mathematical programme, together with the possibility of meeting and discussing with colleagues in a wonderful, polyhedral town with many exciting sides.

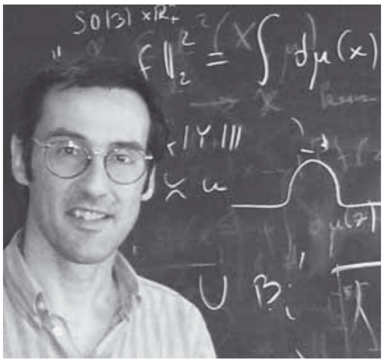
The Tapies foundation, Barcelona

EUCETIFA

Marie Curie Excellence Centre in Vienna

Recently, the EU-commission approved within the sixth framework FP6 a Marie Curie Excellence Grant (appl. Nr. 517154, call of March 2004) to a new European Centre for Time-Frequency Analysis, EUCETIFA. The team leader will be Karlheinz Groechenig (Storrs/CT). The 1.8 million euro project will start in October 2005 and is funded for 4 years. The host institution is the Faculty of Mathematics of the University of Vienna, and the local coordinator is Hans G. Feichtinger, head of NuHAG (the Numerical Harmonic Analysis Group). According to the proposal, EUCETIFA is going to develop the foundations and algorithms of time-frequency analysis (resp. Gabor Analysis), which has applications in communication theory, signal and image processing, geosciences, and many branches of mathematical analysis, such as the theory of pseudo-differential operators, frame theory, abstract wavelet theory etc.

Some basic information can be found on the centre's webpage (under construction): www.univie.ac.at/NuHAG/EUCETIFA/eucetifah.htm including a call for Post-Doc positions.



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Wolf Prize in Mathematics, 2005

Mina Teicher (Bar-Ilan University, Israel)

On January 18 2005, The Wolf foundation announced: "Two Russian Mathematicians, Working in the US, Share The Wolf Prizes for Mathematicians 2005".

The Minister of Education, Culture and Sport, and chairperson of the Wolf Foundation Council, Mrs. Limor Livnat, announced that the 2005 Wolf Prize in Mathematics will be awarded to Gregory A. Margulis, of Yale University, New Haven, Connecticut, USA, and to Sergei P. Novikov, of the University of Maryland, College Park, Maryland, USA, and the L.D. Landau Institute for Theoretical Physics, Moscow, Russia. The anonymous international jury decided upon Professor Gregory A. Margulis "for his monumental contributions to algebra, in particular to the theory of lattices in semi-simple Lie groups, and striking applications of this to ergodic theory, representation theory, number theory, combinatorics, and measure theory"; and Professor Sergei P. Novikov "for his fundamental and pioneering contributions to algebraic and differential topology on one hand, and to mathematical physics on the other hand". The President of the State of Israel, Mr. Moshe Katsav, will present the $100,000 prize at a special ceremony at the Knesset (parliament) in Jerusalem, on Sunday May 22, 2005.

The prize winners

Russian-born Professor **Gregory A. Margulis**, 58, received his Ph.D. in 1970, from Moscow State University, Russia. Since 1970, he has been associated with the Institute for Problems in Information Transmission at this University, first as a junior scientific worker, later as a senior staff member, and from 1986 until he left in 1991, as leading scientist. Since 1991, Margulis has been Professor of Mathematics at Yale University, New Haven, USA. Margulis received the Fields Medal in 1978. He is Foreign Honorary Member of the American Academy of Arts and Sciences.

Born in Russia in 1936, Professor **Sergei P. Novikov** graduated from Moscow State University in 1960. In 1965, he received his Ph.D. in Physics and Mathematics from the Steklov Institute of Mathematics, Moscow, Russia. Since 1971, Novikov has been Head of the Mathematical Division at the L.D. Landau Institute for Theoretical Physics. Since 1992, he has been Professor at the Department of Mathematics and at the Institute for Physical Science and Technology, University of Maryland, USA. Novikov received the Lenin Prize, USSR, in 1967, and the Fields Medal in 1970. In 1981, he was elected as a full Member of the Academy of Sciences, USSR. He is a Foreign Member of the National Academy of Sciences, USA. In 2004, he represented Russia in the Council of the European Mathematical Society

The Wolf prize

The Israel-based Wolf Foundation was established by the late German-born inventor, diplomat and philanthropist, Dr. Ricardo Wolf. A resident of Cuba for many years, Wolf became Fidel Castro's ambassador to Israel, where he lived until his death in 1981. Five annual Wolf Prizes have been awarded since 1978, to outstanding scientists and artists, "for achievements in the interest of mankind and friendly relations among peoples, irrespective of nationality, race, colour, religion, sex, or political view." The prizes, of $100,000 in each area, are given every year in four out of five scientific fields in rotation: Agriculture, Chemistry, Mathematics, Medicine and Physics. In the Arts, the Prize rotates among Architecture, Music, Painting and Sculpture. To date, a total of 224 scientists and artists from 21 countries have been honoured.

Previous prize winners from Europe include: Prof. Friedrich Hirzebruch (the first president of the EMS got the prize in 1988), Prof. Lennart Carleson (the president of the scientific committee of the 4 ECM got the prize in 1992), André Weil (France/USA), Izrail M. Gelfand (Russia), Carl L. Siegel (Germany), Jean Leray (France), Henri Cartan (France), Andrei N. Kolmogorov (Russia), Ilya Piatetski-Shapiro (Israel), Mark Grigor'evich Krein (Russia), Paul Erdos (Hungary), Atle Selberg (Norway/USA), Lars Hörmander (Sweden), Andrew Wiles (England/USA), Ennio De Giorgi (Italy), John G. Thompson (U.K.), Mikhael Gromov (France), Jacques Tits (France), Jürgen K. Moser (Switzerland), Yakov G. Sinai (Russia/USA), Laszlo Lovasz (USA and Hungary), Jean-Pierre Serre (France), Vladimir I. Arnold (Russia/France), Saharon Shelah (Israel).

Mina Teicher [teicher@macs.biu.ac.il] is a Professor of Mathematics and Computer Science, specializing in Algebraic Geometry with applications to Brain Research, Computer Vision and Cryptography. She is an international leader in topological methods in Algebraic Geometry and has lectured in major centres and universities. She heads a research group of 20 graduate students and post-doctoral fellows. She serves as Vice President for Research and Development of Bar-Ilan University (in charge of Technology Transfer).

Among many other distinctions, she is the director of the Emmy Noether Research Institute for Mathematics and she is a member of the Board of the Wolf Foundation. In the years 2001–2004, she served in the Executive Committee of the European Mathematical society. From this year on, she is the chairman of the EMS Education Committee.

ICMI Study 16

Challenging Mathematics in and beyond the Classroom

Edited by Mariolina Bartolini Bussi (Modena, Italy), member of the IPC

From time to time the ICMI (International Commission of Mathematical Instruction) mounts studies to investigate in depth and detail particular fields of interest in mathematics education. A Discussion Document was prepared by the IPC (International Program Committee), appointed by the ICMI and chaired by Edward J. Barbeau (Canada) and Peter J. Taylor (Australia). The first IPC meeting took place in Modena at the end of 2003, at the Department of Mathematics of the University of Modena-Reggio Emilia. The convenor of the IPC meeting was the author of this short paper and the activity took place in the Laboratory of Mathematical Machines (Modena), a place where challenging mathematics is at home!

The work of this Study will take place in two parts. The first consists of a Conference (by invitation) to take place in Trondheim, Norway, from 27 June to 03 July 2006. The second part of the Study is a publication that will appear in the ICMI Study Series. The IPC hereby invites individuals or groups to submit contributions (deadline: August 31, 2005) on specific questions, problems or issues related to the theme of the Study for consideration by the Committee. Those who would like to participate should read the complete Discussion Document, available (in English, Spanish and French) at the official website of the Study: http://www.amt.edu.au/icmis16.html. Inquiries on all aspects of the Study, suggestions concerning the content of the Study Conference and submission of contributions should be sent to both co-chairs:

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In the following, I summarize the Discussion Document.

Introduction

What is a mathematical challenge? This question is regarded as fundamental to the Study. The IPC offers a number of definitions, but one answer is that a challenge occurs when people are faced with a problem whose resolution is not apparent and for which there seems to be no standard method of solution. So people are required to engage in some kind of reflection and analysis of the situation, possibly putting together diverse factors. Those meeting challenges have to take initiative and respond to unforeseen eventualities with flexibility and imagination.

Mathematics can challenge students both inside and outside the classroom. Learning takes place in many contexts. Mathematical circles, clubs, contests, exhibits, recreational materials, or simply conversations with peers can offer opportunities for students to meet challenging situations. It is our responsibility to provide these situations to students, so that they are exposed to challenges both in the classroom and beyond.

In this endeavour, the role of the teacher is critical. It is the teacher who is faced with the difficult task of keeping alive in the classroom the spontaneity and creativity students may exhibit outside the classroom.

The support of the general public is likewise critical. Since children are products of their entire social environment, they need the support of the adults around them in acquiring an understanding and appreciation of mathematics. And, in supporting the new generation, the engagement of citizens in mathematics will open new opportunities for their own personal growth and the public good.

Challenging situations provide an opportunity to do mathematics, and to think mathematically. Some are similar to the activities of professional mathematicians. These include: solving non-routine problems, posing problems, working on problems without achieving a complete solution, individual investigations, collaborative investigations in teams, projects, historical investigations, organizing whole-class discussions searching ways to solve a problem, a puzzle or a sophism.

Other challenges are less like formal mathematics. These attract in a different way, leading into mathematics from other contexts. Some of these are: games, puzzles, construction of models, manipulation of hands-on devices.

Still other challenges connect mathematics with other fields. Some examples are: mathematics and other sciences, mathematics and the humanities, mathematics and the arts, real-world problems.

Challenges can be found in a variety of venues and vehicles, including: classrooms, competitions, mathematics clubs, circles or houses, independent studies, expository lectures, books, papers, journals, web sites, science centres, exhibits, festivals, mathematics days, mathematics camps.

Instances

In the Discussion Document various instances of challenge are discussed. A short summary follows.

Competitions:

There are many well-known competitions such as the International Mathematical Olympiad (IMO) and Le Kangourou des Mathématiques. The former involves small groups of students from many countries (an example of an exclusive competition) while the latter involves thousands of students in France and Europe (an example of an inclusive competition). Other instances are Euromath (a European cup of mathematics) and KappAbel (a Nordic competition) where teamwork is fostered.

Classroom problem solving:

Teachers may use problem solving to develop the students' ideas, knowledge and understanding of curriculum material. This approach can reflect the creative nature of mathematics and give students some feel for the way that research mathematicians develop mathematics. Problem solving may be viewed as either an individual or a collective activity, the latter being developed in classroom discussion.

Exhibition and math centres:

Some science centres have mathematical experiments, but there are also science centres devoted exclusively to mathematics, for instance the *Mathematikum* in Germany or *Giardino di Archimede* in Italy. There are also annual exhibitions, varying in content from year to year (e.g. *Le Salon de la Culture Mathématiques et des Jeux* in Paris). There are also occasional exhibitions, such as the international exhibition Experiencing Mathematics sponsored by UNESCO and ICMI jointly with other bodies. Exhibitions can have a special theme, such as the one at the University of Modena and Reggio Emilia featuring *mathematical machines*.

Publications:

There are many examples around the world of journals designed to stimulate student interest in mathematics. These journals contain historical articles, articles exposing issues with current research, such as the four colour theorem and Fermat's Last Theorem, and Problem corners, where new problems are posed, other current problems from Olympiads are discussed and students may submit their own solutions. There are many publications that enrich and challenge the student's interest in mathematics. In the English language, the Mathematical Association of America has a massive catalogue and the Australian Mathematics Trust has a significant number of publications. In Russian there is also a very rich resource, traditionally published through Mir. In the French language, the Kangourou and other publishers have a prodigious catalogue, as does the Chiu Chang Mathematics Education Foundation in the Chinese language. There are a number of examples in which people can join a classroom by Internet.

"Mathematics assemblies":

These activities are aimed at groups of people who generally assemble together in one place to be educated by an expert or group of experts (e.g. mathematics clubs, mathematics days, summer schools, master classes, mathematics camps, mathematics festivals).

Trends and problems identified

It seems that, with few exceptions, the overall trends are positive. Yet there are still some difficulties that fall into two categories: development and applications (in school). In the former category, most new initiatives depend on a small number of people for their success. This makes them fragile. Moreover, it is not clear that much of the new material available is being used successfully by great numbers of teachers in the regular classroom. This may be for a variety of reasons. First, teachers are frequently plagued with time constraints as more material, especially involving new subjects outside of mathematics, enters the school curriculum. These subjects reduce the time available for mathematics. Second, especially in senior secondary school, high stakes examinations force teachers into teaching for the examination rather than developing mathematical ideas. And third, teachers may lack the confidence to deal with the new material that was not part of their undergraduate training. They may also be uncomfortable with the more open pedagogy required for challenging situations which are, by their nature, less structured than the traditional pedagogy.

Questions Arising

One goal for the Study Conference will be to get a good picture of what is state of the art. Here are some examples of issues that may be considered in the context of this Study.

Impact of teaching and learning in the classroom:

- How do challenges contribute to the learning process?
- How can challenges be used in the classroom?
- How much challenge is provided in current curricula?
- What further opportunities to challenge would enhance teaching and learning in the regular classroom?
- How can teachers be made aware of the existence of the different types of challenges?
- How can we ensure that these challenges are compatible with the mandated syllabus?
- How can time constraints in the classroom be handled?
- How can challenges be evaluated?
- How can students be evaluated in challenges?
- How can the effectiveness of using challenging materials be supported by the grading system?

– What sorts of challenges are appropriate for remedial and struggling students?
– What are the implications for teacher training of challenges which are in the classroom?
– What are the implications for teacher training of challenges which exist outside of the classroom?
– What background do students need to handle challenging material and how can this be introduced into the classroom? This includes familiarity with mathematical notation and conventions, ability to reason and draw conclusions, ability to observe and classify, and skill at communication.
– How can "beyond classroom activities" like competitions, exhibitions, clubs, maths fairs etc influence the classroom activities and learning in such a way that all students in the class are challenged and motivated?
– How can teachers, parents and students be made aware that these kinds of activities and challenges will also strengthen the learning and understanding of basic concepts and skills in mathematics?
– Can experience with competitions, maths fairs etc be part of teacher training and in service teacher education? And will this help to engage teachers in "beyond classroom activities" or implement these kinds of activities in classroom practice?
– How can textbooks be written so that challenging activities is the philosophy and leading idea behind the textbook, and not only a fragmental part of the content of the book?
– How can teachers and students use technology to create challenging environments?

Beyond classroom activities

- What is the effect on the visitors of exhibitions, festivals etc., where they have only a short meeting with mathematical challenges? How can parents, teachers, students and others be helped to go deeper into the mathematics beyond these short meetings?
- How can one make visible the mathematics behind everyday technological devices, and how can this be put into a context that is accessible and mathematically challenging for different groups of people?

Research

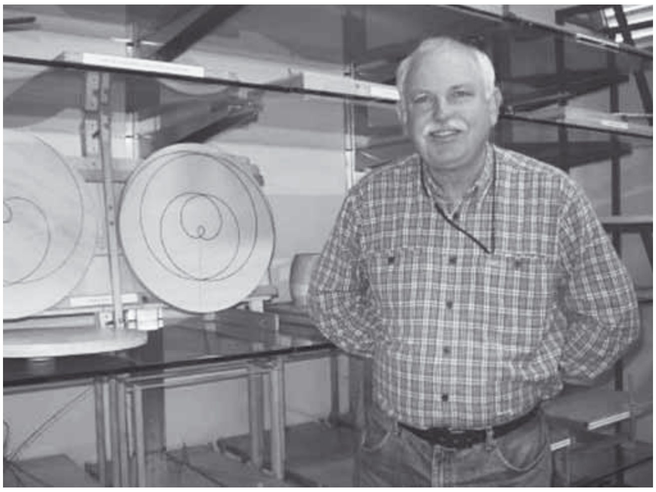
- What research has been done to evaluate the role of challenges?
- What can research into the use of challenges tell us about the teaching and learning of mathematics?
- What questions require further research?

More general questions

- How can the mathematics and mathematics education community be involved in this kind of challenging activity that goes beyond their own research interests?
- Are there some branches of mathematics that are more suitable for producing challenging problems and situations?
- How can different designs of challenging activities, in particular competitions, attract different groups of people (ability, gender, cultural differences, different achievement etc)?
- What can be done to identify, stimulate and encourage the mathematically talented students?
- These questions try to ask how challenges improve the learning process and identify difficulties and issues in the provision of challenge.

As shown above, the study has the potential to attract both mathematicians and mathematics educators. Interested people are invited to read carefully the Discussion Document at the official website of the Study: http://www.amt.edu.au/icmis16.html. See you in Trondheim.

Mariolina Bartolini Bussi is the Newsletter editor within Mathematics Education. A short biography can be found in this issue on page 4.



Chairs Ed Barbeau and Peter Taylor in front of mathematical machines at Modena

Mathematical Visualization

Maciej Klimek and Grażyna Klimek (Uppsala, Sweden)

Introduction

According to the Oxford English Dictionary to visualize means to make visible to the mind or imagination, to make visible to the eye, to render visible. The sense of vision, in terms of evolutionary development, is among the oldest and best developed senses. Mathematics, in historical terms, is one of the oldest and highest developed forms of manifestation of human intellect. Both have been instrumental to the success of our species. The main objective of mathematical visualization is to explore the fascinating area where the two domains of human existence meet.

This article is a result of the cooperation of a mathematician (Maciej Klimek) and an artist (Grażyna Klimek), and was partly inspired by earlier joint work on a book [6] on mathematical graphics. One of the goals of this paper is to explain the fundamentals of mathematical visualization and its relevance to mathematics and science in general. But primarily, we want to show that even elementary mathematical objects possess an extraordinary beauty that deserves to be revealed to a wider audience. Ultimately, our motivation for this work comes from the shared belief that to discover or create beauty – whether in science or in art – is one of the most profound experiences in human life.

The images in Section 6 constitute a small sample of artistic graphics designed by Grażyna Klimek[1]. The images should be regarded as snapshots of three dimensional virtual sculptures created with the help of mathematical functions. One could say that the images and the accompanying formulas represent a new breed of conceptual art. On the one hand, much in the spirit of Marcel Duchamp and his artistic descendants, it is a dematerialized art, not committed to any long lasting materials. Instead, it exists in the virtual world of mathematical formulas. Furthermore, the visually seductive ingredient is limited to one two dimensional image of each of the three dimensional objects. Since the formulas defining the shape of these objects are revealed, the mathematically and computer literate spectator is encouraged to participate in the creative process by examining, manipulating and modifying the shapes at will. However, in sharp contrast to many creations of conceptual artists, the aesthetic aspect is in the forefront.

In many ways research in pure mathematics can also be regarded as a very extreme realization of conceptual art. It is all about ideas that are free from the restrains of the physical world. It expands the boundaries of human imagination and relishes challenging our common sense. Its material products are largely limited to means of information storage. Moreover, just as in more orthodox conceptual art, visual manifestations of pure mathematics are either non-existent or minimalistic and deemed to be of no consequence. In fact, just like art, pure mathematics is prone to fashions and trends based on subjective choice. This subjective element rapidly fades and disappears as creations of pure mathematics enter the world of applicable or applied mathematics and become part of science. Both pure and applied mathematics use the same rigorous rules of reasoning, but the most crucial difference lies in the criteria of importance. In pure mathematics, its creators – influenced by tradition and current tendencies – decide what is important. In applied mathematics it is the natural world that provides, often via other sciences, the ultimate criteria of importance.

All this enriches mathematics as a whole, but it also shows that visualization of mathematics can have neither a single meaning nor a single objective. It has to encompass a wide range of endeavours, from sophisticated art and research oriented imaging to educational illustrations and simple graphs. Consequently, a short article can address only a few general themes. This particular presentation is intended for a general but scientifically inclined readership. Those interested in more technical aspects of mathematical visualization are referred to e.g. [1].

The authors wish to thank the Mathematics Department of the Jagiellonian University, Kraków, Poland, for the hospitality and interest in their work.

Overview of visual perception

The effective use of mathematical visualization does not require too much information about the mechanisms of visual perception but nevertheless it is helpful to be aware of the fundamentals. Our present knowledge of the way we see has evolved only within the past three decades. Until the mid 1970s, a very simple model, which separated sensing from understanding, was commonly used. According to this model, an image was projected onto the retina of the eye and then the retinal impression of the image was transmitted to a part of the brain called the visual cortex, where the image was decoded and analyzed, allowing a person to comprehend what was being seen. Sensing was regarded as a passive process in contrast to understanding. The latter was seen as an active analytical task based on association with images experienced previously. More recent discoveries in neurobiology have dramatically altered this view.

The main conceptual change can be best expressed in the words of leading researchers in the field. According to the neurobiologist Semir Zeki of University College London "Interpretation is an inextricable part of sensation. To obtain its knowledge of what is visible, the brain cannot [...] merely analyze the images presented to the retina; it must actively construct a visual world" (see [13]). Nobel laureate Francis Clark adds that "there is not one place where you have [perception], right at the top of the visual system" (see [2]).

Recent discoveries have demonstrated the existence of functional and anatomical specialization in the visual cortex. Various attributes of the visible environment – like colour, form, motion, line orientation – are processed separately in different but interconnected areas of the brain. Other cortical areas are responsible for dispatching different signals to the appropriate destinations for further analysis. Lesions in specific areas of the visual cortex cause specific visual syndromes. For example, if the area selective for colour is damaged, the result is achromatopsia. A lesion in the area analyzing motion results in akinetopsia.

An impressive example of the flexibility of the human vision system is the ability to perceive colours accurately under different illumination conditions. This phenomenon is known as colour constancy. It can be contrasted with what we observe in colour photography, where by changing the illumination we change the colour temperature of the scene and hence affect the resulting colours on the photographs. The best known account and explanation of colour constancy in human perception is due to the inventor of the Polaroid camera and physicist Edwin H. Land. He discovered that the perceived colour does not depend on the relative amounts of blue, green and red light entering the eye, and in his *retinex theory* he proposed a model of the image forming mechanisms.

Unfortunately, there are limits to this marvelous complexity and adaptability of our visual system and occasionally it fails to be accurate. This is the reason for various types of visual illusions. A gray piece of paper placed on a black background looks whiter than before. Certain configurations of converging, parallel and diverging straight lines disturb our perception of distance, because of our natural sense of perspective. Perhaps the most interesting illusions are related to the so called *bistable percepts*, that is, images that produce two distinct perceptions alternating involuntarily in our mind. The figure below shows an example of such ambiguity. We either see a vase or two symmetrical profiles of human faces.

Figure 1. A bistable percept

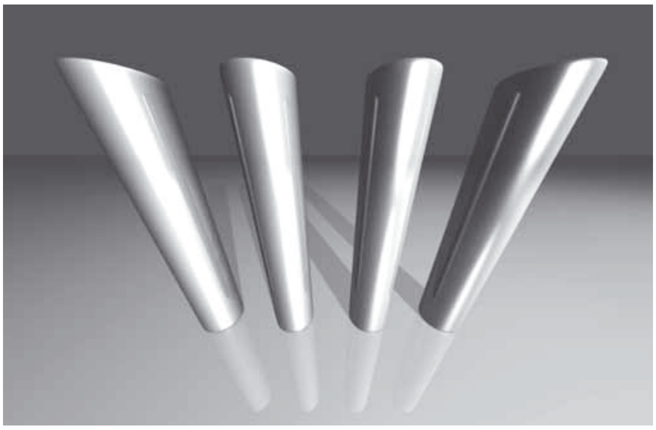


Figure 2. Leonardo's paradox

Problems with visualization

The prerequisite of successful visualization of any kind – artistic or utilitarian – is the creation of a virtual viewing environment consistent with the demands of human vision.

Suppose now, for simplicity, that we already have a mathematically described object that can be regarded as a subset of the three dimensional space $\mathbb{R}^3$. There are four main factors affecting the outcome of the visualization:
– perspective;
– lighting;
– colour;
– texture.

A gentle introduction to the first three items has been given in [6]. Here we will just reiterate the basics and add a comment about the use of textures.

A rigorous study shows consistent use of perspective in art dates back to the Renaissance period. Earlier drawings and paintings often appear hopelessly clumsy in this respect. Lack of correct perspective projection is particularly striking in images of architectural objects, interiors and furniture. Renaissance artists and architects succeeded in working out the details of the perspective projection from both the mathematical and the practical point of view. The basic idea can be easily described in the language of geometry. First we fix the *station point*, i.e., the point in $\mathbb{R}^3$ from which the object is to be viewed. Then we fix the *picture plane* on which the perspective image of our object is to be produced. The choices are made so that no line passing through the station point and a point belonging to the object we want to draw is parallel to the picture plane. The line orthogonal to the picture plane and passing through the station point is called the *center line of vision*. Then the perspective projection of a point from the object is the intersection of the line passing through this point and the station point with the picture plane. One important practical restriction concerns the assumed size of the *cone of vision*, i.e., a circular cone with vertex at the station point and the center line of vision as its axis of symmetry. We choose the size of the cone by choosing the *angle of vision* and agreeing that the produced picture should fit into the intersection of the cone of vision and the picture plane. In terms of the final image, the role played by the angle of vision can be best explained by analogy to photography. A narrow angle of vision suppresses perspective, rather like a telephoto lens. A wide angle of vision corresponds to wide angle lenses and exaggerated perspective. If the angle is too wide, we see a type of distortion discovered by Leonardo Da Vinci and known as Leonardo's paradox. A wide-angle perspective projection of a row of four parallel circular columns, shown in Figure 2, illustrates this phenomenon.

Proper lighting is another prerequisite of a good visual representation of any object. Of course, we refer to virtual lights supplied courtesy of computer software (which also has to support shadows). Again, the best way to describe the requirements is to use a comparison to a photographic studio. Ideally, one wants to have three types of light. First of all, one needs an ambient light providing a non-directional diffuse light, which is soft and shadowless. Then, two or more directional lights are needed. They act like photographic reflectors, giving strong parallel beams of light. Finally, a weaker directional light might be needed to reduce or eliminate unwanted shadows in cavities of the object. If the reader has doubts about the importance of proper lighting, it is worth remembering how bad passport photographs from an automatic photo-booth can be.

The use of colour and texture can very much enhance or destroy the final result or can make some important features of the object we draw almost invisible. Here however, there are no simple rules one could follow. Experimentation is often necessary. It is useful to know that attributing mathematical meaning to colour has to be done very carefully. If the plotted object is very complicated, colouring may totally obscure its true shape.

Finally, additional problems may sometimes occur due to hidden constrains of our visual system, or more precisely, due to spatial ambiguity of the object we want to observe. This is particularly true if we have no idea what the visualized object should look like. For example, an infinite variety of three-dimensional objects can have the same two-dimensional perspective projection (on a fixed picture plane and with a fixed station point). Furthermore, we can experience a bistable percept. Luckily, both problems can be solved, at least partly, by careful use of lighting combined with changing of the perspective projection.

Geometrization vs. visualization

It is important to make a distinction between visualization and geometrization in mathematics. Briefly, geometrization aims at reinterpreting existing mathematics or explaining newly created mathematics in geometric terms. The meaning of the word *geometric*, is constantly evolving. More often than not it has very little to do with objects that potentially could be visualized. For example, the theory of Hilbert spaces provides a powerful generalization of the three dimensional Euclidean geometry to vector spaces of arbitrary dimension. Consequently, it is fully justifiable to use the term *geometric* in conjunction with anything based on the theory of Hilbert spaces.

And yet, even in Euclidean spaces of dimension higher than three, our visual intuition fails miserably. To see this, consider the following example in $\mathbb{R}^n$ furnished with the usual Euclidean distance. In the cube $Q \subset \mathbb{R}^n$ centered at the origin and with vertices at $(\pm 2, \pm 2, \dots, \pm 2)$ inscribe 2^n balls with radius 1 centered at $(\pm 1, \pm 1, \dots, \pm 1)$. Construct the ball B which has its center at the origin, lies outside the other balls and is tangent to each of them. At this stage one could ask if $B \subset Q$? If we draw a picture in $\mathbb{R}^2$ and in $\mathbb{R}^3$ the answer is a resounding yes. But in fact, our ability to visualize the situation in dimensions two and three is misleading. The answer is affirmative only if the dimension n is not greater than nine. This is so for the very simple reason that the radius of B is $\sqrt{n} - 1$.

The descriptive language of functions

During the twentieth century the abstract concept of a function, defined on a set and with values in another set, has migrated, albeit very reluctantly, from the realm of pure mathematics to science, engineering and, to a limited extent, school education. And yet, despite its extraordinary universality the concept remains conspicuously absent in natural everyday languages. Without much exaggeration one could speculate that this very fact maybe the main stumbling block to efficient communication of mathematical ideas between mathematicians, scientists, engineers and the general public. In particular, it causes the popularization of mathematics to often be reduced to rather simple stories about very basic geometry and properties of numbers. Sadly, the overwhelming tendency in education is to perpetuate this situation by putting too much faith in overly egalitarian pedagogical ideas, often hostile towards anything even remotely related to abstract thinking.

What is the relevance of these comments to the problem in hand, that is, to mathematical visualization? The answer is simple. The concept of a function provides by far the most efficient tool for describing, transforming and organizing data of any kind: from shape, colour, movement to practically any sort of signals around us – analogue or digital, artificial or occurring in nature.

The simplest definition of a function can be stated as follows. Let A and B be non-empty sets of objects. Any rule f which assigns to each element x of the set A exactly one element, denoted as $f(x)$, from the set B is said to be a *function* (from A to B). It is customary to denote such a function with the help of the arrow notation: $f : A \longrightarrow B$. The set A is referred to as the *domain* of f. The *range* of f is defined to be the set of all elements of B of the form $f(x)$, where x belongs to A. We can also say that the range of f is the set of data items, access to which can be gained by applying f to the addresses from A. The *graph* of f is defined as the set of all pairs of the form $(x, f(x))$, where x varies over the set A.

There are two basic ways of looking at functions in general. The first view would be to regard B as a set of data items and A as a set of addresses of at least some of these data items. The function f can be then regarded as a rule indicating how to get from an address to a corresponding data item. With this interpretation in mind we can see functions as means of organization, description or storage of data. For instance, a rectangular matrix (a_{ij}), with m rows and n columns, can be seen as a function that associates to any pair of indices (i, j) the object a_{ij} at the intersection of the i-th row and the j-th column.

In general, the descriptive role of $f : A \longrightarrow B$ is particularly clear if the function f is *one-to-one*, that is, if different addresses lead to different destinations in the range of f. In this case we say that the function provides a *parameterization* of its range. In the context of geometry we parameterize curves, surfaces and more general objects e.g. colour.

The second natural interpretation of functions is to regard them as recipes for transformation of data. This time, we have two sets of data A and B. If $b = f(a)$, then the function f tells us how to modify a to obtain b. In this context a is the input of f that produces the output b. This role of functions is apparent in geometry, where we use rotations, translations, symmetries, projections etc.

Modulation of shapes

The fact that elementary analytic functions can be used to generate surprisingly complicated geometric phenomena has been known for some time, mainly due to the rapid development of the theory of fractals (see e.g. [12], [3] or [5]; for constructions of some less common types of fractal sets see also [8], [9] and [10]). Many well known fractal sets are results of an iteration of a finite family of functions. Infinite repetition of a simple formula may lead to a very complicated geometric object often displaying self-similarity, i.e., similar features at different levels of magnification. This process can be partly reversed. Given a geometric object, possibly a shape sampled from nature, one can find a family of functions that through iteration approximates the given object. Such families are called iteration function systems. The fact that they have been successfully used in the compression of images is a testimony to their efficiency.

Another popular method of modeling the existing shapes is based on splines. Let us say that we want to have a mathematical description of a surface. The surface is sampled at a large number of points and then interpolated by a new surface created from a large number of patches parameterized by polynomials. The patches are glued together so that the newly created surface is smooth, resembles the old one and passes through all the given sample points.

Iterated function systems, splines and other modeling methods have one characteristic feature in common. The object we model is decomposed into a large number of simpler components and the formulas for the approximating functions are derived from properties of these components. One could say that the functions used in these methods are irrelevant and invisible as individual functions in the sense that the visual output is totally dictated by the object being modeled. Typically, such functions themselves may be extremely simple and all of the same type, e.g., affine functions or cubic polynomials. Not so dissimilar statements can be made about two other methods of shape modeling: Fourier series and wavelet expansions. This time scaled version of one or several basic functions is added up into an infinite series. If a partial sum of such a series has sufficiently many terms, it offers an acceptable approximation of the target surface.

The approach to construction of surfaces presented below is in a way the opposite. A few elementary analytic functions are made to interact, or modulate one another, in order to generate complicated shapes. In contrast to what has been said about other methods – as the motivation is aesthetic rather than utilitarian – the nature of these functions is allowed to shine through. The results are often surprisingly complex and at the same time flexible. The latter becomes clear when one looks at the more realistic pictures created with this method.

The general idea is somewhat similar to the use of frequency modulation (FM) in sound synthesis. The frequency modulation technique is well understood in relation to radio transmission. It was developed in the early 1930s by an American engineer Edwin H. Armstrong to reduce noise and interference affecting radio reception. In a nutshell, the frequency of a carrier wave of constant amplitude is altered in accordance with an audio signal being sent. The frequency of the carrier is thousands of times higher than the frequency of the modulating sound signal. In the 1970s, John Chowning [4] discovered that if both the carrier frequency and the modulating frequency are in the audio band, the method can be successfully used in sound synthesis. It allowed generation of very complex audio spectra with unexpectedly simple means.

By analogy, the method that follows can be seen as shape modulation. It involves just a few basic ingredients. The initial shape that is to be modulated (or sculpted) and the final shape (or the modified version of the initial shape) can both be parameterized by vector-valued functions

$$\mathbf{S}_{\text{init}} : \mathbf{D}_{\text{init}} \longrightarrow \mathbb{R}^3, \qquad \mathbf{S}_{\text{final}} : \mathbf{D}_{\text{final}} \longrightarrow \mathbb{R}^3,$$

where $\mathbf{D}_{\text{init}}$ and $\mathbf{D}_{\text{final}}$ are parameter domains in $\mathbb{R}^2$. The first of the two parameterizations is the starting point, the second one is the objective of the design process. Two additional vector-valued functions

$$\mathbf{M}_{3\text{D}} : \mathbb{R}^5 \longrightarrow \mathbb{R}^3, \qquad \mathbf{M}_{2\text{D}} : \mathbf{D}_{\text{final}} \longrightarrow \mathbf{D}_{\text{init}},$$

provide – respectively – the magnitude modulation and the parameter modulation. The mapping $\mathbf{M}_{3D}$ can be interpreted as a family of geometric transformations of $\mathbb{R}^3$ given by the formula

$$(x,y,z) \mapsto \mathbf{M}_{3D}(u,v,x,y,z)$$

and depending on the control parameters u and v.

The above ingredients are combined into a formula used to form the parameterization of the final surface

$$\mathbf{S}_{\text{final}}(u,v) = \mathbf{M}_{3\text{D}}\left(u,v,\mathbf{S}_{\text{init}}\left(\mathbf{M}_{2\text{D}}(u,v)\right)\right),$$

where $(u,v) \in \mathbf{D}_{\text{final}}$.

The main point is that the component functions, although sometimes quite complicated, are obtained from standard elementary functions in a very direct way.

The following description of three images provides a more practical illustration of shape modulation. All the surfaces used in the composition of these images (with the exception of the background planes) have been generated with the help of sums, products and compositions of trigonometric, exponential and polynomial functions. Furthermore, the surfaces we are going to look at are all ranges of functions of two real variables with values in the three-dimensional space $\mathbb{R}^3$. Of course, we cannot see the graphs of these functions, as they reside in the five-dimensional space $\mathbb{R}^5$.

The first image (see Figure 3) is basically an abstract design, but it is easy to see that the surface shown here resembles a four-legged spider.

Despite the complexity of the shape of the surface, the spider is represented by a relatively simple parameterization:

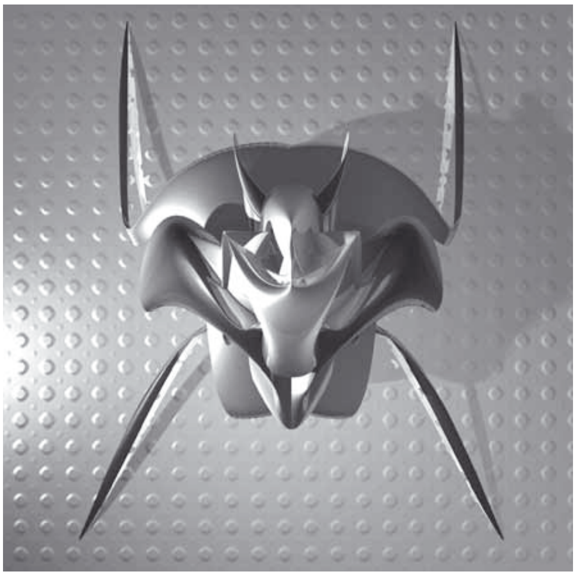


Figure 3. A virtual spider

$$x(u,v) = \big(u\cos(2v) + v\sin(uv)\cos(uv) + \sin u \cos v\big)\exp\big(0.1(u^2+v^2)\big),$$
$$y(u,v) = \big(v\cos(2u) + \sin(uv) - \sin v\big)\exp\big(0.1(u^2+v^2)\big),$$
$$z(u,v) = 2\exp\big(0.1(u^2+v^2)\big),$$

where $-\pi \le u \le \pi, -\pi \le v \le \pi$.

The next image (see Figure 4) is somewhat less abstract – it shows a carnival mask of a human face. Define

$$G_{h,a_1,a_2,b_1,b_2}(u,v) = h\exp\big(-(u-b_1)^2/a_1 - (v-b_2)^2/a_2\big),$$

where $u, v, h, a_1, a_2, b_1, b_2 \in \mathbb{R}$. This is simply a two-dimensional Gaussian bump whose height, position and shape are controlled by the parameters h, a_1, a_2, b_1, b_2. The "flattened face" is the graph of the sum of 10 such Gaussian bumps:

$$\begin{aligned} f(u,v) = {} & G_{.125,.84,.34,0,-.5}(u,v) + G_{.1,.02,.01,-.4,-.1}(u,v) + \\ & + G_{-.6,.03,.001,-.4,-.1}(u,v) + G_{.1,.02,.01,.4,-.1}(u,v) + G_{-.6,.03,.001,.4,-.1}(u,v) \\ & + G_{.2,.007,.04,0,.2}(u,v) + G_{.2,.04,.007,0,.3}(u,v) + G_{-.5,.05,.002,0,.6}(u,v) \\ & + G_{.25,.03,.01,0,.6}(u,v) + G_{.1,.6,.01,0,1}(u,v). \end{aligned}$$

Figure 4. Silver mask

Figure 5. Five wine glasses

The first term models the forhead, the 2nd and 3rd term correspond to the right eye, the 4th and 5th to the left eye, the 6th and 7th to the nose, the 8th and 9th to the lips and the last one to the chin. To obtain a parameterization of the mask we modulate the radius of a sphere:

$$x(u,v) = \cos u \cos v\big(1 + f(u,v)\big)(1 - .12\sin v),$$
$$y(u,v) = \sin u \cos v\big(1 + f(u,v)\big)(1 - .12\sin v),$$
$$z(u,v) = 1.25\sin v * \big(1 + f(u,v)\big),$$

where $-1.1 \le u \le 1.1,\ -Pi/2 \le v \le Pi/2$.

The third image (Figure 5) shows five wine glasses. We will list here the parameterization of one of them – the one which is not a solid of revolution. We need three auxiliary functions

$$A(u) = (1 + 1.1\sin^2 u)(1 + 1.1\cos^2 u),$$
$$B(v) = (1 + 3\sin^2 v) - .87\cos v + .3\sin(3v),$$
$$C(v) = \big(\sin(v + .5) + \cos v\big)\big(1 + \sin(v^3\cos v)\sin(v + 2.09)\big)(1 + \sin^3 v).$$

The parameterization of the glass is then given by the formula

$$x(u,v) = A(u)B(v)\cos u \cos v,$$
$$y(u,v) = A(u)B(v)\sin u \cos v,$$
$$z(u,v) = 7C(v),$$

where $-\pi \le u \le \pi,\ -\pi/2 \le v \le \pi/2$.

Obviously, for the design of the actual pictures, the surfaces have to be translated and/or rotated.

Closing remarks

The utilitarian aims and realizations of visualization of mathematics are often met with criticism and sometimes disapproval verging on hostility. The critics claim that visualization of mathematics is only useful as a help in education and perhaps also as an advertisement, and hence should not be of primary concern. An obvious retort would be to say that dwindling student numbers among those interested in abstract mathematics and science in general, should make education a problem of paramount importance. Furthermore, the world of education, and in particular university education, increasingly resembles a market place in which not only the goods but also advertising make the difference between success and failure. Consequently, advertising and popularization of mathematics and science should be treated very seriously.

It is also said that to visualize or concretize mathematics in any other way misses the whole point: after all, mathematics is to serve as a probe into the unknown and provide guidance, when direct comprehension is difficult or impossible. Sometimes it is claimed that concrete models rob mathematics of its generality and thus of its power. Although some aspects of these statements could be justified, it is not difficult to show the basic fallacy of such arguments.

First and foremost, the better we understand and interpret what we already know, the better we can move forward with research. Needham's book [11] can serve as a very impressive example of this role of visualization of mathematics. What is often overlooked is that for the vast majority of people a good visual interpretation can enhance understanding and does not have to affect the degree of generality of whatever one is studying. We use symbolic languages because they offer superior control over the flow of information. But our brains can analyze visual input of immense complexity, far greater than that of anything that can be expressed in terms of a symbolic language. So there is no rational reason against relying on both verbal and non-verbal channels of communication. Secondly, through visualization, we can gain a sense of direction facilitating our exploration of the unknown.

The aesthetic and artistic aspects of the visualization of mathematics have not come under much scrutiny yet, simply because they represent a relatively new area of mathematics related activity. One thing is certain however: mathematical visualization can reveal and make tangible the intricate beauty of mathematical objects. And even if this was the only reason for trying to make mathematical creations visible to the eye, it would be a very worthwhile pursuit indeed.

Note

1. See [7] for more examples of mathematically designed art.

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[11] T. Needham, *Visual Complex Analysis*, Oxford University Press, Oxford 1997.

[12] H.-O. Peitgen and D. Saupe (Eds.) *The Science of Fractal Images*, Springer-Verlag, New York 1988.

[13] S. Zeki, *The Visual Image in Mind and Brain*, Scientific American, September 1992, 43–50.

Maciej Klimek [maciej.klimek@math.uu.se] is a professor of mathematics at Uppsala University in Sweden. He obtained his Ph.D. in 1981 at the Jagiellonian University in Kraków, Poland, and prior to moving to Sweden had worked for many years in Ireland, first at Trinity College Dublin and then at the University College Dublin. Much of his research has been focused on properties of plurisubharmonic functions and in 1991 he wrote a successful monograph on this subject for the Oxford University Press. For the last few years his research has included mathematical modeling in business, economics and finance.

Grażyna Klimek [gklimek@telia.com] is an author and a computer graphics artist based in Uppsala, Sweden. Her graphics have been shown in USA, Japan, Sweden, Poland and Canada. The graphics – whether abstract or utilitarian (like a music CD cover) – are all composed around mathematically generated surfaces she designs herself. In 1997, she wrote a book for Springer-Verlag in New York, jointly with Maciej Klimek, on graphical capabilities of the computer algebra system MAPLE.

Felix Hausdorff and the *Hausdorff edition**

Erhard Scholz (Wuppertal, Germany)

Figure 1. Felix Hausdorff

Hausdorff and Mongré

Felix Hausdorff (b. November 8, 1868, at Breslau, d. January 26, 1942, Bonn) studied mathematics at Leipzig, Freiburg and Berlin between 1887 and 1891 (dissertation). He started research in applied mathematics related to the work of his teacher, the astronomer H. Bruns.[1] After his habilitation in 1895, he taught at Leipzig university and a local commercial school. He moved in a milieu of Leipzig intellectuals and artists, strongly influenced by the early work of F. Nietzsche, striving for a cultural modernization of late 19th century Germany.

Between 1897 and 1904, with some additional later contributions, Hausdorff published two philosophical books, a poem collection, and a satirical theatre play under the pseudonym *Paul Mongré*. The play ridiculed the honour codex of late 19th century German *Bildungsbürger* adapting to the values of the Wilhelminean officer corps. At the time it was quite successful. It had about 300 performances between 1904 and 1930 in about 40 towns, among them Berlin, Budapest, Prag, Strassburg, Wien, and Zürich.[2] Moreover, Mongré regularly contributed cultural critical essays to the *Neue Deutsche Rundschau*, a leading intellectual journal.[3] In his second book, *The Chaos in Cosmic Selection* (Hausdorff 1898), he critically decomposed metaphysical remnants in contemporary concepts of space and time. He combined Niezschean and Kantian views and enriched them with mathematical arguments in terms of Cantorian set theory and stepwise generalized transformations, comparable to F. Klein's approach in the *Erlanger Programm*. In Hausdorff's perspective, the generalization of transformations from Euclidean via differentiable and continuous to any point transformation would lead to a general transfinite set as symbol for some structureless fictitious "absolute". The progression of "absolute" or "transcendent" time might then be perceived as *any* order structure on the set of the "transcendent" world content, without any perceivable relation to the order of the empirical or phenomenological time ordering. That served Mongré as an argument that "the absolute" has to be considered as essentially void of objective meaning. He thus proudly proclaimed the "end of metaphysics".[4]

During this period, Hausdorff reoriented his mathematical work towards the new field of transfinite set theory. He gave one of the first lecture courses on the topic in the summer of 1901 and contributed important results, among others the *Hausdorff recursion* for aleph exponentiation and deep methods for the classification of order structures (confinality, gap types, general ordered products, and η_α sets).[5] Hausdorff considered the contemporary attempts to secure axiomatic foundations for set theory as premature. Working on the basis of a "naive" concept of set (expressedly understood as a semiotic tool of thought), he nevertheless achieved an exceptionally high precision of argumentation. Although his set theoretical studies prior to 1910 concentrated on order structures (remember that his earliest interest in transfinite set theory was triggered by the tremendous amount of possible different modes of progression of a fictitious "transcendent time point" in a transfinite set), he contributed crucial insights in foundational questions. Most important were his *maximal chain principle* (related to Zorn's lemma, but different from it), a characterization of *weakly inaccessible cardinals* (in present terminology) and the *universality property* for order structures of what he called "η_α sets". The latter became one of the roots of "saturated structures" in model theory of the 1960s. Moreover, Hausdorff hit upon the importance of the *generalized continuum hypothesis* in his studies of $\eta_\alpha$sets.[6]

The *"Grundzüge"*

In 1910, Hausdorff started teaching at Bonn university as "extraordinarius" (associate professor) and broadened his perspective on set theory as a general symbolical basis for mathematics. In early 1912 he found a beautiful axiomatic characterization of topological spaces by neighbourhood systems and started to compose a monograph on "basic features of set theory" (*Grundzüge der Mengenlehre*). It was finished two years later, after he had moved to Greifswald university in 1913 on a call to an "ordinary" (full) professorship, and became his *opus magnum* (Hausdorff 1914*b*)[7].

In this book, Hausdorff showed how set theory could be used more broadly as a working frame for mathematics. It contained three parts, (I) *general set theory* and order structures, (II) *topological spaces* and their basic properties, (III) *measure theory* and integration. While set theory was introduced in a non-axiomatic style, although with extraordinary precision, topological spaces and measure theory were given an axiomatic presentation. In part (II), Hausdorff published his *neighbourhood axioms* for general spaces, found two years earlier, introduced separation and countability axioms, studied connectivity properties and other concepts. This part of the book contained the first comprehensive treatment of the theory of metric spaces, initiated by M. Fréchet in 1906, and laid the basis for an important part of the tradition of general topology of the coming century.[8]

In part (III) he gave a lucid introduction to measure theory, building upon the work of E. Borel and H. Lebesgue. In a paper published shortly before the book, and added in content as an appendix to the latter, Hausdorff gave a negative answer to Lebesgue's question (for $n \geq 3$); whether a (finitely) additive content function invariant under congruencies can be defined on *all* subsets of Euclidean $\mathbb{R}^n$ (Hausdorff 1914*a*). Using the axiom of choice, he "constructed" a partition of the 2-sphere (up to a countable residual set), in which each part is congruent to the union of two of them. This was the starting point for the later paradoxical constructions of measure theory by Banach and Tarski.[9]

An intense reception of the *Grundzüge* started only after World War I, and most strongly in the rising schools of modern mathematics in Poland, around the journal *Fundamenta Mathematicae*, and the Soviet Union mainly among N. Lusin's students around P. Alexandroff. Between the latter and Hausdorff there arose a close scientific exchange and intellectual friendship, interrupted only after 1933. All in all, the *Grundzüge* became one of the founding documents of *mathematical modernism* in the sense of the 1920/30s. In a lecture course in 1923, Hausdorff introduced an axiomatic basis for probability theory, which anticipated Kolmogorov's axiomatization of 1933.[10]

Real analysis and descriptive set theory

In his own research, Hausdorff took up questions in real analysis, now informed by the new "basic features" of general set theory. His introduction of what are now called *Hausdorff measure* and *Hausdorff dimension* (Hausdorff 1919) became of long-lasting importance in the theory of dynamical systems, geometrical measure theory and the study of "fractals", which stirred broad and even popular interest in the last third of the 20th century.[11]

Other important technical contributions dealt with summation methods of infinite divergent series and a generalization of the Riesz-Fischer theorem, which established the now well known relation between L^p function spaces and l^q series of Fourier coefficients, for $\frac{1}{p}+\frac{1}{q}=1$, and opened the path for later developments in harmonic analysis on topogical groups (Hausdorff 1923).[12]

Like in the case of his earlier studies of order structures, such investigations led Hausdorff back to foundational questions of set theory. Already in the *Grundzüge* he had been able to show that certain Borel sets were either countable or of the cardinality of the continuum. In 1916, Hausdorff, and independently P. Alexandroff, could show that any Borel set in a separable metrical space is of cardinality $\aleph_0$ or of the continuum. That was an important step forward for a strategy proposed by G. Cantor to clarify the continuum hypothesis. Although this goal could not be achieved along this road, it led to the development of an extended field of investigation on the border region between set theory and analysis, now dealt with in *descriptive set theory*.[13]

When Hausdorff revised his *opus magnum* for a second edition in the late 1920s, he rewrote the parts on descriptive set theory and topological spaces completely, extending the first considerably and concentrating the second on metrical spaces. As other books on general set theory and general topology had appeared in the meantime, he omitted these parts; thus the so-called "second edition" was a completely new book on specialized topics of set theory (Hausdorff 1927).

Last years at Bonn

In 1921 Hausdorff had returned to Bonn university, now as a full professor and colleague of E. Study and (a little later) O. Toeplitz. After the rise to power of the Nazi regime, life and work conditions deteriorated steadily and more and more drastically for Hausdorff and other people of Jewish origin (F. Hausdorff had distanced himself from religion during the 1890s, his wife had converted to Protestantism). While he was still regularly emeritated in early 1935, his colleague O. Toeplitz was dismissed and left Nazi-Germany for Palestine shortly before the outbreak of the second World War. Hausdorff's attempts for emigration came too late to be successful and his contacts to local mathematicians reduced essentially to one sensible and upright colleague, E. Bessel-Hagen.[14]

When Felix Hausdorff, his wife Charlotte and a sister of hers were ordered to leave their house for a local internment regime in January 1942, they opted for suicide rather than suffering further persecution. At that time their (adult) daughter was living in Jena. She escaped from deportation and managed to hide in the Harz region until the end of the war and the downfall of the Nazi regime.

The *Nachlass* and the *Hausdorff edition*

Hausdorff's voluminous *Nachlass* was handed over to a local friend of his. It survived the end of the war with only minor damages (Hausdorff n.d.). It now lies at the University library at Bonn and has been made accessible for research by a detailed catalogue [http://www.aic.uni-wuppertal.de/fb7/hausdorff/findbuch.asp].

An interdisciplinary group of 21 persons from four countries, under the direction of E. Brieskorn and W. Purkert (Bonn), is preparing a collected edition of the scientific, literary, and philosophical works of Felix Hausdorff in nine volumes (Hausdorff Werke). This edition has been generously supported by the *Deutsche Forschungs Gemeinschaft* and the *Akademie der Wissenschaften Nordrhein-Westfalen*. It is now run as a long-term project of the latter. Four volumes have already been published or are in preparation for immediate publication; the remaining five are scheduled to follow during the next few years [http://www.aic.uni-wupper\-tal.de/fb7/hausdorff/baende.htm].

Call for support in retrieving Hausdorff correspondence

Volume IX of the edition will contain the available scientific, literary, and personal correspondence of F. Hausdorff. Very informative parts of the exchange between P. Alexandroff and F. Hausdorff have been preserved, and also letters of Mongré/Hausdorff to the Nietzsche archive and to literary intellectuals of the turn to the 20th century; but much of the correspondence seems to be lost. Most of what is known, is due to the patient and laborious collecting activities of E. Brieskorn, the driving force behind the editorial project.

Readers of this note who know about letters from or to Felix Hausdorff are heartily invited to get in contact with the editorial office and to communicate their findings to its scientific coordinator:
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Notes

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1. See (Hausdorff Werke, V (2005), forthcoming).
2. Information due to a communication of U. Roth.
3. Cf. (Vollhardt/Roth 2002); more in (Hausdorff Werke, vol. VIII (forthcoming)).
4. Cf. (Stegmaier 2002) and (Hausdorff Werke, VII (2004), 49–61); for relations to mathematics (Hausdorff Werke, vol. VI (forthcoming)).
5. (Hausdorff Werke, vol. I (forthcoming)); detailed references to Hausdorff's publications in all volumes.
6. See (Hausdorff Werke, II (2002), 600ff.), (Moore 1982, 116 etc.) and (Felgner 2002).
7. (Purkert 2002)
8. See (Epple/Herrlich e.a. 2002) and further commentaries in (Hausdorff Werke, II (2002), 745–772).
9. (Chatterji 2002)
10. (Hausdorff Werke, V (2005)), cf. (Hochkirchen 1999).
11. Commentaries in (Hausdorff Werke, IV (2001), 44–54,) and in (Brieskorn 1996).
12. Cf. S. Chatterji's commentaries in (Hausdorff Werke, IV (2001), 163–171, 182–190).
13. (Koepke/Kanovei 2002)
14. (Neuenschwander 1996)

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Erhard Scholz [scholz@math.uni-wuppertal.de] studied mathematics, physics and history of mathematics at Bonn and Warwick. Since 1989, he has been professor for history of mathematics at the department for mathematics and natural sciences at Wuppertal university. His research interests are concentrated on recent history (19th and 20th century), in particular the relationship between mathematics, physics and philosophy.

Interview with Ian Stewart

Interviewers: Krzysztof Ciesielski and Zdzisław Pogoda

Early career

When interviewing mathematicians, one usually begins with the typical sentence: "How did your adventure with mathematics start?" So, we also begin with this standard question. When did you decide that you would become a mathematician? What were your relations with mathematics in your childhood? Did you hesitate between mathematics and other possible university studies?
I was good at mathematics from a very early age, and I was fortunate to have a series of very good teachers from the age of 11 onwards. By age 13, I was definitely thinking of going on to some area of science or mathematics. At age 18 I wasn't sure whether to take mathematics or physics at university, but then I was offered a place at Cambridge University to take a mathematics degree (based on some good exam results) so that decided it for me.

Tell us a little about your mathematical life at university.
I spent four years at Churchill College Cambridge – the first three doing a BSc in mathematics and the final year doing postgraduate study. Then I moved to the University of Warwick for my PhD. I thought I wanted to work on group theory but in the end I did a thesis on Lie algebras. Both of those topics have since proved very useful, even in work on dynamical systems, because the core theme to my work (nearly all of it joint with Marty Golubitsky) is the influence of symmetry.

In the United Kingdom it is rather unusual that after obtaining a Ph.D. from a particular university, one gets a job in the same university… How was it in your case?
In the late 1960s, there was a big expansion of universities in the UK and for a time there were more jobs than good candidates. People did occasionally stay on at the same University, moving from PhD to an academic position. This was dying out by 1969, when I was looking for a job, but even so, the competition wasn't as extensive as it became a year or two later. It so happened that Warwick had a temporary position available, for one year, and I was offered that, even though I hadn't formally applied for it. I accepted; the next year it was made permanent. I was lucky.

What mathematicians (first of all, amongst your teachers) had the greatest influence on you?
At Grammar school (High School) the senior mathematics master, Gordon Radford, devoted much of his free time to providing extra 'lessons' for kids who were good at the subject. I benefited immensely from his generosity and he was also a very good teacher.
Another key influence wasn't a teacher at all, not even a mathematician; it was Martin Gardner, whose columns in Scientific American inspired me. He made it clear that mathematics wasn't a dead subject, but an active source of new problems and ideas.

Popularization

One of your first connections with writing about mathematics was perhaps "Manifold". Please, tell the readers of the "Newsletter" more about this journal – it was wonderful yet we believe that plenty of people ar-e hearing about this now for the first time, it is almost forgotten…
Manifold was great fun. A few graduate and undergraduate students decided that it would be good to produce a mathematics magazine. We asked the Chairman of the mathematics department, Christopher Zeeman, for permission, and he was enthusiastic. So we put it together and made lots of copies on the department's duplicating machine (no photocopiers then) and stapled them together by hand. It was what the science fiction fraternity calls a 'fanzine' – lots of energy and wild ideas, but rather scruffy. It ran to 20 issues altogether, over 12 years.

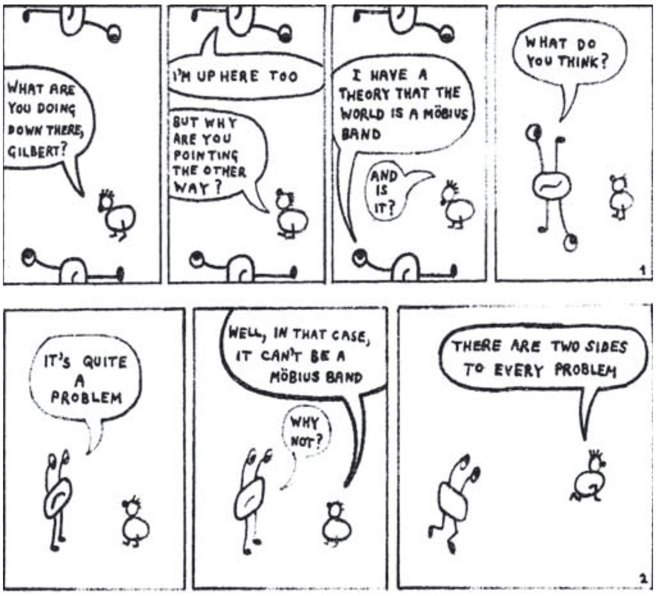
You can also draw cartoons. Where did the nickname "Cosgrove" come from?
Manifold's cartoonist (me) was looking for a pseudonym, and we had a principle of drawing on our surroundings for inspiration. On the wall in the duplicating room (which was also the kitchen) was a calendar from a local garage – the Cosgrove Garage.

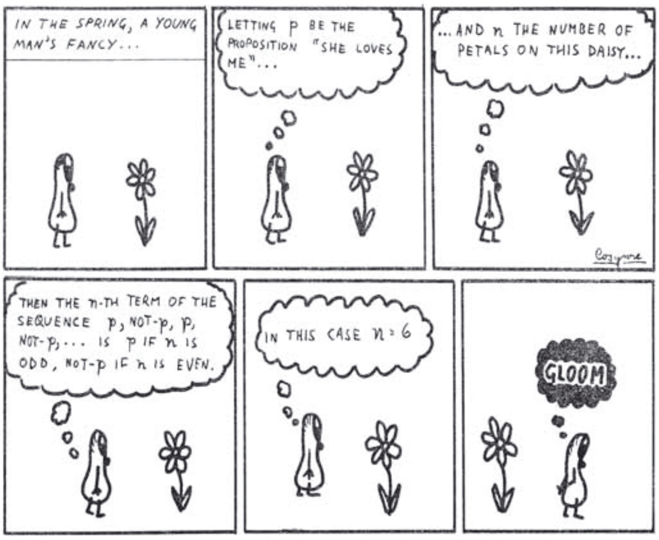
An odd evening

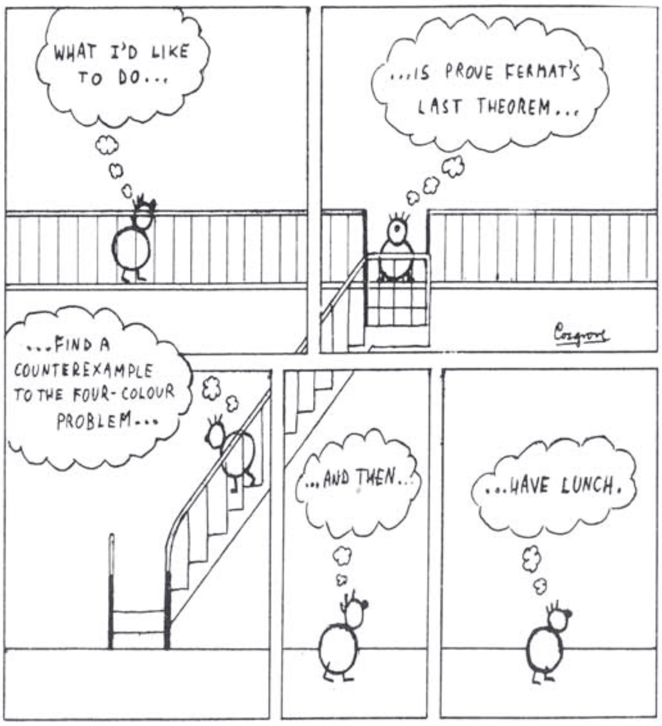
Ian Stewart (*from "Manifold" 12*)

As dust settles gently over the undulating English countryside we find our hero Rosen Crantz, research student, discussing his latest ideas with his supervisor, Prof. Guilden Stern, a none-too-successful number-theorist.

Crantz: Guilden, I'm stuck on my research problem.
Stern: What, the one about prime numbers?
Crantz: Yes. I was going to prove it for each prime number in turn, using that paper of Randy and Hartlisnujam…
Stern: You mean A complete List of all Prime Numbers, Journal of Infinity, volumes 173 onwards?
Crantz: Yes, but they've only published the even primes so far – I think they got stuck somewhere.
Stern: I had a letter from Hartlisnujam a few weeks ago. He said they'd started off well with 2 – that's prime, of course – and they decided to run through all the even numbers first in hope of finding some more. He said they'd got up to about 1355579014264890988 but hadn't found any.
Crantz: Perhaps there aren't any other even primes.
Stern: But what about that theorem of Dirichlet's – you know, the one that says there are an infinite number of primes in any arithmetical progression. The even numbers form an arithmetical progression, don't they?
Crantz: I guess so. I've forgotten most of what I did at school. It's very puzzling.
Stern: Perhaps Dirichlet made a mistake? He did with his principle, you know.
Crantz: Wasn't that Riemann? Anyhow, it seems unlikely. Maybe we could prove there exist infinitely many even primes?
Stern: By modifying Euclid's proof for arbitrary primes, you mean?
Crantz: Exactly. We'll work with just even primes and see what happens. Suppose there's only a finite number…
Stern: We can miss out 2, we know about that…
Crantz: So let's suppose there are only finitely many even primes greater than 2, say $p_1, p_2, \ldots, p_n$. Now what? Euclid forms $P = p_1 \cdot p_2 \cdot \ldots \cdot p_n + 1$ and…
Stern: That won't work: it's odd.
Crantz: Very odd.
Stern: Ha. So why not define $P = p_1 \cdot p_2 \cdot \ldots \cdot p_n + 2$?
Crantz: OK. Then P is even so it must be divisible by some even prime, say q. And q can't be any of the p's since they leave a remainder 2 when you divide P by them…
Stern: …and it can't be 2, since if 2 divides P then it divides $p_1, p_2, \ldots, p_n$ as well, so it divides one of the p's… but that p is prime and greater than 2 so it can't be divisible by 2.
Crantz: So q is an even prime not equal to $2, p_1, p_2, \ldots, p_n$…
Stern: Contrary to our assumption. So there must be an infinite number of even primes altogether.
Crantz: I guess that does it. Dirichlet was right after all.
Stern: I'll write to Hartlisnujam about it.
Crantz: I wonder if it'll help my problem?
Stern: What is your problem?
Crantz: Uh… well… I think my girlfriend is…
Stern: Your research problem.
Crantz: Oh, yeah, It's a sort of converse to Goldbach's Conjecture.
Stern: You mean "every even number is the sum of two primes"?
Crantz: Yes. I want to prove that every prime is the sum of two even numbers. You see, if I could prove that, then…
Stern: But it's false, surely? What about 3? If 3 is a sum of two even numbers, then one of them is 2… so the other is 1. And that's odd.
Crantz: Very odd.
Stern: Ha. You need extra hypotheses. Why not assume your prime is even?
Crantz: I thought of that. But suppose we take an even prime q and assume that $q = x+y$ where x and y are even – say $x = 2u$ and $y=2v$. Then $q = 2(u+v)$ so 2 divides q. But q is prime – contradiction.
Stern: So that disproves it for even primes.
Crantz: Does it? I never realised…
Stern: Which means you need only look at odd primes.
Crantz: But I can't wait for Randy and Hartlisnujam to get to them…
Stern: Well, anyway, you've disposed of half the possible cases.
Crantz: Plus 3, which you did.
Stern: Then write it up and publish it. That way, if you do work out the odd ones, you get two papers out of it.
Crantz: I thought they weighed publications, rather than counting them?
Stern: No, that was before they started printing Mosaic on stone tablets. No; five papers and you're a lecturer, fifteen a senior lec-
Crantz: Wait! Wait! Where in the proof have we assumed that q is even?
Stern: Oh, where we – no. We didn't. We haven't! The same proof works for odd primes too!
Crantz: I can see it now! Falsity of the Converse Goldbach Conjecture by R. *Crantz* And G. *Stern*…
Crantz: Yes. We could publish it in the *Notices*…
Stern: The *Journal*…
Crantz: The *Bulletin*…
Stern: The *Proceedings*…
Crantz: The *Transactions*…
Stern: The *Annals*!
Crantz: ….Ivanov Gos. Ped. Inst. Uc. Zap. Fiz.-Mat. Nauki -
Stern: (Thumping him on the back) Nasty cough you've got there.
Crantz: What a reference!
Stern: Fame! Fame at last! Oh, wait till I see Stevie Smale…
Crantz: We can present it at the International Congress of Mathematicians. We might get a Fields Medal.
Stern: Two Fields Medals.
Crantz: I'll be a Professor in no time, They make thousands, you know. Absolutely rolling in it. I hear one of them recently sold his 13th century cellar…
Stern: No! Really?
Crantz: And I won't even have to write thirty-one papers and two –
Stern: I could do a lecture tour of the USA!
Crantz: A sort of Malcolm Muggeridge?
Stern: Not exactly; more a Charles Dickens or a – what was that American chap's name?
Crantz: Twain?
Stern: No, I'll hire a car.
Crantz: And I could do a tour of Paris – lunch at the Sorbonne, dinner at the Institut – I might even get to meet Bourbaki! Yes! Yes! (He pauses, suddenly puzzled.) Wait a minute. What about 2?
Stern: 2?
Crantz: 2.
Stern: What of it? Go on, go on!
Crantz: = 0+2.
Stern: Brilliant.
Crantz: 2 is prime. 0 and 2 are even.
Stern: Oh, BOTHER!
Crantz: Maybe we could patch it up…
Stern: But where have we assumed things are non-zero? I don't see it.
Crantz: It's odd.
Stern: Very odd.







How did it happen that you decided to write about mathematics for a broader audience? What was your purpose?

I enjoyed writing; I enjoyed telling people about mathematics. I'd been editor of Eureka, the student mathematics magazine at Cambridge. Then Manifold... it was a natural progression. I never really thought consciously about it until years later. A major step was being asked by *Pour La Science* (the French translation of *Scientific American*) to write a mathematical games column (following on from Martin Gardner). This led to writing the column for *Scientific American* itself. In all, I wrote 144 columns. It developed from there.

One thing that I really enjoy very much is talking about mathematics on the radio. No pictures except what's in the listener's head...; the funny thing is, it works. I've done about 260 radio broadcasts.

We have never heard about Eureka. Tell us something about it.

It still exists. It's the official magazine of Cambridge University's undergraduate mathematics society, the Archimedeans.

Have you collaborated also with TV? What have you done for them?

I've appeared in about 60 TV broadcasts, ranging from five seconds saying nothing to a 5-hour series. I gave the 1997 'Christmas Lectures' on BBC television. Michael Faraday started these lectures about 180 years ago: they are always about science and primarily aimed at young people. They've been televised for the last 30 years or so.

More recently I presented a programme for Channel Five about how the world will end.

Was it difficult to convince editors of different journals that it may be a good idea to include articles about mathematics? Do you remember your first article?

It was a book review in the *Times Literary Supplement*, 1973. This was the easy way in, since the book was about mathematics. But it was more a review article than just a review. The first genuine piece of mathematical journalism was 'The seven elementary catastrophes', *New Scientist* 68 (1975). One of the features of the media is that the more you do, the more you get asked back to do it again. Editors were generally receptive to the idea of an article about mathematics – provided readers could understand it. I managed to convince them that this was actually possible.

For many years, you worked for* The Mathematical Intelligencer*, serving as the Editor-in-Europe of the journal for some time. Tell us something about this.

Klaus Peters and a few other people at Springer started a small duplicated newsletter on one sheet of (yellow) paper, as a way to advertise their books. This quickly turned into a proper magazine. I got roped in, and basically I asked people to write articles, wrote things myself, contributed crossword puzzles and a few cartoons…; did

Ian Stewart with Krzysztof Ciesielski (right) and Zdzislaw Pogoda (left)

odd jobs, that kind of thing. I enjoy doing a wide range of things, so it was great fun and gave me an outlet for my creative juices.

Books

Let us turn to your books. It is really incredible: you write advanced monographs, textbooks for students, computer books, comic strips, and – perhaps first of all – popular books about mathematics. We heard a joke that "Stewart writes one book per week". How many books did you write? Which of them do you regard as the most interesting and most valuable?

I think the total is about 80, not counting translations, reprints, or any other frills like that. But about 30 were 'how to program your home computer' books in the 1980s, which were rather formulaic, so perhaps they shouldn't count. Except that they sold a lot of copies! That amounts to only about 2.7 books per year, which isn't really that prolific. (Isaac Asimov wrote over 300 books.) When I do write, I tend to write fast, and the first draft is close to the final one, so I don't waste a lot of time polishing.

The best known, which is on chaos, is definitely 'Does God Play Dice?' That's the one that moved the whole activity up to professional level. From then on, I was as much a science writer as a mathematician. Others that I'm especially pleased with are 'The Collapse of Chaos', 'Life's Other Secret', and the two (shortly three) 'Science of Discworld' books with Terry Pratchett and Jack Cohen. Oh, and I really enjoyed writing two science fiction books (also with Cohen): 'Wheelers' and 'Heaven'.

How many editions did 'Does God Play Dice?' have? How many copies were sold?

There have been two editions (plus a curious sort-of-new edition in the USA) in English, with at least 12 translations. Sales in English were only somewhere between 150,000 and 200,000. Worldwide it has reached at least 250,000.

You may be interested to hear a funny story. It was shortly after 'Does God Play Dice' was translated into Polish. Our friend, who worked together with us at the Mathematics Institute of the Jagiellonian University, was visiting a large bookshop in Kraków and noticed your book in the department: "Religion". He went to a shop assistant and told her that it is a book about mathematics and should be moved to another place. The shop assistant refused. She said: "I know this book, this is a religious book, and it is in its proper place now. I am responsible for the religious department in the store and this book should be just here. Moreover, here it has sold very well!" Would you comment on this?

I believe that there are at least four books with that title, and the other three are about religion. Assuming she wasn't just confusing my book with one of those, I can only assume that people who found it in that section were sufficiently intrigued that they bought it anyway.

Several of my books do what is known in the trade as 'genre-bending', a pun that doesn't translate well but means that the books involve two distinct 'genres', or topics. The 'Science of Discworld' books, for instance, are part fantasy and part science. Bookstores like to have all copies of a given book in one location (for stock control reasons), so such books cause the headaches. Should it go in the fantasy section, or the science section?

What was your first book popularizing mathematics? What is your opinion about that book after so many years?

The first 'real' popular mathematics book was 'Concepts of Modern Mathematics', originally published by Penguin but now reissued by Dover. I still like it: the style is bright and breezy, and the content is still relevant.

Yes, we know the book. By the way, it was because of this book that we first met your name; it was translated into Russian and the Russian translation came to our library in the early eighties. In Poland in those years, it was very difficult to know about books of this kind published in the West. Into what languages were your books translated? In what country, excluding the U.K. and the USA, were the largest number of your books published?

French, German, Dutch, Italian, Spanish, Polish, Russian, Hungarian, Romanian, Swedish, Finnish, Norwegian, Japanese, Portuguese, Brazilian, Indonesian, Estonian, Croatian, Korean, Chinese, Hebrew, Greek, and Arabic.

The largest number is in German. Then Japanese.

Aren't you worried about the translations? In your books, there are plenty of jokes, very much involved with particular meanings and the English language. Let us give some examples. A title of one of your books is "Game, Set, and Math". In one of your recent books "Math Hysteria", we have the chapter "The Anthropomurphic Principle". In this book we read about the sculptor Rockchopper Rocknuttersson, about We-Haul-it-4U Moving Company, and about Demagog and Wolligog. We remember your cartoon advertising the

Signing off

Ian Stewart (from Tate)

Differences are obvious: similarities run deeper. Many square miles of forest have been felled to bemoan or celebrate the differences between art and science, a goodly chunk stemming from C.P. Snow's belated and intellectually snobbish breast-beating about the polarisation of Western culture. By comparison, the trees consumed in contemplating the similarities between science and art amount to a few bundles of firewood.

Humanity gains very little if a poet can state the second law of thermodynamics or a physicist name the author of Endymion: the surface may change, but the depths remain divided. Humanity gains a great deal, however, if poets have respect for the work of physicists, and conversely. And it is here that an understanding of the similarities between these two ways of viewing the world, rather than a distaste for their differences, could well pay dividends. The same goes within Snow's two cultures, too. It is all very well for a physicist to deplore the poet's ignorance of thermodynamics – but how much does your typical physicist know about immunology? What proportion of biologists can state Maxwell's equations for electromagnetism? How many astronomers can fertilise a mouse egg in vitro?

Does it matter?

In 1966 the science fiction writer Samuel R. Delany published a little-known but highly unusual novel called Empire Star. The main narrative line is a convoluted time-travel/many worlds story which eats its own tail. The philosophical subtheme is a study of how human minds structure their perception of the universe. 'Simplex, complex, multiplex' is a running catch-phrase. The test for a simplex mind is to ask it what is the most important thing in the world: if it knows the answer then it is simplex. A complex mind can perceive the many intertwining strands of cause and effect that combine, within one consistent worldview, to constrain the unfolding of some selection of events. Rarer still is the multiplex mind, which can work simultaneously with several conflicting paradigms. Order your perceptions multiplexually, says Delany, and you will understand the universe in its own terms.

So: does it matter whether an astronomer can fertilise a mouse? It does if the astronomer is simplex, seeing the rest of the world as a tiny fringe attached to the huge bulk of astronomy, and despising those idiots who play silly games with mice. It does not if he is complex, respecting the expertise of others. It matters even less if he is multiplex, having a clear idea of how his tiny area relates to the vastly greater and different world outside.

Let's try some multiplex thinking about parallels between art and science. For instance, take mathematics and literature. How, asks the writer, can the sterility of Pythagoras's Theorem possibly compare to the vast human tragedies and triumphs of War and Peace? How, asks the mathematician, can The Three Little Pigs compare to Andrew Wiles's magnificent proof of Fermat's Last Theorem? But both are asking simplex questions. They should at the very least compare like with like: Pythagoras with Pigs, Tolstoy with Wiles. And here the multiplex mind sees a connection: the common underlying structure is the story. The story of Pythagoras is a simple moral tale: chop up these two squares like this and fit them together to make this other one. Pigs is a simple moral tale too, but one of housing materials and prudence. Wiles's proof unfolds a compelling tale of epic proportions that starts from a familiar world, dazzles us with new events and new characters, and builds to its inevitable climax. So does War and Peace.

Again, let us compare poetry with physics. Both seek to understand the world by stripping its essence down to a few elegant lines. The symmetry, power, and economy of Maxwell's equations evoke a similar feeling among physicists to that evoked by Blake among lovers of poetry. The difference is that poetry seeks to understand the world of people, whereas physics concentrates on the inhuman universe of space, time, and matter. Yet even this difference is superficial. Humans evolved in that inhuman universe, they exist in space and time, and they are made from matter.

Today's science offers many new insights about the big questions – the beginning of the universe, the origins of life, the workings of the human mind. These are questions that interest almost everybody – not just Snow's scientists and artists, but plumbers, bus-drivers, and people who bake cakes for the village fete. A growing number of scientists have taken upon themselves the task of explaining these insights in a manner that is accessible to all of us: showing us the poetry in physics and the stories in mathematics. In so doing, they are helping to erode simplex thinking – and it is a pity to see some artistically minded people complaining that scientists are invading their patch, thereby demonstrating their own simplexity. We must get away from the simplex emphasis on the differences between areas of human culture, and begin to construct a multiplex vision founded on their similarities.

movie: "Radius of the lost arc". Do you think that it is possible to translate such phrases or words to an adequate level? Aren't you afraid that the poor translators could destroy your wonderful work?

No. I probably should be, but I trust the translators to do a professional job. They usually do. In most languages I wouldn't know if they didn't!

What are your colleagues' opinions about your popularisation activities? Your name appears very frequently in radio, TV, journals, and daily newspapers. You write about mathematics, and inform about the possibility of solving famous conjectures. We can imagine three possible reactions. The first: "Wonderful! Thanks to Ian people know more about mathematics, and he does it perfectly!" The second: "Terrible! Ian should work on serious mathematics, do research and not waste time on such rubbish!" And the third: "It's not my business. I do what I do, Ian does what he does". How is it?

First, I do plenty of serious mathematics too, publishing about 6 papers a year, so no one can really complain on that score. My colleagues at Warwick are very tolerant and supportive – they seem to understand that what I do with the media is good for mathematics. Colleagues from other universities in the UK have sometimes thanked me for getting mathematics on the radio or in the newspapers – there is a general perception that it does the subject good if the public understands that new things are happening. Or just that mathematicians are human. I've not had any negative reactions.

You also write science fiction. We heard that you wrote some stories under a pseudonym. Could you tell us, how many science-fiction novels and stories have you writ-

ten? Would it be too private a question to ask about this pseudonym?

It's not a pseudonym. I always use my own name. I've written 21 science fiction short stories (in *Analog*, *Omni*, *Interzone*, and two in *Nature* would you believe?) and two specifically science fiction novels, 'Wheelers' and 'Heaven'.

Speaking about science fiction, in Crichton's "Jurassic Park" one of the main characters is a mathematician, Ian Malcolm. This mathematician, moreover, is interested in chaos. It is difficult to believe that it is a coincidence…

No, he's not modelled on me, though several people have suggested this. I think Crichton does say somewhere who it was based on, but I can't recall.

Recently, you wrote some famous books with Terry Pratchett and Jack Cohen. Could you tell us something about that collaboration?

That's a long story. Jack knew Terry from before he was famous, from science fiction conventions ('cons'). I met Jack in 1990 and he introduced me to Terry at Novacon, the Birmingham science fiction group's annual convention. We got on well and the friendship developed. When 'The Physics of Star Trek' came out, I got the idea of doing something similar for Discworld, Terry's fantasy universe that rides on four elephants on the back of a giant turtle, and where magic works. Terry was amenable, except that he pointed out 'there's no science on Discworld. It runs on magic and narrative imperative – the *power of story*'. It took us six months to work out an answer: 'if there's no science on Discworld, you'll have to put some there'. So we came up with a format that we've never seen used elsewhere – interleaved chapters by Terry telling a fantasy story, and by me and Jack giving scientific commentary. In the first 'Science of Discworld' book the wizards of Unseen University accidentally create our entire universe (as the Roundworld project) – and are puzzled by how it works given that there's no magic. In the second one, Elves invade Roundworld and the wizards have to get Shakespeare born to kick them out again. And in the third, just in the final stages of writing, Victorian England heads off along the wrong historical track and the wizards have to get it back on track again. But I'm not going to reveal more of the plot than that.

Three people writing one book is complicated, but we keep it as simple as possible. Jack and I have collaborated a lot, so we know how that works, and we jointly write the even-numbered science chapters. Terry concentrates on the odd-numbered fantasy ones. We agree a plot beforehand, and then as soon as we start writing we forget all about that and follow our noses. Every so often we all get together to hammer out any problems. At the end, Terry goes over the 'final' version and administers what we call 'a scattering of fairy-dust'.

We have firmly decided that three is a good number for a trilogy, so the series should now stop. But we reserve the right to find another way to work together.

You wrote a lot of books and articles jointly. Could you mention some of the authors with whom the collaboration was particularly good?

They all were, otherwise I wouldn't have done them... Mathematically, my main collaborator is Marty Golubitsky, who had a huge (and positive) influence on my career by converting me to dynamical systems in 1983. Working with Jack Cohen (and subsequently Terry Pratchett) has been enormous fun and has led me into unexpected areas.

Research

Now we should come to another important point. Please, tell us something about your research. You have worked in many areas of mathematics… Which?

Lie algebras, singularity theory, and dynamical systems are the main ones.

Which of your results do you regard as especially valuable?

I very much like the Equivariant Hopf Bifurcation Theorem that Marty Golubitsky and I proved in 1983, soon after we first started to work together. It stimulated a lot of later work. The other idea that I'm particularly pleased about is very recent: the discovery that the natural algebraic framework for the dynamics of networks is the theory of groupoids. Which are like groups, except products aren't always defined. We're still following up on that one.

Working in mathematics, we enjoy some of its branches and not others. What area of mathematics is your favourite? And is there any branch you don't like?

My favourite area is always what I'm doing right now. Which is currently the nonlinear dynamics of networks.

I've never been much good at homological things. I know they're important, but my mind doesn't seem to work that way.

You were awarded several prizes. Which of them do you consider the most honourable?

The first significant one was the 1995 Royal Society's Michael Faraday Medal – one award per year across the whole of science, for 'furthering the public understanding of science'. Another big one was the 2001 Public Understanding of Science and Technology Award from the American Association for the Advancement of Science – also one award per year across the whole of science. The Gold Medal of the Institute for Mathematics and Its Applications (2000) is another major award. And perhaps the most important of all was being elected a Fellow of the Royal Society, the UK's premier scientific association, in 2001.

About 15 years ago, the readers of The Mathematical Intelligencer were asked about their opinion about beauty in mathematics, i.e. about the choice of the most beautiful theorems. What mathematical theorem (or theorems) is, in your opinion, the most beautiful?

The proof that knots exist (3-colour the trefoil knot) is probably my favourite. Many people like Euler's formula, but I don't find that surprising any more. From the point of view of linear differential equations, it says that if you go half way round the unit circle at unit speed, it takes time π to do so. It was beautiful when Euler discovered it, but it's a bit tarnished nowadays.

Ah, we both like Eulers's formula very much also, but we prefer it written in another form, i.e. one of the main arguments is that it connects, in a remarkably simple way, the five most famous mathematical constants. By the way, the readers of the **Intelligencer** ***also selected this formula as the most beautiful theorem.***

Modern mathematics

Let us come back to modern times. What results of the 20th century were, in your opinion, particularly important?

Fermat's Last Theorem (and even more so the Taniyama-Shuimura conjecture), the classification of the finite simple groups, Atiyah-Singer index theorem, the Jones polynomial, the existence of the Lorenz attractor, exotic differential structures on R^4, chaos in the 3-body problem, classification of singularities of mappings, Floer homology, symplectic structure on the cotangent bundle…; then there are the theories as well as the theorems: symplectic geometry, singularity theory, K-theory, ergodic theory… Really, the most important thing is how all these bits and pieces fit together to form today's mathematics.

And what unsolved problem (or problems) do you regard as particularly important?

Riemann Hypothesis, $P = NP$?, Poincaré Conjecture (maybe now a theorem), and fundamental theorems underlying string theory. The Clay Prize problems aren't a bad selection! A computable complete knot invariant would be nice.

Could you try to present your hypothetic vision of mathematics at the end of the 21st century?

That's too far into the future to predict. Think about trying to predict today's mathematics (and society) in 1900. Mobile phones? Internet? Computer algebra? But I'll try for 2050. My guess is that there will be two huge influences on mathematics, both visible now. One is the computer, as a standard tool for exploring problems and for intelligently proving theorems. (I'm not impressed by attempts to get the computer to do all the work, though that may be a good computer-science problem, because I think the point of view on what math consists of is wrong.) The other is biology as a source of major new problems requiring entirely new techniques. The growth of an organism, for instance, is some kind of spatially extended dynamical system with feedback between geometry and biochemistry, but all of it is mediated by genetic 'instructions' that aren't really instructions at all, but parameters in some network of interacting chemical reactions. We don't have any formalism to handle that kind of behaviour. Yet.

Literature

We were talking about writing. Surely you do not only write, you also read. What are your favourite books (mathematical and non-mathematical)?

Douglas Hofstadter's 'Gödel, Escher, Bach.', Terry Pratchett's 'Discworld' books, anything by Jack Vance (generally, I read a lot of science fiction) and John Barth's 'Giles Goat-boy'. At the moment I'm reading a lot on geology and ancient Egypt.

Ah, as you read a lot of science fiction, we should, as Poles, ask you another question. Have you read Stanisław Lem's novels or stories? If so, what's your opinion about them?

Yes, I've read several of Lem's books. They're all very well written, and many are very funny. Solaris is excellent. His work can be very deep.

Have you met mathematics mentioned in some of Lem's novels? Do you know that in his novel "Magellanic Cloud", published in 1955, he writes (as science-fiction, of course) what the computer's answer was for the question of ideal beauty? The computer gave a description of such an ideal object that perfectly suits the description of fractal.

Lem is unusual in that he employs mathematical imagery in a way that is effective as metaphor, but also good mathematics. Very few science fiction writers do that – they use physics or biology as a source of inspiration instead. Lem has also understood something that most people don't: mathematics can be highly amusing. There is something about the relentless logic of mathematics, which can lead in unexpected directions. This can be very funny. The fantasy stories of Terry Pratchett also have a sense of humour that is rooted in rigorous logic applied in a weird context.

For example, take it as given that the Tooth Fairy pays good money to children for old teeth. Only Pratchett, to my knowledge, has ever asked: why? What advantage does the Tooth Fairy get from possessing all those teeth? The answer, in Hogfather, is very dark and sinister. Pratchett also parodies Zeno's Paradoxes. In fact, I recently prepared a lecture on 'The Mathematics of Discworld' to be given at the next Discworld Convention in 2006. There is endless material. It would also be possible to base a lecture on Lem's mathematics (I've only just realised this, but it's an attractive idea) and it would be similarly amusing.

What were the favourite books of your childhood? Were you a great fan of 'Winnie the Pooh' or 'Alice in Wonderland'?
Top of the list is 'The Wind in the Willows'. 'Winnie the Pooh' and 'The House at Pooh Corner' come next. I also liked 'Coral Island'. But 'Alice' didn't impress me until my teens.

Free time

We must pose this question. How do you find time for all of this?
I don't play golf.

What do you do in your free time (if you have any)?
Reading, watching cricket and Formula-1 on TV, amateur geology (the house is full of rocks), amateur Egyptology (my wife got me interested), traveling (Egypt now high on the list), snorkeling (especially in the Caribbean), training at the local gym, eating out and feeding the departmental fish. At various times I paint pictures, mostly landscapes, but that happens in bursts with big gaps in between. Currently I'm in a gap.

Many mathematicians like music. Do you? If so, what kind of music do you especially like? Do you play any instrument?
Yes, but only for my own fun. I play electric guitar – as an undergraduate I was lead guitar in a rock band for two years. My musical tastes seem to have been formed during that period: I mostly listen to rock music, and more recently to movie sound-tracks from science fiction and fantasy films (Star Wars, Lord of the Rings, Dune…). I don't mind listening to classical music, but it doesn't really do a lot for me. My loss.

Is it too private a question to ask you about your family?
My wife and I have been married for 34 years. We have two grown-up sons, and the eldest has two daughters, making me a double granddad. They all live locally and we see them regularly.

In your books, there are plenty of mathematical jokes, anecdotes… Please, could you tell us some of them you especially like? Of course, there is nothing against recalling stories that are already published in your books or articles.
I still find the joke about black sheep amusing. You know, the one where the astronomer says 'all sheep are black,' the physicist says 'some sheep are black', and the mathematician says 'there exists at least one sheep, at least one side of which is black.' It's still amusing because it still has a grain of truth.

As for 'true' stories – my wife and I were in Lapland at a math conference, and the Swedish organisers decided we ought to learn to ski. So they lent us cross-country skis, drove us 10 kilometres out into the countryside, and dropped us off beside a huge, frozen lake. We looked around and decided that the flattest thing we could see was the lake itself, and the conference centre was visible along the shoreline. So we spent the morning practicing skiing on the lake, intending to ski back across the lake to the centre in the afternoon. When we started to practice, there was one Lapp fisherman on the lake, fishing through a hole in the ice. By the time we went to lunch, there were ten of them. We were convinced that they had all appeared because they couldn't believe their eyes – weird foreigners who couldn't even stand up on skis on a perfectly flat sheet of ice.

Thank you for the conversation.

Avril and Ian Stewart

Ian Stewart, FRS [ins@maths.warwick.ac.uk] is Professor of Mathematics and Director of the Mathematics Awareness Centre at the University of Warwick, Coventry, UK. The interviewers were Krzysztof Ciesielski [ciesiels@im.uj.edu.pl] and Zdzisław Pogoda [zpogoda@im.uj.edu.pl] from the Mathematics Institute of the Jagiellonian University at Kraków, Poland.

Mathematics and the media

Ian Stewart (from "The Scientist", 1987)

The Guardian's New Year review or 1986 included a collective obituary of public figures who had died during that year. There were long sections devoted to the arts, politics, and sport. The only scientists mentioned were part of a rag-bag collection of Nobel prizewinners (including the Peace Prize) and buried in the middle of them was – of all people – Lafayette Ronald Hubbard, of Scientology fame. As Old Mother Time begins to close her net curtains on this decade of scientific decline and neglect, scientists are complaining more and more that science does not get its fair share of media attention, and that even when it does get attention it is not treated seriously.

What goes for science goes in particular for mathematics. (Hello there? Yes, we're here too. Did you know there are more mathematicians in the world than astronomers? Amazing, isn't it?) The total media coverage of mathematics in the past decade is less than that given on 3rd January 1987 to Elton John's throat. Mathematicians have not helped their cause by behaving like a bunch of panicky old maids, fearful to open the door to the milkman in case they lose their virginity, in regard to their relations with the press. I am firmly convinced that when René Thom's catastrophe theory was reported as the greatest thing that had happened in mathematics since Newton invented sliced bread - sorry, calculus - it was because a lot of people thought that it was the only thing that had happened in mathematics since Newton invented the calculus. I don't blame them: nobody had told them any different.

Recently the London Mathematical Society set up a standing committee on the public image of mathematics. A decade ago this would have been unthinkable. But then, a decade ago mathematics received twice the proportion of the Research Council budget that it gets now. The Americans, as you'd expect, have thought bigger. The Joint Policy Board for Mathematics is an umbrella organization representing the American Mathematical Society, the Society for Industrial and Applied Mathematics, and the Mathematical Association of America. Academics, applied mathematicians, teachers. It has recently appointed a full-time public relations officer for mathematics.

I wish more of my colleagues would make the effort to explain their subject to a wider audience. But they should be warned of what they're letting themselves in for if they doff their mathematician's cowl for a journalist's trilby. Mathematicians are united in what they believe constitutes the kind of topic that deserves widespread publicity. It should be something sound, solid, serious, and significant: a showpiece of mathematical genius, something we can all be proud of. Unfortunately these are not the criteria used by journalists. What a journalist wants is a story.

What makes a good story? The most obvious stories are new results on famous unsolved problems: Fermat's Last Theorem, the Riemann Hypothesis, the Four-Colour Problem. Another good "hook" is a catchy name: flying pancakes, the Monster simple group, catastrophe theory. Bizarre coincidences – five different research groups proving the same thing at the same time – are irresistible. Anything that can be related to "the real world" – the dynamics of galaxy formation, the knot theory of DNA, how to win at blackjack. Genuine surprises, like the possibility of five celestial bodies disappearing to infinity in finite time. And anything controversial. Not every story that meets these criteria is worth writing. I could probably sell the inside story of the latest calculation of pi to millions of decimal places on the latest Japanese supercomputer to everything from the News of the World upwards – but I wouldn't, because the decimal expansion of pi has no significance for mathematics.

He who dares expose himself to the public also exposes himself to its wrath, which can take unexpected forms. In a Guardian article on knot theory I made a jocular remark about Alexander the Great. A gentleman from the home counties took me severely to task. I never did quite grasp what my sin consisted of, but it had something to do with insulting the memory of the great man Alexander the Great by referring to him incorrectly as "the Great".

He also risks editorial incompetence. When a proof of the Poincaré Conjecture was announced, by Eduardo Rêgo of the Ruy Luis Gomez Centre for Mathematics, University of Oporto, and Colin Rourke of Warwick, *The Times* managed to state that it had been proved by Ruy Luis Gomez and Colin Rourke.

An urbane Portuguese gentleman telephoned me to point this out. Gomez was a highly distinguished mathematician who was also prominent in politics.

Panic. In the event a diplomatic incident was avoided, because Gomez had been dead for several years.

Two more pitfalls form a duality. They are "local boy makes good" and "not invented here". The former is a kind of parochialism. A local newspaper will print any sort of rubbish about a lad or lass from the home town. The latter is chauvinistic: anything that foreigners can do must be trumped by an achievement of our own people. The two are often combined.

When the American mathematicians Kenneth Appel and Wolfgang Haken solved the Four-Colour Problem, what did no less an organ than the Times Higher Educational Supplement have to say about it? "Man climbs Math Mountain".

The article completely ignored the work of Appel and Haken, and described only the counter-claims of a Briton who was not even a mathematician. These were supported by specious arguments about priority. The person concerned was invited to the Unwersity of Illinois, where the alleged proof rapidly fell apart.

Professional journalists can suffer too. Gina Bari Kolata writes regularly about mathematics in Science in the USA. A few years ago Kolata came under fire for an article about the Russian mathematician L.G. Khachian's new algorithm for linear programming. As part of the motivation she had mentioned the "travelling salesman problem". Within a few days, newspapers worldwide were saying that Khachian had solved the travelling salesman problem, which wasn't true. But Kolata's article was perfectly correct: the media had garbled the message in transmission.

Difficulties are compounded when, instead of reporting an established mathematical result, one attempts to report one that is still in the process of discovery. I think this is one of the most exciting ways to write for non-specialists – to involve them in the work while it is actually happening – but many scientists misunderstand the process and the motives behind it. This opens up new dangers.

One is the accusation of "premature publicity" This reflects confusion between what is proper for a mathematical journal, and what is necessary when dealing with the media. It is rightly improper to publish, in the scientific literature, a claim to a mathematical result without it being accompanied by a rigorous, refereed proof. However, suppose you want to write a story for a newspaper or magazine about the very latest development in some area of mathematics. You can't wait for two years while the author circulates his preprints for comments, corrects the mistakes, sends the thing off to a journal, waits for the referee to get round to reading it, and waits again while it goes through a lengthy publication process. So you must write the story as it is, warts and all, and await further developments.

And there you face the really big danger. What do you do if it subsequently turns out that the discoverer has made a mistake? It's embarrassing, to say the least, but nothing short of clairvoyance can do much about it – apart from gluing your teeth together and burying your wordprocessor in concrete, which I refuse to contemplate. Many mathematicians act as if putting an error into print is the End of the World. But after two decades of news media trumpeting MIRACLE CURE FOR CANCER one need not, I feel, be too fearful of the odd blunder in print. The readers don't treat all this stuff as gospel, chaps.

The Poincaré Conjecture is a case in point. The gist of the conjecture is that the only object having a particular simple and important property – every loop in it can be continuously deformed to a point – is the three-dimensional analogue or the surface of a sphere. First posed in 1904 by Henri Poincaré, it is the major unsolved problem in topology. When someone – other than a crank – claims to have proved it, you have an irresistible story-line. So, when Rêgo and Rourke announced their proof to the mathematical community, I donnied my journalistic trilby, took several deep breaths, and wrote about it for Nature and The Guardian. Rourke and I later wrote about the conjecture in New Scientist. We made it clear that the proof was still controversial, quoting the Danish poet Piet Hein:

"A problem worthy of attack
proves its worth by hitting back."

Hein was right. Almost a year after the proof was announced, the 3-sphere did hit back. Rourke found a mistake while lecturing on the proof in Berkeley. A proof that collapses is no proof. But journalism doesn't work that way. A story that collapses is another story.

The media have a habit of behaving like Winnie-the-Pooh searching for the Woozle. You may recall that Pooh Bear, finding footprints, began to track them. Soon a second Woozle joined the first, then a third, then a fourth… But Pooh was only following his own footprints. So it can be with the media. The original story is trampled underfoot and soon the media are gazing only at their own tracks in the sand. In the case of the Poincaré Conjecture, the story of the mathematics gave way to a veiled controversy about the role of "publicity" in science. It now seems to have died down. My kids have just regaled the family with the video Re-Animator, based on a horror story by H.P.Lovecraft, full of headless mad scientists rushing around covered in gore. I hope my remarks here don't re-animate the Poincaré publicity corpse – that was kind of headless too.

I don't think you can set out actively to "publicize" mathematics – not in the same way you can publicize Madonna's toothache. I wish you could. But there's no guaranteed audience for mathematics, no set channels of communication. No news columns, no fanzines, no chat-shows. You must cast your bread on the waters and wait to see if it floats. It may return in a soggy condition: Tomorrow's World combined the Poincaré Conjecture with some not-so-recent work on minimal surfaces, linked both to the Big Bang, and garbled the lot. But even then a million housewives found out, for at least twenty seconds, that something new was happening in mathematics. I count that a positive success.

The best thing that came out of it all was a marvellous article in the New York Times by James Gleick, who told the tale, controversy and all: mathematical content plus human interest. Anyone who read the article got several vivid impressions. Topology is powerful and important. New mathematics is going on all the time. There is an international mathematical community, it cares about mathematics, it argues about mathematics, and it is absolutely committed to making sure that its mathematics is right.

Those are exactly the messages that we need to get over. But we'll never do it if we're so scared of putting our trotters into our snouts that we never open them until what we want to grunt about is as cold and as unappetizing as last week's pig-swill. Another of A.A. Milne's characters, Eeyore, would have known what to say about that attitude. Pathetic. That's what it is. "Pathetic."

CIRM Luminy

Centre International de Rencontres Mathématiques

A brief outlook

CIRM has been created to host scientific meetings in mathematics and provide visitors, with accommodation facilities and scientific tools (library, computers, meeting rooms). CIRM is located within peaceful surroundings, next to the university campus of Luminy (Marseille) in the beautiful "massif des calanques", in the south of France. Besides classical meetings or workshops – about 40 a year – CIRM also holds mini-workshops of about 10 people and welcomes activities of the type "Research in Pairs" (sometimes nicknamed "Research in Peace"!). There are also special sessions for junior scientists. Founded 20 years ago and now equipped with all necessary scientific, accommodation and restaurant facilities, CIRM not only holds conferences but also plays an important role in fostering new collaborations between mathematicians from diverse origins. The centre welcomes about 2 000 researchers every year, half of them coming from foreign institutes.

Patio at the entrance to CIRM

A large variety of scientific meetings

Meetings organized at CIRM are rather diversified, in terms of theme, size and duration. Let us just mention a few examples of conferences from 2004: "Groupoids and stacks in physics and geometry", "Non commutative artinian algebra", "Cryptography", "Groups", "Geometry and logics", "Arithmetic Galois groups", etc.

Most themes reflect, of course, the major mathematical ideas of our times, but others refer to very specific fields such as the history of sciences (for example, the contribution of D'Alembert), or to relations of mathematics with computing, environment or biology. The relations between mathematics and theoretical physics have always been rather close, and this is reflected by several conference titles (also taken from the 2004 list), for instance: "Non perturbative quantum gravity: loops and spinfoams", "New symmetries in mathematical physics", or "Infinite dimensional analysis and path integrals". Let us also mention, in this respect, the four week conference entitled "Non commutative geometry in mathematics and physics", which took place during the whole month of February 2004 and put together many participants coming from the fields of operator algebras, quantum symmetries or quantum field theory.

Most conferences gather about 50 or 60 people for a single week. However, as the centre possesses the capacity of holding up to 85 people, it often welcomes several groups at the same time, usually one "main" meeting and one smaller workshop.

Every year since 2001, about 15 small groups (two to five people) came to CIRM, within the framework of the Research in Pairs programme; this type of activity is quite popular and demand is growing. Several meetings are dedicated to the training of junior scientists (PhD level). Twice a year, sometimes three times, the centre holds rather long meetings that are organized on a five or six week period. The first residential session usually takes place in February, and is dedicated to the various aspects of a given mathematical thematic. The other residential session, which usually takes place during the whole month of August, is specifically dedicated to the "C.E.M.R.A.C.S." (Summer Centre for Mathematics and Advanced Research on Scientific Calculus) and is organized by S.M.A.I. (Applied and Industrial Mathematical Society). During this kind of "summer camp", young researchers from the industry and senior scientists are put together and work on a common project, usually related to business or industry projects involving advanced mathematical techniques. As another example of a residential session, let us mention the future conference in June-July 2006, on Double Affine Hecke algebras, Conformal Field Theory and Matrix Models, which will gather a big number of specialists belonging to these rapidly evolving areas of mathematics and mathematical physics.

Library, computing services and accommodation facilities

CIRM can house up to 83 people in 50 rooms (33 double, 17 single) and the restaurant serves about 90 guests. Several studios are also available. However, since its creation, CIRM has not been a "hotel-restaurant": it was and it remains thought of as a piece of scientific equipment, including all facilities used by scientists. Its library is the biggest, for mathematics, in south of France. It supplies a large set of 30 000 books and publications, and 700 titles of journals. Every year, about 1 000 new publications are added to the catalogue. Private collections of books (for instance the Mandelbrot fund or the Gaston Julia fund) have also been donated to CIRM. The library possesses a very rich collection of complete works. It covers all fields of mathematics and, to some extent, of theoretical physics. For those reasons, about 600 readers coming from regional research centres benefit from its facilities, in par-

Library

Computing room

Common room

ticular the members from two related research institutes, the I.M.L. (Institut de Mathématiques de Luminy) and the C.P.T. (Centre de Physique Théorique), that are situated on the Luminy campus.

Conference participants as well as local scientists also appreciate the range of computing tools that are at their disposal: computer algebra programs like Mathematica, Maple, Mathlab, Magma, Reduce, etc, numerical mathematical software or even artificial intelligence programs like Lisp or Prolog. This software is installed on several types of machines – PC's under Linux, Windows, Macs (OSX), Sparc workstations with X terminals etc. The available software of course includes classical e-mail programs, Internet and office automation packages as well as dedicated graphics programs. Two computer rooms are devoted to these activities, but many terminals are available in all CIRM buildings. In order to make the use of personal laptops easier, wi-fi and airport connections or Ethernet plugs can be accessed from almost everywhere within CIRM (including the bedrooms).

In view of the fact that mathematicians are prone to work almost everywhere at any time, most places have been set to fit them: conference participants can access the library at any time, even at night, and several blackboards or computer terminals are available inside the buildings as well as outside, for instance on the patio. Of course, CIRM offers several seminar rooms. The biggest one can hold up to 80 people and will soon be replaced by a bigger and more modern auditorium. Three other seminar rooms can hold groups of up to 30 people. They are equipped with blackboards, video-projectors, and can be hooked to the Internet network via X terminals or personal laptops. A small number of offices will also be made available to visitors coming for a Research in Pairs program. Conference talks are video recorded; they are later sent to the organizers of the meetings and are made available on the CIRM website.

A sunny and enjoyable place

Work is not incompatible with relaxation and gastronomy. At CIRM, meals are prepared by a very good cook (we think so!) and served on the spot. Particular menus can be specially ordered, to suit a vegetarian diet for instance. Every week, a soirée (dinner party) is organized and the traditional meal called the "bouillabaisse" (the Marseille sea food speciality) is offered to all participants. Apart from coffee breaks, hot drinks can be obtained, at will, from a free coffee-machine.

Located near Marseille, a big city (with a French scale…) in the south of France, CIRM benefits from 300 days per year of full sunshine. Cloudy days with temperatures going down to 15°C are considered as "bad weather". The temperature can actually go lower than that in winter, but the sky is usually crisp and sunny.

The various CIRM buildings are situated in a grove with oaks, cedar and pine trees, next to the university campus of Luminy, between the city of Marseille and the summer resort of Cassis. It is in the middle of the so-called "Calanques", this area is the French equivalent of Norwegian fjords: vertical cliffs of 300 to 400 meters plunge into the Mediterranean Sea. The seashore, accessible from CIRM by footpaths, is only forty minutes away. Participants can also make boat trips to the islands or visit interesting places in the "Provence" region. CIRM is a little bit far from downtown, and for this reason it is much more peaceful than if it were located elsewhere, and its recluse atmosphere is propitious to reflection and interaction between scientists.

Councils and staff

From the administrative point of view, CIRM is a mixed services unit combining the CNRS and the SMF (French Mathematical Society). It also has a contract with the Ministry of Higher Education and Research, and enjoys the advantages of several regional partnerships. CIRM is ruled by its Director, R. Coquereaux (a theoretical physicist, research director at the CNRS, and Head of CIRM since 2000). It is controlled by two committees that gather twice a year: a Scientific Council (its president is D. Barlet, Institut Elie Cartan) and an Administrative Council (its president is Marie Françoise Roy, Univ. of Rennes, also president of SMF).

The French Ministry for Research and CNRS provide two thirds of the CIRM budget. Local public institutions (Region Provence Alpes Cote d'Azur, Département des Bouches-du-Rhone, City of Marseille) together with the contributions from those participants who are not granted free CIRM-days, make the last third.

The centre relies on a staff of about 35 people, half of them in charge of food or housing, half of them in charge of all other services: planning of conferences, check-in, accounting, scientific secretary, library, computing etc. The only permanent scientist at CIRM is the director; he is nominated for four years (sometimes five!). Engineers, technicians and administrative staff members working at CIRM are employed by CNRS, by the University, or by SMF. People working in the restaurant or in the guesthouse are employed by a catering company. All these people will do their best to render the stay of participants at CIRM both pleasant and scientifically productive.

Organisation of meetings

The Scientific Council meets twice a year (usually in June and October). It selects the meetings, their dates – we try to respect the wishes of organizers – and the amount of financial support that can be offered. This support takes the form of a number of free CIRM-days. We offer no per diem, and no reimbursement for travel expenses. Such a subvention cannot exceed one-half of the total number of CIRM-days that will be used for the conference itself and is usually of the order of 30%.

People who wish to organize a meeting at CIRM should fill out a form online; it is advisable to make plans at least 18 months in advance. The standard application forms for CIRM meetings (the usual conference programme) are available online. Details can be obtained from the CIRM home page http://www.cirm.univ-mrs.fr/

For mini-workshops or research in pairs, it is enough to send a message to the CIRM director with a scientific programme and several options for the dates. In those cases (mini-workshops or research in pairs), depending upon the number of scientists involved in a given research group and the length of their stay, the financial support offered by CIRM can be rather high.

Restaurant

Very often, people only reimburse the meals taken at the CIRM restaurant, but the accommodation is free of charge.

History and prospects

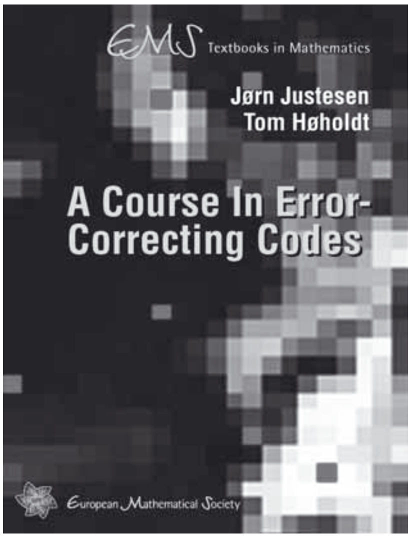
In a sense CIRM (at least its main architectural component, the old Provençal Bastide) was founded in 1000 AD, and was previously the property of St Victor's monks. In 1970, an association called the "Luminy Centre for Mathematical Meetings" was formed in Luminy on the initiative of internationally renowned mathematicians (Serre, Dieudonné, Schwartz, Leray etc). However, it was only in 1979 that the creation of CIRM was finalized with the signing of a long lease between the SMF and the Education Authority (owner of the Luminy property) that transferred part of the property for the purpose of the Centre. It opened in 1981. The renovation of the old Provençal Bastide, its patio and its outbuildings, is still going on today and a major rehabilitation project was initiated in 2000.

The CIRM library needs to grow. Its only possibility is to annex the present main conference room, which has reached its limits in terms of capacity, comfort and renovation. For this reason, a new auditorium is being built which will be more spacious and comfortable. This operation has been made possible by several grants from national agencies (in particular CNRS). However, one fact deserves to be mentioned: the budget being very tight, it was decided to make a call for donations near the community of mathematicians, and an email message was sent to all of those who came to CIRM at least once in the last three years. In less than six months, about 120 donators have sent 30 000 euros, manifesting in this way their support and their attachment to "their" centre. CIRM is grateful for their help. The new auditorium should be ready by spring 2006.

Information about CIRM can be found on
http://www.cirm.univ-mrs.fr

Book review

Christian Thommesen and Olav Geil
(Aalborg, Denmark)



Jørn Justesen & Tom Høholdt
A Course In Error-Correcting Codes
EMS Textbooks in Mathematics
European Mathematical Society 2004
ISBN 3-03719-001-9

Recently the European Mathematical Society implemented an old plan by establishing its own publishing company, the European Mathematical Society Publishing House.

On the EMS Publishing House website Thomas Hintermann writes:

"… there is certainly no denying that at present in every company the order of the day is to meet the short-term (short-sighted?) targets, most often at the expense of everything else. Financial considerations are clearly given first priority, editorial matters and publishing aspects rank second. One of the aims of the EMS publishing house is to reverse that order. The needs of the community are foremost in our minds, admittedly with the obligation to run an economically sound operation".

The EMS Publishing House issues two journals "Interfaces and Free Boundaries" and "Journal of the European mathematical Society". Moreover, they have now published seven books. This book review concerns one of these books, viz. "A Course In Error-Correcting Codes" by Jørn Justesen & Tom Høholdt, both professors at the Technical University of Denmark.

The book deals with a broad range of topics within coding theory. Coding theory is the part of information theory dealing with how to practice communication over noisy channels with almost no errors. The theory is said to have its starting point in Shannon's article from 1948 in which he proves – put roughly – that it is possible to communicate efficiently with a vanishing number of errors if one works with very large packets of information. Shannon's proof is not constructive, and this is the reason why coding theory has been and still is an area with a lot of research activity.

The fact that both authors work actively within the research area is visible in the book thus describing relevant classical problems in a modern language and dealing with a number of topics of great current interest. The authors' wide range of experience has made it possible for them to write a book that is both appealing to students studying coding theory within mathematics as well as engineering. The book is based on a course held by the authors; in the preface they write that the target group consists of graduate and advanced undergraduate students. A very precise description of the book could be given by citing the formulated aims of the EMS Textbooks in Mathematics:

"EMS Textbooks in Mathematics" is a book series aimed at students or professional mathematicians seeking an introduction into a particular field. The individual volumes are intended to provide not only relevant techniques, results and their applications, but afford insight into the motivations and ideas behind the theory. Suitable designed exercises help to master the subject and prepare the reader for the study of more advanced and specialized literature."

In the preface, the authors state that the reader is expected to have a knowledge of basic linear algebra and algorithms and moreover, to have a certain amount of maturity. Justesen and Høholdt have made efforts to use just the absolute necessary amount of mathematics when introducing the subjects to avoid a theoretical jungle that would block the view of most readers.

As an example we can mention that a finite field has been successfully described almost without using abstract algebra, and that Hermitian codes, with a background in algebraic geometry, are primarily handled by using linear algebra. As to Hermitian codes, however, the reader must accept to pay the price of being served Bézout's theorem without a proof.

The book gives a basic introduction to the fundamental concepts of coding theory and presents the reader with concepts from information theory such as error probability, mutual information and channel capacity.

Reed-Solomon codes and the related BCH codes are treated mainly with a view to their algebraic decoding. Both classical decoding algorithms and the new list decoding algorithms, originally introduced by Sudan, are treated. Apart from one chapter on the decoding of Reed-Solomon codes and BCH codes using Euclid's extended algorithm, the "Sudan setup" forms the underlying concept for explaining the algorithms, i.e. the code polynomials are roots in an interpolation polynomium. This method, which is also used for the decoding of Hermitian codes, gives a coherent understanding of the algebraic decoding methods for the family of Reed-Solomon codes and their relatives.

The presentation of cyclic codes and information frames leads to a very successful and unorthodox treatment of convolutional codes and their decoding.

Composed codes such as product codes and concatenated codes are treated emphasizing on error probabilities.

Finally there is a chapter on the topics that are presently the hottest in the field, viz. LDPC (Low-Density Parity Check) codes, turbo codes and iterative decoding.

Every section contains a number of fine and very concrete exercises, the solutions to which can be found on the last pages of the book. On the website for the book, a number of Maple-worksheets are obtainable that deal with finite fields, Reed-Solomon and BCH codes as well as their decoding. Some of the exercises in the book can only be solved if you use Maple or similar mathematical software. A list of errata can also be found on the website.

This book review appeared originally (in Danish) in the Newsletter "Matilde" no. 22 of the Danish Mathematical Society. We thank the editors for the permission to republish it here.

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Christian Thommesen [cthom@math.aau.dk] received his Master of Science degree from Copenhagen University in 1969 and his Ph.D degree in Electrical Engineering from Aalborg University in 1982. His research focuses on Information and Coding Theory.

Forthcoming conferences

compiled by Vasile Berinde (Baia Mare, Romania)

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

March 2005

9–April 1: 14th Internatiomal Workshop on Matrices and Statistics (IWMS-2005), Massey University, Albany Campus, Auckland, New Zealand
Information: *Web site: http://iwms2005.massey.ac.nz/*
[For details, see EMS Newsletter 53]

April 2005

1–July 30: Diophantine Geometry, Centro di Ricerca Matematica Ennio De Giorgi – Scuola Normale Superiore, Pisa, Italia, *http://www.crm.sns.it*
Theme: Among the many topics touched by Diophantine Geometry the meeting should focus mainly on integral and rational points on algebraic varieties and heights and dependence of points on subvarieties of group varieties.
Aim: This programme aims at providing the mathematical community with some of the main new ideas which have appeared in the past few years.
Main speakers: F. Amoroso, F. Baldassarri, M. Bennett, M. Bertolini, D. Bertrand, Y. Bilu, F. Bogomolov, E. Bombieri, P. Cohen, J.-L. Colliot-Thélène, P. Corvaja, S. David, C. Deninger, R. Dvornicich, J.-H. Evertse, G. Faltings, R. Ferretti, C. Gasbarri, P. Habegger, R. Heath-Brown, M. Hindry, M. Laurent, D. Masser, L. Merel, M. Mignotte, J. Noguchi, P. Philippon, G. Rémond, A. Schinzel, H.P. Schlickewei, W. Schmidt, J. Silverman, S. Dyer, Lucien Szpiro, R. Tijdeman, Y. Tschinkel, T. Tucker, E. Ullmo, E. Viada, C. Viola, P. Vojta, M. Waldschmidt, G. Wuestholz, Y. Zarhin, S.-W. Zhang
Format: lectures and invited talks
Programme (Scientific) committee: Y. Bilu (Univ. de Bordeaux I); E. Bombieri (Institute for Advanced Study – Princeton Univ.); D. Masser (Univ. Basel); L. Szpiro (Graduate Center-CUNY); U. Zannier (Scuola Normale Superiore)
Location: Centro De Giorgi, Collegio Puteano, Piazza dei Cavalieri 3, 56100 PISA, Italia
Grants: A limited number of grants are available for junior participants
Deadlines: for applications February 15, 2005
Information: e-mail: crm@crm.sns.it

3–8: "High Order Non-Oscillatory Methods for Wave Propagation: Algorithms and Applications"
Scientific Organizers: E.F. Toro (Trento) and C.-D. Munz (Stuttgart).
Plenary Speakers: P. Bountoux (Marseille), M. Dumbser (Stuttgart), H. Igel (Munich), M. Kaeser (Trento), C.D. Munz (Stuttgart), G. Russo (Catania), W. Schroeder (Aachen), C.W. Shu (Brown), Y. Takakura (Tokyo), V. Titarev (Trento), E.F. Toro (Trento), J. van der Vegt (Twente)
Site: Istituto Trentino di Cultura, IRST, Povo, Trento, Italy
Information: e-mail: michelet@science.unitn.it
Web sites: *http://www.science.unitn.it/cirm/wavepropagation.html, www.science.unitn.it/cirm/*

4–8: International conference on Selected Problems of Modern Mathematics, dedicated to the 200th anniversary of K.G. Jacobi, and the 750th anniversary of the Koenigsberg foundation
Information: e-mail: cyber@mathd.albertina.ru
[For details, see EMS Newsletter 54]

May 2005

9–20: The Third Annual Spring Institute on Noncommutative Geometry and Operator algebras & 20th Shanks Lecture, Vanderbilt University, Nashville, Tennessee, USA
Information: e-mail: ncgoa05@math.vanderbilt.edu
Web site: http://www.math.vanderbilt.edu/~ncgoa05
[For details, see EMS Newsletter 54]

16–18: Conference "Algorithmic Information Theory", University of Vaasa, Finland
Information: e-mail: ait05@uwasa.fi
Web site: http://www.uwasa.fi/ait05
[For details, see EMS Newsletter 54]

20–22: Joint BeNeLuxFra conference in Mathematics, Gent, Belgium
Description: This conference is a joint organization of the Mathematical societies of France, Luxembourg, The Netherlands and Belgium. It is the fourth in the series for Belgium, and counts as the 41st KWG meeting.
It focuses on some main current themes in pure and applied mathematics. On the meeting, the KWG awards the Brouwer Medal, and the Award Winner will give a plenary lecture.
Plenary Speakers: F. Campana (Nancy, France), Y. Benoist (Paris, France), J. Willem Klop (Amsterdam, The Netherlands), F. Point (Mons, Belgium), and the Brouwer Medal Award Winner. Evening Leisure Lectures by J. Doyen (Brussels, Belgium) and B. Polster (Monash, Australia).
Sessions and their (responsible) organizers: 1a. Differential Geometry, N. Poncin (Luxembourg) and M. Schlichemaier (Luxembourg); 1b. Algebraic Geometry, O. Debarre (France); 2a. Mathematical Statistics, R. Gill (The Netherlands); 2b. Coding/Crypto Theory, H. van Tilborg (The Netherlands); 3a. Harmonic Analysis, A. Valette (Belgium/Switserland); 3b. Partial Differential Equations, G. Lebeau (France) and J. Hulshof (The Netherlands); 4a. Computer Science, B. Hoogewijs (Belgium); 4b. History of Mathematics, G. Alberts (The Netherlands) and M. Bullinck (Belgium); 5a. Non commutative Algebra, L. De Bruyn (Belgium) and J. Alev (France); 5b. Model Theory, F. Point (Belgium)
Scientific Organizing Committee: A. Hoogewijs (Ghent Univ.), F. Loeser (Ecole Normale Superieure, Paris), C. Molitor-Braun (Univ. of Luxembourg), H. te Riele (Centrum voor Wiskunde en Informatica, Amsterdam), H. Van Maldeghem (Ghent Univ.)
Information: e-mail: hvm@cage.ugent.be
Web site: http://cage.ugent.be/bnlf/

22–27: "Fourth School on Analysis and Geometry in Metric Spaces"
Scientific Organizers: L. Ambrosio (Pisa), B. Franchi (Bologna), R. Serapioni (Trento) and F. Serra Cassano (Trento). Short courses by: A. Agrachev (SISSA Trieste),
Z. Balogh (Bern), B. Kleiner (Ann Arbor), P. Pansu (Paris Sud).
Site: Istituto Trentino di Cultura, IRST, Povo, Trento, Italy.
Information: e-mail: michelet@science.unitn.it
Web sites: http://www.science.unitn.it/cirm/Ann4MeSpa.html, www.science.unitn.it/cirm/

29–June 5: Spring School in Analysis: Function Spaces and Applications, Paseky nad Jizerou, Czech Republic
Theme: function spaces and applications
Topics: Hardy Operators, Function Spaces, Embeddings, Whitney Extension Problem, Helly's intersection theorem
Main speakers: W. Desmond Evans (Univ. of Wales, Cardiff, UK), P. Shvartsman (Technion, Haifa)
Organizing committee: J. Lukes, L. Pick (Czech Republic) Lecture notes containing main talks: to be published
Grants: probably support for a limited number of students
Deadlines: for reduced fee, 15 February 2005; for support, 15 February 2005
Information: *Web site*: http://www.karlin.mff.cuni.cz/katedry/kma/ss/jun05/

30–June 6: "Complex Analysis and Geometry – XVII"
Scientific Organizers: V. Ancona (Firenze) and A. Silva (Roma I).
Site: Grand Hotel Bellavista, Levico Terme, Trento, Italy.
Information: *Web site*: www.science.unitn.it/cirm/

June 2005

1–7: International Conference Constructive Theory of Functions, Varna, Bulgaria
Aim: To bring together specialists working in the field of Approximation Theory.
Topic: The whole spectrum of Approximation Theory and its applications
Main speakers: C. de Boor (Wisconsin, USA), B. Kashin (Moscow, Russia), S. Konyagin (Moscow, Russia), A. Kuij-laars (Leuven, Belgium), G. Nikolov (Sofia, Bulgaria), V. Totik (Szeged, Hungary and Tampa, USA)
Special guest of the organizers: P. Enflo (Kent State, USA)
Format: keynote lectures and contributed presentations
Sessions: two parallel sessions will follow each plenary lecture
Call for papers: the researchers who wish to participate in the conference and deliver a contributed talk, are asked to submit short abstract (at most 30 lines) written in LaTeX, to the e-mail address: ctf2005@math.bas.bg
Organizers: Institute of Mathematics and Informatics of the Bulgarian Academy of Sciences, and Sofia University
Programme committee: W. van Assche (Leuven, Belgium), B. Bojanov (Sofia, Bulgaria), Z. Ciesielski (Gdansk, Poland), W. Haussmann (Duisburg, Germany), B. Sendov (Sofia, Bulgaria) – Chairman, A. Shadrin (Cambridge, United Kingdom), J. Szabados (Budapest, Hungary), V. Tikhomirov (Moscow, Russia)
Organising committee: B. Sendov (Sofia) – Chairman, A. Andreev (Sofia), B. Bojanov (Sofia) – Co-chairman, K. Ivanov (Sofia), G. Nikolov (Sofia), P. Petrushev (Columbia)
Proceedings: The survey papers by the invited speakers and referred contributed papers will be published in the proceedings volume. The length of contributed papers should not exceed 8 pages.
Location: The conference will be hosted by the International Home of Scientists "F. Joliot-Curie", which is located in the oldest Bulgarian Black sea resort "St Constantine", near Varna.
Deadlines: For registration and abstract submission: 30 April, 2005. For manuscript submission to be published in the Proceesings Volume: 30 September, 2005.
Registration: The registration fee is 140 EURO for participants and 90 EURO for accompanying persons, paid upon the arrival
Information: e-mail: ctf2005@math.bas.bg
Web site: http://www.math.bas.bg/CTF-2005

2–10: Seventh International Conference on Geometry, Integrability and Quantization with a special session on Multisymplectic Geometry and Classical Field Theory, Sts. Constantine and Elena resort (near Varna), Bulgaria
This seventh edition of the conference aims like the previous ones to bring together experts in the Classical and Modern Differential Geometry, Complex Analysis, Mathematical Physics and related fields in order to assess recent developments in these areas and to stimulate research in intermediate topics.
Organizers: I.M. Mladenov (Sofia), A. Hirshfeld (Dortmund), M. de Leon (Madrid)
Location: Sts. Constantine and Elena resort (near Varna), Bulgaria
Information: For more information please contact I.M. Mladenov (e-mail: mladenov@obzor.bio21.bas.bg), A. C. Hirshfeld (e-mail: hirsh@physik.uni-dortmund.de), Manuel de Leon (e-mail: mdeleon@imaff.cfmac.csic.es) or visit the Conference Web page: http://www.bio21.bas.bg/conference/ .

June 3–5: International Conference on Mathematics Education, Svishtov, Bulgaria.
Dedicated to the 50–anniversary of the Department of Mathematics Education at the Faculty of Mathematics and Informatics – Sofia Univ.
Aim: The Conference is dedicated to the 50th anniversary of the Department of Mathematics Education at the Faculty of Mathematics and Informatics – Sofia University, the 15th anniversary of the Department of Mathematics and Informatics Education at the Institute of Mathematics and Informatics – Bulgarian Academy of Sciences and the 70th anniversary of I. Ganchev – the first Bulgarian full professor and DSc in Mathematics Education.
Format: The Conference will consist of several sessions covering multiple themes but all under the general aim of Mathematics Education
Topics: Mathematics in the Modern World; Mathematics and Didactics; Mathematics and Society; Mathematics and Sciences; Mathematics and Technology; Mathematics and Talent; Mathematics and Motivation; MATHEU European Project; Mathematics and Statistics; History of Mathematics
Organizers: Union of the Bulgarian Mathematicians; "D. A. Tsenov" Academy of Economics – Svishtov; Faculty of Mathematics and Informatics – Sofia University; Southwestern University – Blagoevgrad; Institute of Mathematics and Informatics – Bulgarian Academy of Sciences
International Scientific Committee: M. Georgieva (Univ. of V. Tarnovo, chair), S. Slavova (College of Dobrich, Secretary); A. Gagatsis (Univ. of Cyprus), G. Makrides (Intercollege, Cyprus), Y. Koljagin (Acad. for Pedagogical Sciences, Russia); G. Lukankin (Acad. for Pedagogical Sciences, Russia), F. Spagnolo (Univ. of Palermo, Italy), R. Malceski (Univ. of Skopje, Macedonia); S. Anastasiadou (Univ. of Thessalonica, Greece)
Program Committee: S. Grozdev (Institute of Mathematics and Informatics, Sofia) – Chair; A. Velchev (Institute of Mathematics and Informatics, Sofia) – Secretary; K. Bankov (Sofia Univ.), J. Tabov (Bulgarian Academy of Sciences), S. Bilchev (Rousse Univ.), G. Kozhuharova (Stara Zagora), N. Georgieva (Sofia Univ.), V. Milushev (Univ. of Plovdiv), I. Ivanov (Univ. of Shumen), L. Politova (Ministry of Education), I. Tonov (Sofia Univ.), Z. Lalchev (Sofia Univ.)
Organizing Committee: S. Stefanov ("D. A. Tsenov" Academy of Economics, Svishtov, Chair), M. Bogdanova (Svishtov Municipality), Z. Ivanov (Union of the Bulgarian Teachers), I. Asparuhova , A. Sarkisjan, I. Totev (all "D. A. Tsenov" Academy of Economics, Svishtov), E. Velikova (Univ. of Rousse), T. Chehlarova, D. Frenkev (both Univ. of Plovdiv), J. Krastev, M. Shopova (both "D. A. Tsenov" Academy of Economics, Svishtov), N. Nikolov ("D. Blagoev" School, Svishtov), S. Tinchev ("Ts. Radoslavov" School, Svishtov), R. Ivanova ("D. Hadjivassilev" School, Svishtov)
Information: e–mail: smb@math.bas.bg

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

13–17: Computational Methods and Function Theory CMFT 2005, Joensuu, Finland
Information: e-mail: cmft@joensuu.fi
Web site: http://www.joensuu.fi/cmft
[For details, see EMS Newsletter 54]

20–22: Workshop on Mathematical Problems and Techniques in Cryptology, Centre de Recerca Matemàtica, Campus of the Universitat Autònoma de Barcelona
Information: e-mail: work-cryptology@crm.es
Web site: http://www.crm.es/jornadas_criptologia
[For details, see EMS Newsletter 54]

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

28-July 2: Barcelona Conference on Geometric Group Theory, Centre de Recerca Matemàtica, Campus of the Universitat Autònoma de Barcelona
Information: e-mail: GeometricGroupTheory@crm.es
Web site: http://www.crm.es/GeometricGroupTheory
[For details, see EMS Newsletter 54]

July 2005

5–15: Advanced Course on the Geometry of the Word Problem for finitely generated groups, Centre de Recerca Matemàtica, Campus of the Universitat Autonoma de Barcelona
Information: e-mail: WordProblem@crm.es
Web site: http://www.crm.es/WordProblem
[For details, see EMS Newsletter 54]

7–9: OTFUSA2005: Conference on Operator Theory, Function Spaces and Applications, Dedicated to the 60th birthday of Professor F.-O. Speck
Aim: The conference OTFUSA2005 will celebrate the 60th birthday of Professor Frank Speck and aims to bring together those enrolled in the research activities related with operator theory, function spaces and related applications. It aims to promote the exchange of ideas and knowledge and to reinforce scientific contacts.
Topics: include 1. Convolution type operators and related classes of singular operators, Bessel potential and pseudo-differential operators, factorisation theory, operator relations and normalisation problems; 2. The theory of function spaces and distributions around Lebesgue, Lorentz, Sobolev, Besov and Triebel-Lizorkin spaces, embeddings, interpolation, traces and extensions, representation formulas, oscillation; 3. Applications to mathematical physics, wave diffraction and scattering theory, elliptic boundary value problems, mixed problems in canonical domains, localisation, interface problems, boundary integral methods, boundary-domain methods, explicit solutions, regularity, singularities, fractal analysis and asymptotic behaviour.
Information: Web site: http://www.mat.ua.pt/otfusa2005/

17–August 14: Summer School of Atlantic Association for Research in the Mathematical Sciences, Campus of Dalhousie University in Halifax, Nova Scotia, Canada
Information: e-mail: tony@mathstat.dal.ca; renzo@ matapp.unimib.it; renzo@mathstat.dal.ca
[For details, see EMS Newsletter 54]

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

24–28: 25th European Meeting of Statisticians (EMS 2005), Oslo, Norway
Topics: all areas of methodological, applied and computational statistics, probability theory and applied probability
Main speakers: D. Donoho (Stanford), Y. Peres (Berkeley), B. Virag and O. Aalen (Oslo), J. Bertoin (Paris), W. Kendall (Warwick), N. Shephard (Oxford), L. Davies (Essen), K. Worsley (Montreal)
Format: invited talks and contributed presentations
Sessions: there will be plenary lectures and parallel sessions
Call for papers: If you wish to present a contributed presentation, please submit an abstract limited to one standard A4 page. Most formats are acceptable. Abstracts should be submitted via the conference web pages (ems2005.no).
Organizers: University of Oslo and Norwegian Computing Center
Programme committee: A. van der Vaart (chair, Amsterdam), R. Borgan (Oslo), U. Gather (Dortmund), S. Richardson (London), G. Roberts (Lancaster), T. Rolski (Wroclaw), J. Steif (Göteborg)
Organising committee: A. Frigessi (chair), N. Lid Hjort (deputy), B. Storvik, A. Teigland, A. Leeland, K. Homme, R.B. Huseby, M. Aldrin, G. Hagnad, _. Steinbakk, I. Helland, S.O. Samuelsen, G. Fenstad, G. Storvik, R. Borgan
Location: University of Oslo
Grants: The EU is funding a special pre-conference course, open to PhD students, postdocs and researchers with less than 10 years experience, members of the European Union or one of the Associated States. The grant will provide support towards travel, accommodation, part of local expenses, but not the registration fee to the EMS.
Deadlines: for early registration, 1 May 2005; for conference registration, 30 June 2005; for submission of contributed papers and poster, 31 March 2005; for grant application, 1 March 2005
Information: e-mail: ems2005@nr.no
Web site: ems2005.no

30–August 6: Groups St. Andrews 2005, University of St. Andrews, St. Andrews, Scotland
Information: e-mail: gps2005@mcs.st-and.ac.uk
Web site: http://groupsstandrews.org
[For details, see EMS Newsletter 54]

August 2005

21–26: SEMT ,05 (International Symposium on Elementary Mathematics Teaching), Czech Republic, Charles University in Prague, Faculty of Education
Information: e-mail: jarmila.novotna@pedf.cuni.cz
Web site: http://www.pedf.cuni.cz/kmdm/index.htm
[For details, see EMS Newsletter 54]

28–2 Sept: Workshop „Arithmetic Geometry and High Energy Physics“, Lorentz Center (Leiden)
Aim: Besides the traditional fields of mathematics that interact with (theoretical) physics (such as analysis, group theory and, in the past decade, algebraic geometry), recent years have seen an increasing and surprising role of arithmetic and number theory in high energy physics. Conversely, ideas from quantum field theory and string theory are beginning to have an influence on these mathematical subjects. In this workshop we intend to bring together a moderately sized group (30–50 participants) of mathematicians and physicists to present and discuss some of these recent developments.
Topics: Holography and uniformization (Kleinian groups, non-archimedean uniformization, Arakelov geometry, AdS/CFT, Liouville action, gerbes); Quantum field theory and motives (renormalization, motivic galois theory, multiple zeta values, dilogarithms); String theory and modularity (arithmetic Calabi-Yau manifolds, complex multiplication); M-theory and automorphic forms (M-theory duality and Howe duality)
Organizers: G. Cornelissen (Utrecht), M. Marcolli (MPIM, Bonn), A. Waldron (UC Davis)
Information: *Web site*: http://www.lc.leidenuniv.nl/

29–September 2: Conference on Differential Geometry and Physics, Budapest, Hungary
Aim: The aim of the conference is to bring together mathematicians and physicists interested in differential geometry and its applications in mathematical physics to give lectures on new results, exchange ideas, problems and conjectures
Topics: Riemannian, Lorentzian and Finslerian geometry, submanifold theory, connection theory; General relativity, singularities, twistor theory, string theory, gauge theory; Symmetries, Lie groups, Lie theory of loops, symmetric spaces
Main speakers: T. Friedrich (Humboldt Univ.), P. Gilkey (Univ. of Oregon), … (invitations are in progress)
Organizers: Eötvös Univ. (Budapest); Univ. of Debrecen; KFKI Research Institute for Particle and Nuclear Physics (Budapest)
Organising committee: B. Csikós (chairman), S. Bácsó, Z. Horváth, L. Kozma, G. Moussong, P. Nagy, I. Rácz, L.B. Szabados, J. Szenthe, J. Szilasi, R. Szõke, L. Tamássy, L. Verhóczki.
Location: the new campus of the Faculty of Science, Eötvös University Budapest
Deadline for registration: 31 May 2005
Information: e-mail: csikos@cs.elte.hu
Web site: http://www.cs.elte.hu/geometry/DGP05/

September 2005

1–December 31: The Scientific Revolutions of the XVI and XVII Century, Centro di Ricerca Matematica Ennio De Giorgi - Scuola Normale Superiore, Pisa, Italia (http://www.crm.sns.it)
Theme: Modern science is usually considered to have started in the XVI century: from then on mathematics, physics and astronomy have taken up a new form; the image of the world and of nature – from cosmos to the human body – have undergone a radical and definitive change, starting a process that is still going on.
Aim: The Centro di Ricerca Matematica Ennio De Giorgi intends to organize a period of three months of intensive studies on this crucial period, addressing it especially to young researchers.
Topics: 1. the origin of mechanics: classical and medieval traditions and the birth of Galilean "new science"; 2. revolutions in astronomy: Copernicus, Brahe, Galileo and others; 3. the birth of symbolic algebra and the impact of the classic tradition: the rediscovery of Pappus, Diophantus and the work of Francois Viete; 4. the theory of indivisibles: from Valerio and Cavalieri to Leibniz; 5. science and arts: new images for a new science; 6. war and the new science; 7. from the discovery of the human body to the birth of a new medicine
Main speakers: there is not yet a definite list of invited speakers
Format: short courses and thematic workshops; in addition, talks and debates will be held on the relationship between science and culture in the XVI and XVII century. Programme (Scientific) committee: M. Ciliberto (Scuola Normale Superiore), E. Giusti (Univ. di Firenze), E. Knobloch (Technische Univ. Berlin), M. Mugnai (Scuola Normale Superiore), P. Daniele Napolitani (Univ. di Pisa), P. Radelet-de Grave (Univ. Catholique de Louvain)
Location: Centro di Ricerca Matematica Ennio De Giorgi, Collegio, Puteano, Piazza dei Cavalieri, 3, 56100 Pisa, Italy

Grants: A limited number of grants is available for junior participants.
Deadlines: June 15, 2005
Information: e-mail: crm@crm.sns.it

7–9: 4th IMA International Conference on Mathematics in Transport [A Conference in Honour of Richard Allsop]
Aim: To bring together academics and practitioners with an interest in mathematics in the fields of transport planning, transport safety, and traffic management across the modes.
Scope: To present novel methods and applications of mathematical and statistical methods in transport.
Main speakers: to be announced
Format: Invited speakers and contributed presentations
Sessions: Plenary lectures
Call for papers: Please submit an abstract of 300–500 words by 11 March 2005 either electronically or hard copy.
Organisers: The Institute of Mathematics and its Applications (UK)
Organising Committee: B.G. Heydecker (chair) (London), M.G.H. Bell (London), M. Carey (Belfast), M.J. Maher (Edinburgh), M.J. Smith (York), B. Waterson (Southampton), D.P. Watling (Leeds), C.C. Wright (London)
Location: University College London
Deadlines: for abstracts 11 March 2005
Information: e-mail: conferences@ima.org.uk
Web site: www.ima.org.uk

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

16–18: EMS-Catalan Mathematical Society Joint Mathematical Weekend Barcelona, Spain
Topics and plenary speakers: Combinatorics and Graph Theory, B. Bollobas (Trinity College, Cambridge and Univ. of Memphis); Dynamical Systems, J.-C. Yoccoz (College de France); Evolution PDEs and Calculus of Variations, H. Berestycki (Ecole des Hautes Etudes en Sciences Sociales, France); Module Theory and Representations of Algebras, Henning Krause (Univ. Paderborn); Non-commutative Geometry , A.I. Bondal (Steklov Mathematical Institute, Moscow)
Format: Plenary lectures and session lectures
Organising Committee: Marta Sanz-Sole (Chair), Univ. de Barcelona, J. Amores, Univ. Politecnica de Catalunya, J.A. Carrillo de la Plata. ICREA-Univ. Autonoma de Barcelona, C. Casacuberta, Univ. de Barcelona, D. Herbera, Univ. Autonoma de Barcelona, T. Martinez-Seara, Univ. Politecnica de Catalunya, R.M. Miro-Roig, Univ. de Barcelona, M. Noy, Univ. Politecnica de Catalunya
Session co-organisers: L. Angeleri-Hegel (Univ. degli Studi dell'Insubria), X. Cabri (ICREA-Univ. Politecnica de Catalunya), P. Cameron (Queen Mary, Univ. of London), A. Laudal (Univ. of Oslo), D. Sauzin (CNRS, France), G. Toscani (Univ. di Pavia)
Information: *Web site*: http://www.iecat.net/scm/emsweekend

20–22: 7th Hellenic-European Research on Computer Mathematics and its Applications (HERCMA 2005) Conference, Athens, Greece
Theme: Computer Mathematics and its Applications *Aim*: To provide updated overviews of methodologies, techniques and tools used in Computer Mathematics and its Applications.
Scope: to present the state of the art, design the current trends in the field and contribute to the diffusion of the scientific knowledge in Mathematics-Informatics-Economics.
Topics: Computational Mathematics, High Performance Computing, Operational Research and Statistics, Mathematics in Economics and Industry.
Main speakers: R. Penrose* (Oxford Univ.), T. Asano (Japan Adv. Inst. of Sc. and Technology), J.-Z. Cui (AMSS-Chinese Academy of Sciences), B. Fischer (Univ. of Luebeck), T. Huckle (Techn. Univ. of Munchen), C. Johnson (Chalmers Univ. of Technology), G. Karniadakis (Brown Univ.-MIT), J. Menlek (Univ. of Reading), S. Osher (Univ. of California), N. Papamichael (Univ. of Cyprus) (*) To be confirmed
Format: Keynote Lectures, Invited Talks, Contributed Presentations
Sessions: Plenary Lectures, Parallel Sessions, Minisymposia
Languages: English and Hellenic
Organizers: Athens University of Economics And Business (AUEB), Department of Informatics, Research Group for Advanced Computational Mathematics & Parallel Processing
Proceedings: to be published
Location: The Athens University of Economics & Business, 76 Patision Street, Athens 10434, Greece.
Deadlines: for submission of the full papers (extended abstracts): 20 February, 2005; for mini-symposia proposals: 20 February, 2005; Notification of acceptance: 10 April, 2005; for the submission of the complete papers: 30 May, 2005
Information: *Web site*: http://www.aueb.gr/conferences/hercma2005

October 2005

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

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

Recent books

edited by Ivan Netuka and Vladimir Souček (Prague)

L. Ambrosio, P. Tilli: Topics on Analysis in Metric Spaces, *Oxford Lecture Series in Mathematics and Its Applications, Oxford University Press, Oxford, 2004, 141 pp., £29,50, ISBN 0-19-852938-4*

Analysis in metric spaces has considerably expanded in recent years. Experts in analysis on (weighted) Euclidean spaces, manifolds, Carnot groups, and fractals, who are interested in function spaces, harmonic analysis, geometry of curves or quasiconformal geometry, have observed that a ground for some of their methods can be reduced to metric structures and thus the theory can be developed once for all frameworks.

The book by Ambrosio and Tilli presents a representative part of the fundamentals of this development. Part of the text gives elements of measure and integration theory: Riesz representation theorem, weak convergence of measures, construction of measures and particularly Hausdorff measures, abstract integration (this for general increasing set functions by the method of De Giorgi and Choquet). Next, Lipschitz mappings are studied and results related to area and coarea formula are discussed. The part on the geodesic problem presents Busemanns existence result. This claims the existence of a geodesic (i.e., shortest) connection between two points x,y in a metric space E provided all bounded sets of E are compact and there exists a connection of finite length. It is also shown that it is equivalent to consider the connections as connected sets (measured by the one-dimensional Hausdorff measure) or as parameterized curves. This requires some nontrivial facts on rectifiability. The Gromov-Hausdorff convergence of metric spaces is introduced and compactness and embedding results are proved. The method of Gromov-Hausdorff convergence is used to prove an existence theorem for the Steiner problem, which is a generalization of the geodesic problem. Even in the geodesic case, the assumptions are further weakened. The theory of Sobolev spaces of Hajlasz type on metric spaces is developed. It is shown that this concept generalizes the ordinary Sobolev spaces on extension domains. Inequalities of Sobolev and Poincaré type are proved.

The book is based on lectures given by the authors at the Scuola Normale in Pisa and presents a well-chosen selection of what to say to students in the field, when time is limited, with suggestions for further studies. The enjoyable exposition of the subject is supplemented by exercises of various levels. (jama)

C. Anné et al., (Eds.): Laurent Schwartz (1915–2002)*, Gazette des Mathématiciens, suppl. no. 98, Société Mathématique de France, Paris, 2003, 212 pp., ISBN 2-85629-140-6*

The famous French mathematician Laurent Schwartz (born on March 15, 1915) died on July 14, 2002. The book contains articles written by Schwartz's colleagues, former students, relatives and friends. Some articles are devoted to mathematical questions and can be appreciated mainly by mathematicians; some others describe Schwartz's numerous political and social activities, his private interests and fancies, concerns and events of his private life. Laurent Schwartz became famous as the author of the theory of distributions, a branch of mathematics that has made its way to all branches of mathematical analysis and applied mathematics. He worked at the University of Paris from 1953, and moved to the École Polytechnique in 1959. His students recall him as an excellent teacher. He had a passion for teaching (he taught his younger brother in childhood to decline Greek nouns with enjoyments on both sides). Schwartz was also involved in a reform of the system of education, including the system for selection of students entering universities. He was also very active in social and political questions. He always supported human rights and actions against wars and colonialism. When the first Mathematical Congress after the war took place in Harvard in 1950, Schwartz had serious troubles getting an entry visa to the USA. After a big effort from mathematicians, a visa was given to him (as well as to J. Hadamard, which was Schwartz's condition).

The mathematician Laurent Schwartz had always made a big effort to improve the world he lived in. He was the chairman of a protest association "Comité Audin", investigating the murder of a mathematician Maurice Audin during the Algerian war in the 50's, and a founding member of the "Comitée des mathématiciens" in the 70's, which was created to support all persecuted mathematicians in totalitarian countries. He was also engaged in many other social activities. Shortly before his death, he published his autobiography "Un mathématicien aux prises avec le siècle", which is an excellent description and analysis of development of mathematics and of the political events in the past century. (jjel)

J. Appell, E. De Pascale, A. Vignoli: Nonlinear Spectral Theory*, de Gruyter Series in Nonlinear Analysis and Applications, vol. 10, Walter de Gruyter, Berlin, 2004, 408 pp., EUR 148, ISBN 3-11-018143-6*

Nonlinear spectral theory is a relatively new field of mathematics, which is far from being complete, and many fundamental questions still remain open. The main focus of this book is therefore formulated by the authors as the following question: How should we define a spectrum for nonlinear operators in such a way that it preserves useful properties of the linear case but admits applications to a possibly large variety of nonlinear problems? Contrary to the linear case, the spectrum of a nonlinear operator contains practically no information on this operator. The authors convince the reader that it is not the intrinsic structure of the spectrum itself, which leads to interesting applications, but its property of being a useful tool for solving nonlinear equations. The book is an excellent presentation of the "state-of-the-art" of contemporary nonlinear spectral theory as well as a glimpse of the diversity of directions in which current research is moving.

The whole text consists of 12 chapters. The authors recall basic facts on the spectrum of a bounded linear operator in the first chapter. In Chapter 2, some numerical characteristics providing quantitative descriptions of certain mapping properties of nonlinear operators are studied. The classical Kuratowski measure of noncompactness plays a key role here. Chapter 3 is devoted to general invertibility results. In particular, conditions that guarantee that the local invertibility of a nonlinear operator implies its global invertibility are of interest. The Rhodins and the Neuberger spectra are studied in Chapter 4. In Chapter 5, the authors study a spectrum for Lipschitz continuous operators, first proposed by Kachurovskij in 1969, and a spectrum for linearly bounded operators, introduced recently by Dörfner. Chapter 6 discusses the spectrum for certain special continuous operators introduced by Furi, Martelli and Vignoli in 1978, and its modification introduced recently by Appell, Giorgieri and Väth. The Feng spectrum is discussed in detail in Chapter 7. Chapter 8 is devoted to the study of "local spectrum" due to Väth, which in the literature is called "phantom". In Chapter 9, the authors investigate a modification of the Feng spectrum proposed by Feng and Webb and another spectrum introduced by Singhof-Weyer and Weberand Infante-Webb. Chapter 10 is devoted to the study of nonlinear eigenvalue problems. The authors concentrate on the notion of a "nonlinear eigenvalue", nonlinear analogue of the Krein-Rutman theorem, connected eigenvalues, etc. Chapter 11 contains a description on how numerical ranges may be used to localize the spectrum of a nonlinear operator on the real line or in the complex plane. Selected applications are presented in the last Chapter.

The exposition of nonlinear spectral theory in this book is self-contained. All major statements are proved; each definition and notion is carefully illustrated by examples. To understand this text does not require any special knowledge and only modest background of nonlinear analysis and operator theory is required. The book is addressed not only to mathematicians working in analysis but also to non-specialists wanting to understand the development of spectral theory for nonlinear operators in the last 30 years. The bibliography is rather exhaustive and so this text will certainly serve as an excellent reference book for many years. I am convinced that at least one copy of this book should be in any mathematical library. (pdr)

V. I. Arnold: Lectures on Partial Differential Equations*, Universitext, Springer, Berlin, 2004, 157 pp., 39,95, ISBN 3-540-40448-1*

The presented book is, as are all V. Arnold's books, full of geometric insight. Its aim is to cover most basic parts of the subject, in particular the Cauchy and Neumann problems for the classical linear equations of mathematical physics. In the preface to the second Russian edition (which is included in the book) one reads: "The author… has attempted to make students of mathematics with minimal knowledge… acquainted with a kaleidoscope of fundamental ideas of mathematics and physics. Instead of the principle of maximal generality, which is usual in mathematical books, the author has attempted to adhere to the principle of minimal generality, according to which every idea should first be clearly understood in the simplest situation; only then can the developed method be extended to more complicated cases.…" The book follows a series of lectures, which were delivered to the third year students in the Mathematical College of the Independent University of Moscow during the fall semester of 1994/95. The examination problems at the end of the book form an essential part of it. (oj)

V. Berinde: Exploring, Investigating and Discovering in Mathematics*, Birkhäuser, Basel, 2003, 268 pp., EUR 34, ISBN 3-7643-7019-X*

The book is a collection of problems from elementary mathematics. It can be of substantial help in work with gifted secondary school students. On the other hand, it also contains problems on determinants, special sequences, functional equations, primitive functions, difference and differential equations, so that it will be useful for work with students of basic courses on analysis and algebra. The collection is divided into 24 groups. Over 100 problems are presented with solutions, and another 150 are accompanied by hints and clear ideas how to proceed on the way to a solution. Using included material, the author leads readers from active problem solving to exploration of methods to obtain new problems and to an active use of the gained inventive skills. The book is based on the author's personal long lasting cooperation with the Romanian journal *Gazeta Matematica*. (jive)

B. Booss-Bavnbek, J. Hoyrup, Eds.: Mathematics and War*, Birkhäuser, Basel, 2003, 416 pp., 39, ISBN 3-7643-1634-9*

The book contains contributions from mathematicians, historians of mathematics, historians of military and war, military analysts and philosophers from eight countries (Denmark, Germany, Japan, Norway, Russia, Sweden, United Kingdom, USA), who took part in the "International Meeting on Mathematics and War" (Blekinge Institute of Technology, Karlskrona, Sweden, 2002). The main aim of the book is to give a picture of the interaction between mathematics, war and weapons. Contributions show the role played by military support in the development of modern mathematics and in the careers of some mathematicians (in particular, during the World War II), as well as parts of mathematics important for the war and military industry (e.g., coding machines, optimal control, mathematical modeling). Some chapters contain a discussion on how mathematics influenced the character and performance of modern warfare, weapons and the military industry. The authors also describe difficult individual decisions of certain mathematicians during the war time (including N. Bohr, A.N. Kolmogorov, M. Rees, A. Turing and K. Ogura) and their personal histories. It leads to a discussion of many general ethical questions. The book can be recommended to mathematicians, historians of mathematics and military, as well as to readers interested in ethics, sociology and political sciences. (mnem)

X. Buff, J. Fehrenbach, P. Lochak, L. Schneps, P. Vogel: Moduli Spaces of Curves, Mapping Class Groups and Field Theory*, SMF/AMS Texts and Monographs, vol. 9, American Mathematical Society, Providence, 2003, 131 pp., $44, ISBN 0-8218-3167-4*

This is an English translation of the monograph published by the SMF in French in 1999. The review of the French edition appeared in the *Newsletter* No. 41 (September 2001). (vs)

G. Burde, H. Zieschang: Knots*, second edition, de Gruyter Studies in Mathematics 5, Walter de Gruyter, Berlin, 2003, 559 pp., EUR 69,16, ISBN 3-11-017005-1*

This is the second edition of the famous monograph. Besides correcting mistakes, the authors added some material. In Chapter 10 (Braids), a proof of Markov's theorem was added. In Chapter 15 (Knots, Knot Manifolds, and Knot Groups), the Gordon-Lücke theorem on knot complements was included (without a proof). There is a new Chapter 16 (The 2-variable skein polynomial). Here we find an introduction to the HOMFLY polynomial and a self-contained exposition of basic facts on Hecke algebras. Finally, the bibliography was updated. (jiva)

G. Cherlin, E. Hrushovski: Finite Structures with Few Types*, Annals of Mathematics Studies, no. 152, Princeton University Press, Princeton, 2003, 193 pp., £17,95, ISBN 0-691-11332-7, ISBN 0-691-11331-9*

The monograph develops a structure theory for a class of finite structures, whose description lies on the border between model theory and group theory. Model theoretic methods are applied to a study of certain finite permutation groups, the automorphism groups of structures for a fixed finite language with a bounded number of orbits on 4-tuples. The work uses methods of permutation theory, model theory, classical geometries and combinatorics. The principal results (summarized in Section 1.2) are finiteness theorems showing that the structures under consideration fall naturally into finitely many families, where each family is parameterized by finitely many numerical invariants, dimensions of associated coordinating geometries. (jj)

J. R. Cho, J. Mennicke, Eds.: Recent Advances in Group Theory and Low-Dimensional Topology*, Research and Exposition in Mathematics, vol. 27, Heldermann, Lemgo, 2003, 181 pp., EUR 30, ISBN 3-88538-227-X*

The book contains Proceedings of the 2nd German-Korean Workshop on Algebra and Topology, which was held at Pusan National University, Korea, in August 2000. The main aim of this workshop was to stimulate cooperation between Germany and Korea. The proceedings present 14 articles based on selected lectures delivered at the workshop. We can say that lectures were focused on low dimensional topology. In the proceedings, there are also several contributions concerning group theory but they always deal (maybe with one exception) with group theoretical problems arising in low dimensional topology. All articles are very carefully written, and several of them contain a survey of the recent research in relevant directions (e.g., Recent developments in the theory of Fuchsian and Kleinian groups, Quadratic equations in free groups and topological applications, Colourings of polyhedra and hyperelliptic 3-manifolds, Survey on dimension subgroup problem). The collection will be of interest to topologists working in low dimensional topology and for group theorists cooperating with them. (jiva)

S.B. Cooper: Computability Theory*, Chapman & Hall/ CRC Mathematics Series, vol. 26, Chapman & Hall/CRC, Boca Raton, 2003, 424 pp., $69,95, ISBN 1-58488-237-9*

Computability as a theory is a specifically twentieth-century development. It started with the fundamental work of Gödel, Turing and Kleene, among others, in the 1930's. History of the subject is unusual, because the history (like the Universal Turing machine) preceded its physical embodiment by around ten years. The book presents a wide range of topics such as computably enumerable sets, the degree structures, subrecursive hierarchies, complexity of computations and also some recent work on computability of structures and algorithmic randomness. It provides an excellent introduction to contemporary computability theory. All substantial techniques and results are explained, historical and logical context is also given. The book includes both the standard material for a first course in computability and also more advanced material on forcing, priority methods, determinacy and algorithmic randomness. (akč)

L. Corry: Modern Algebra and the Rise of Mathematical Structures*, second revised edition, Birkhäuser, Basel, 2003, 472 pp., EUR 65, ISBN 3-7643-7002-5*

The book offers an excellent answer to the questions of what mathematical structures are, how they were discovered and how they were adopted in mathematical research. The book is divided into two parts. The first part contains five chapters. Chapter 1 contains information on algebraic research in the late nineteenth century. From Chapter 2 to Chapter 5, the beginning of structural approach and first concepts of modern algebra are discussed. The main aim of these chapters is to show the development of the ideal theory in the period between the work by R. Dedekind and E. Noether. The author describes the most important discoveries of Dedekind, Hilbert, Hensel, Steinitz, Loewy, Fraenkal and Noether. The reader can see the development of algebraic number theory (ideal prime numbers, algebraic invariants, theory of p-adic numbers) and the beginning of axiomatic approach to algebra (the Hilbert axiomatic approach, structural image of algebra, axioms for p-adic systems, theory of rings and ideals).

The second part deals with three different mathematical theories and their historical roots. The first one is the so-called Oystein-Ore lattice developed between 1935 and 1945. The second attempt to create modern structural algebra is associated with the Bourbaki works. Details of Bourbaki's ideas in set theory, algebra, general topology and commutative algebra are discussed in next chapters. The author describes an interpretation of relations between a general non-formalized idea of a mathematical structure and its axiomatic formalization. The third theme described in this part is category theory. The author analyses roots of the theory crystallizing in the USA between 1943 and 1960. Its development in the next decade is described at the end of the book. An extensive bibliography and subject index are included. The book offers excellent information on the treated topics and can be recommended to historians of mathematics and mathematicians who are interested in the development of mathematics in the twentieth century. It could also be of interest to philosophers and historians of sciences studying the development of scientific ideas. (mnem)

H. G. Dales, P. Aiena, J. Eschmeier, K. Laursen, G. Willis: Introduction to Banach Algebras, Operators, and Harmonic Analysis*, London Mathematical Society Student Texts 57, Cambridge University Press, Cambridge, 2003, 336 pp., £24,99, ISBN 0-521-53584-0, ISBN 0-521-82893-7*

The book contains a series of five lectures for graduate students given in two conferences in 1999 and 2002. The first lecture by H. G. Dales is an introduction to the theory of Banach algebras. It contains the Gelfand theory, the functional calculus and properties of homomorphisms and derivations. In the last part of this lecture, a relation of cohomology theory to amenability is described. The last topic is then investigated in connection with group algebras $L^1(G)$ in the second lecture, written by G. A. Willis. Automatic continuity of derivations from $L^1(G)$ is shown for several special cases of G at the end of this lecture. The second part of the book is devoted to theory of B-algebras of continuous linear operators. The central topic here is the invariant subspace problem. The third lecture by J. Eschmeier develops a method due to S. Brown, which is based on H^∞ functional calculus. This method leads to the proof of existence of an invariant subspace for several classes of operators (contractions with dominating spectra and subnormal or, more generally, subdecomposable and reflexive operators). The local spectral theory is investigated in the fourth lecture by K. B. Laursen for a class of operators, which includes decomposable operators. The duality between the so-called β and δ properties is described here together with an extension of the notion of similarity of operators. This part ends with an application of local spectral theory to multipliers on a commutative B-algebra. The last lecture by P. Aiena is closely related to the previous one. It studies properties of decomposable operators, which are similar to properties of compact and normal operators. The so-called single-valued extension property (SVEP) plays an important role in a generalization of Fredholm operators. The reader of the book can benefit from valuable comments on further results and relations, which are attached to each section. There are many exercises at the end of each section emphasizing a didactic character of the lecture notes. (jmil)

K. Devlin: Sets, Functions, and Logic: An Introduction to Abstract Mathematics*, third edition, Chapman & Hall/CRC Mathematics Series, vol. 25, Chapman & Hall/ CRC, Boca Raton, 2003, 160 pp., $49,95, ISBN 1-58488-449-5*

This little book is the third revised edition of a textbook targeted at university students who have passed calculus courses and are entering the world of pure mathematics. The core of the text is a detailed explanation of basic mathematical concepts and notions, such as sets (up to concepts of denumerability and uncountability), operations on them, functions and relations. Also, mathematical notation is analyzed. There are parts written as an essay (What is mathematics and what does it do for us?) and short historical remarks – these should give a motivation rather than a complete account of the topic. The text is accompanied by a lot of exercises. The style is very narrative, sometimes too much, with the aim to motivate and persuade at every step. Therefore the book should even find interested high-school students among its readers. (emu)

J. Dugundji, A. Granas: Fixed Point Theory*, Springer Monographs in Mathematics, Springer, Berlin, 2003, 690 pp., 13 fig., EUR 84,95, ISBN 0-387-00173-5*

This monograph provides an immense text (690 pages!) on classical topics in fixed point theory that lie on the borderline of topology and nonlinear functional analysis. The book grew from the book "Fixed point theory, Vol. I", published by the same authors in 1982 and was finished after the death of Jim Dugundji in 1985. The book starts with an introduction and elementary fixed point theorems (e.g., Banach contraction principle and its extensions, the Knaster-Tarski theorem, applications to the geometry of Banach spaces, to theory of critical points and to integral and differential equations, the Markoff-Kakutani theorem, theorems on nonexpansive maps in Hilbert spaces). The next chapter describes the Borsuk theorems and topological transversality. It contains paragraphs on the Brouwer and Bor-

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John Hempel, Rice University, Houston, TX

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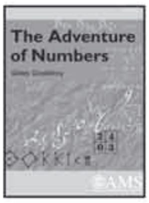
AMS Chelsea Publishing; 2004; 195 pages; Hardcover; ISBN 0-8218-3695-1; List $29; All AMS members $26; Order code CHEL/349.H



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Gilles Godefroy, Institut de Mathématiques de Jussieu, Paris, France, and Directeur de Recherches at the C.N.R.S., Paris, France

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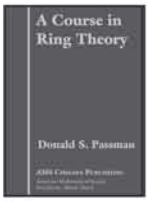

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Donald S. Passman, University of Wisconsin, Madison

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Yuli Eidelman and **Vitali Milman**, Tel Aviv University, Israel, and **Antonis Tsolomitis**, University of the Aegean, Samos, Greece

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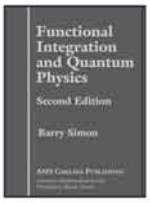
Graduate Studies in Mathematics, Volume 66; 2004; 322 pages; Hardcover; ISBN 0-8218-3646-3; List $55; All AMS members $44; Order code GSM/66

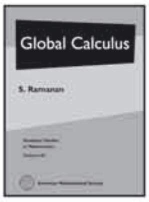


Functional Integration and Quantum Physics Second Edition

Barry Simon, California Institute of Technology, Pasadena, CA

Written with great care and containing many highly illuminating examples, this classic book is highly recommended to anyone interested in applications of functional integration to quantum physics. It makes a fine textbook for a course in functional integration.

AMS Chelsea Publishing; 2005; 306 pages; Hardcover; ISBN 0-8218-3582-3; List $39; All AMS members $35; Order code CHEL/351.H



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S. Ramanan, Chennai Mathematics Institute, India

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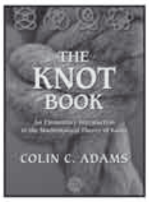
T.Y. Lam, University of California, Berkeley

This new version of a prizewinning book gives a modern and self-contained introduction to the theory of quadratic forms over fields of characteristic different from two. Included are a copious number of carefully chosen examples and a rich stock of some 280 exercises.

Graduate Studies in Mathematics, Volume 67; 2005; 550 pages; Hardcover; ISBN 0-8218-1095-2; List $79; All AMS members $63; Order code GSM/67



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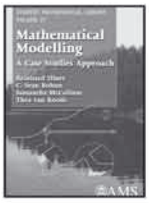
An Elementary Introduction to the Mathematical Theory of Knots

Colin C. Adams, Williams College, Williamstown, MA

Introducing the richness of knot theory, this book starts with our familiar understanding of knots and a bit of college algebra and finishes with exciting topics of current research. The author has included fascinating examples, superb figures, and thought-provoking ideas.

2004; 307 pages; Softcover; ISBN 0-8218-3678-1; List $29; All AMS members $23; Order code KNOT



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A Case Studies Approach

Reinhard Illner, **C. Sean Bohun**, **Samantha McCollum**, and **Thea van Roode**, University of Victoria, BC, Canada

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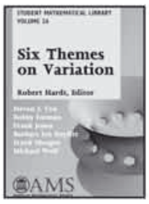

Six Themes on Variation

Robert Hardt, Rice University, Houston, TX, Editor

The calculus of variations is a beautiful subject with a rich history and origins in the minimization problems of calculus. This volume will serve to give the reader a sense of its great character and importance.

Student Mathematical Library, Volume 26; 2004; 153 pages; Softcover; ISBN 0-8218-3720-6; List $29; All AMS members $23; Order code STML/26

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suk theorems, on fixed points for compact maps and on further applications (the antipodal theorem, the Schauder theorem, the invariance subspace problem, absolute retracts, the Ryll-Nardzewski theorem). The next chapter deals with homology and fixed points (simplicial homology, the Lefschetz-Hopf theorem, the Brouwer degree). The monograph emphasizes developments related to the Leray-Schauder theory and consecutive chapters are dedicated to this subject. The final chapter is devoted to selected topics (finite-codimensional Čech cohomology, Vietoris fractions and coincidence theory).

Each chapter is accompanied by "Miscellaneous results and examples" in the form of exercises, which give further applications and extensions of the theory. They are followed by "Notes and comments" containing references to literature and providing some additional information. The book is equipped with a comprehensive bibliography (30 pages), list of standard symbols and indices of names and terms. The book is well understandable and requires only a basic knowledge of topology and functional analysis; moreover, the necessary background material is collected in an appendix. It can be warmly recommended to a broad spectrum of readers – to graduate students, experts and everybody who wishes to become acquainted with the basic elements and deeper properties of this part of functional analysis. (jl)

W.G. Dwyer, H.-W. Henn: Homotopy Theoretic Methods in Group Cohomology*, Advanced Courses in Mathematics CRM Barcelona, Birkhäuser, Basel, 2001, 98 pp., EUR 22, ISBN 3-7643-6605-2*

The volume contains notes on two series of lectures delivered during the Advanced Course on Classifying Spaces and Cohomology of Groups at the Centre de Recerca Matemàtica in Bellaterra. The first series of lectures was written by W.G. Dwyer (Classifying Spaces and Homology Decomposition), and the second one by H.-W. Henn (Cohomology of Groups and Unstable Modules over the Steenrod Algebra). The first series deals with a homology decomposition of the classifying space of a finite group as a homotopy colimit of classifying spaces of some of its subgroups. By homology decomposition we mean a mod p homology isomorphism between the colimit and the classifying space. The second series discusses a broader variety of groups (e.g., compact Lie groups, arithmetic groups, mapping class groups, etc). It is based on non-stable modules over the Steenrod algebra, in particular, on the Lannes functor $T_V H$. It is exactly the calculation of the degree 0 component of $T_V H^*BG$, which coincides with the Quillen theory of F-isomorphisms. The main results show that the knowledge of $T_V H^*BG$ (even a partial one) enables us to discover various approximations to H^*BG. The text is designed first of all for postgraduate students. It is relatively short and students will have to look at original sources for some details. Nevertheless, I think that for a beginner in the area, the book is an excellent introduction. (jiva)

D. Flament: Histoire des nombres complexes*, CNRS histoire des sciences, CNRS Editions, Paris, 2003, 501 pp., EUR 39, ISBN 2-271-06128-8*

The book describes the history of complex numbers from their discovery in the 16th century to their full development in the 18th and the 19th centuries. In the first three chapters we can trace the history of complex numbers throughout time. We can see great transformations in mathematics and mathematical thinking from the Renaissance up to the 19th century. We can read impressive ideas from the original works of great mathematicians who created foundations for the future use of complex numbers (including Chuquet, Cardano, Viète, Girard, Wallis, Descartes, Moivre, Wessel, Argand, Gauss and Cauchy). The last chapter shows the algebra in the British Islands, in particular the so called *British mathematical school*. This chapter contains an analysis of a revolution in algebraic concepts, in notation as well as the birth of *modern algebra*. There are many interesting quotations from Peacock's, Morgan's, Boole's and Hamilton's articles, textbooks and other works. The detailed bibliography, a list of main symbols in some historical works and the author index are included. The book is written in French and can be recommended to everybody wanting to know more about the history of complex numbers and about *British algebra* in the 19th century. (mnem)

S. Garibaldi, A. Merkurjev, J.-P. Serre: Cohomological Invariants in Galois Cohomology*, University Lecture Series, vol. 28, American Mathematical Society, Providence, 2003, 168 pp., $35, ISBN 0-8218-3287-5*

The book contains a discussion of invariants, which are analogues of characteristic classes in topology (Chern classes, Stiefel-Whitney classes, etc.) for Galois cohomology. Topological spaces are replaced here by schemes *Spec(k)* for a field k. Similarly, an analogue of the universal bundle in topology is the notion of versal torsor. Historically, the first example of cohomological invariants of the type considered in the book was the Hasse-Witt invariant of quadratic forms. The book consists of two parts. The first part grew out of lectures by J.-P. Serre at UCLA from 2001. It contains an introduction to Galois cohomology, together with various operations on it (including restriction, corestriction, inflation, etc). As an application, it classifies invariants of quadratic forms and étale algebras with values in Galois cohomology modulo 2, or in the Witt ring. For G a simple and simply connected algebraic group, Rost proved the existence of a canonical and nontrivial invariant of G-torsors with values in Galois cohomology of dimension 3. The second part, written by Merkurjev, gives detailed proofs of the existence and basic properties of the Rost invariant. (pso)

W. Gautschi: Orthogonal Polynomials: Computation and Approximation, Numerical Mathematics and Scientific Computation*, Oxford University Press, Oxford, 2004, 301 pp., £55, ISBN 0-19-850672-4*

This is the first book on constructive methods for and applications of orthogonal polynomials, and the first available collection of relevant Matlab codes. The book begins with a concise introduction to the theory of orthogonal polynomials on the real line (or part thereof) relative to a positive measure of integration and topics, which are particularly relevant to computation. The second chapter develops computational methods for generating coefficients in the basic three-term recurrence relation, including moment-based methods and discretization methods. Other miscellaneous methods are also discussed, including computation of Cauchy integrals, modification algorithms for underlying measures, and computation of orthogonal polynomials of the Sobolev type. The final chapter deals with selected applications: numerical evaluation of integrals (in particular the Gauss-type quadrature methods), polynomial least squares approximation, moment-preserving spline approximation, and the summation of slowly convergent series. Detailed historic and bibliographic notes are appended to each chapter. The book will be of interest not only to mathematicians and numerical analysts but also to a wide range of scientists and engineers. (knaj)

M. Geck: An Introduction to Algebraic Geometry and Algebraic Groups*, Oxford Graduate Texts in Mathematics 10, Oxford University Press, Oxford, 2003, 307 pp., £37, ISBN 0-19-852831-0*

This is a textbook on algebraic geometry with an orientation towards algebraic groups. The first two chapters may serve very well as a first course on algebraic geometry. Exposition is very clear and it proceeds relatively quickly. Starting from the third chapter, the text is devoted to algebraic groups. The main aim is to describe properties of algebraic groups of the Lie type over fields of positive characteristic. The author describes the structural theory of these groups, and in the fourth chapter, he takes into account the Frobenius maps. This leads in a natural way to finite groups of the Lie type. The whole book is a nice and relatively short text also presenting many interesting examples. Each chapter is completed by bibliographical remarks and exercises. The author's intention was to write a quick introduction to the area of algebraic groups of the Lie type over fields of positive characteristic and I think that he was very successful. The first part of the book can be recommended as a very suitable text for undergraduate students, while the second part can be used by postgraduate students at the beginning of their studies. Finally, I agree completely with the author who can imagine it being suitable for someone who just wishes to study some basic aspects of this beautiful area of mathematics. I can only repeat that this area is very nicely presented in the book. (jiva)

U. Graf: Applied Laplace Transforms and z-Transforms for Scientists and Engineers*, Birkhäuser, Basel, 2004, 500 pp., EUR 94,16, ISBN 3-7643-2427-9*

Laplace transformations (for continuous problems) and z-transformations (for discrete problems) are important parts of the mathematical background required for engineers, physicists and mathematicians, particularly for solving classes of differential and difference equations. The first two chapters present the theory and basic properties of these transformations. The next two chapters offer a "User's Guide" for the Mathematica package developed by the author. As seen from the remaining two thirds of the book, the package substantially enhances the built-in facilities of Mathematica and includes algorithms for the numerical inversion of Laplace transforms. The emphasis lies on computational and applied parts, particularly in the fields of control engineering, electrical engineering, and mechanics (heat conduction, diffusion, vibrations). Many examples from applied sciences and engineering illustrate the applicability of the theory and the use of the package. Students, instructors, practical engineers and researchers working in the field of control, electricity or mechanics, will find this textbook a most valuable source and will profit from the package and further examples and Mathematica notebooks on the included CD-ROM. The owner of the book is authorized to use the software on a single machine. (zvl)

A. Guzman: Derivatives and Integrals of Multivariable Functions*, Birkhäuser, Boston, 2003, 319 pp., ISBN 0-8176-4274-9, ISBN 3-7643-4274-9*

The book is intended to be a text for a one-semester course on calculus of several variables. The author presupposes that the reader is familiar with topology of Euclidean spaces, properties of continuous mappings, theory of limits, and basic linear algebra. The theory of derivatives covers the chain rule, the mean value theorem, the inverse and implicit function theorems, the connection of extreme values and second derivatives, and the theorem on Lagrange's multipliers (a necessary condition for the case of several constrains). Also some information on curves, surfaces and tangent planes is given, but the proof of the Lagrange theorem does not use these geometrical notions. The theory of the Riemann integral for functions of several variables includes versions of Fubini's theorem and the change of variable theorem. The theory of line and surface integrals ends with versions of Green's theorem, classical Stokes's theorem and the divergence theorem. All sections contain exercises and their solutions (68 pp.) are presented at the end of the book. The textbook is written in a conversational non-formal style but formulations of theorems and proofs are essentially quite rigorous. An exception is the theory of curves and surfaces where, for example, independence of tangent planes and surface integrals on parameterizations is not proved. (lzaj)

F. Hausdorff: Felix Hausdorff – Gesammelte Werke*, Band VII, Springer, Berlin, 2004, 920 pp., EUR 99,95, ISBN 3-540-20836-4*

Nine volumes are expected to be published in the series of collected work of F. Hausdorff. Up to now, Volume II (Grundzüge der Mengenlehre), Volume IV (Analysis, Algebra und Zahlentheorie) and Volume VII have been published. The first 85 pages of Volume VII are devoted to the analysis of Hausdorff's philosophical work, orientation and letters, from the years around 1900. Then, several of Hausdorff's philosophical publications, written under the pseudonym Paul Mongré, are included. The first one is "Sant'Ilario. Gedanken aus der Landschaft Zarathustras" (almost 400 pages, published in 1897), continued by "Das Chaos in kosmischer Auslese" (more than 300 pages, published in 1898). The volume ends with three shorter essays (5–6 pages) from 1900–1902: "Nietzsches Wiederkunft des Gleichen", "Nietzsches Lehre von der Wiederkunft des Gleichen" and "Der Wille zur Macht". An index of names is added at the very end. (mih)

K. Hulek: Elementary Algebraic Geometry, Student Mathematical Library*, vol. 20, American Mathematical Society, Providence, 2003, 213 pp., $35, ISBN 0-8218-2952-1*

The present small book offers a nice introduction to algebraic geometry, based on an elementary algebraic level, without the use of sheaf or cohomology theory. There are chapters on affine and projective varieties, their smooth points and their dimension. Special attention is paid to plane cubic curves, their classification, group structure and multiplicity of their intersections. The second topic treated in the book is a study of cubic surfaces, its rationality and existence of lines on a cubic surface. The last chapter is an introduction to the theory of curves in projective planes, divisors and the Bezout theorem. Linear systems of curves and their projective embeddings are described here. At the end of each chapter, there are exercises of different level. At the end of the book, the reader can find a short bibliography on commutative algebra and algebraic geometry recommended for further study. The book is nicely written and can be recommended to anybody interested in basic algebraic geometry. (jbu)

F. E. A. Johnson: Stable Modules and the D(2)-Problem*, London Mathematical Society Lecture Note Series 301, Cambridge University Press, Cambridge, 2003, 267 pp., ISBN 0-521-53749-5*

The D(n)-problem can be formulated for every integer $n \geq 1$. Its solution for every $n \neq 2$ is known, which explains the attention the author pays to the D(2)-problem: "Let X be a finite connected cell complex of geometrical dimension 3, and suppose that $H_3(\tilde{X};Z)=H^3(X;B)=0$ for all coefficient systems B on X, where $\tilde{X}$ denotes the universal covering of X. Is it true that X is homotopy equivalent to a finite complex of dimension 2?" Let us denote G to be the fundamental group of X. It is necessary to mention that the D(2)-problem is closely connected with the realization problem.

The author has proved: The D(2)-property holds for a finite group G if and only if each algebraic 2-complex over G is geometrically realizable. It is not appropriate to mention too many details here, but we can say that the author successfully attacks the realization problem and obtains in many cases the solution of the D(2)-problem. He uses two important tools, namely the Yoneda's theory of module extensions and the Swan-Jacobinski cancellation theory. The author prepares the reader for the main part of the book. In chapters 1–3 we find necessary results from the module theory and the representation theory of finite groups. Chapters 4–7 deal with the group cohomology and the module extension theory. The author explains here Yoneda's theory and specializes it to modules over group rings. He makes the reader familiar with the k-invariant method and with the structure of groups of periodic cohomology. Chapters 8–11 are devoted to algebraic and 2-dimensional geometric homotopy theory, to the D(2)-problems and to the realization problem.

Just published

■ Finite Groups 2003

Proceedings of the Gainesville Conference on Finite Groups, March 6 – 12, 2003

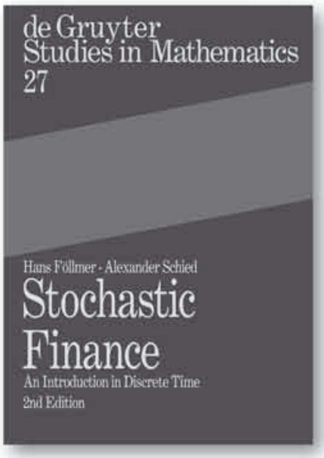
Ed. by Chat Yin Ho / Peter Sin / Pham Huu Tiep / Alexandre Turull

2004. XV, 417 pages. 1 Frontispiece. Cloth.
€ [D] 168,- / sFr 269,- / for USA, Canada, Mexico US$ 168,95.
ISBN 3-11-017447-2

This is a volume of research articles related to finite groups. Topics covered include the classification of finite simple groups, the theory of p-groups, cohomology of groups, representation theory and the theory of buildings and geometries.

As well as more than twenty original papers on the latest developments, which will be of great interest to specialists, the volume contains several expository articles, from which students and non-experts can learn about the present state of knowledge and promising directions for further research.

The Finite Groups 2003 conference was held in honor of John Thompson. The profound influence of his fundamental contributions is clearly visible in this collection of papers dedicated to him.



Hans Föllmer / Alexander Schied

■ Stochastic Finance

An Introduction in Discrete Time

2nd rev. and extend. ed. 2004. XI, 459 pages. Cloth.
€ [D] 58.00 / sFr 93.00 / for USA, Canada, Mexico US$ 59.95.
ISBN 3-11-018346-3

This book is an introduction to financial mathematics.

The first part of the book studies a simple one-period model which serves as a building block for later developments. Topics include the characterization of arbitrage-free markets, preferences on asset profiles, an introduction to equilibrium analysis, and monetary measures of risk.

In the second part, the idea of dynamic hedging of contingent claims is developed in a multiperiod framework. Such models are typically incomplete: They involve intrinsic risks which cannot be hedged away completely. Topics include martingale measures, pricing formulas for derivatives, American options, superhedging, and hedging strategies with minimal shortfall risk.

In addition to many corrections and improvements, this second edition contains several new sections, including a systematic discussion of law-invariant risk measures and of the connections between American options, superhedging, and dynamic risk measures.

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Generally we can say that the book is very well and attractively written and will be indispensable for the specialists in this field. It can also be strongly recommended to postgraduate students. They will be able to orientate themselves in the subject and will find hints for further reading and research. (jiva)

S. Kamvissis, K.D.T.-R. McLaughlin, P.D. Miller: Semiclassical Soliton Ensembles for the Focusing Nonlinear Schrödinger Equation*, Annals of Mathematics Studies, no. 154, Princeton University Press, Princeton, Oxford, 2003, 265 pp., £26,95, ISBN 0-691-11482-X, ISBN 0-691-11483-8*

The model studied by the authors is a key model in modern nonlinear optics, having increasingly important applications in the telecommunication industry. The authors investigate it in the semiclassical limit, where the initial data have a rapidly decreasing amplitude and a phase function that is rapidly approaching the constant value. This model exhibits both "spatial solitons" envisioned as self-guided beams that can form fundamental components of an all-optical switching system, as well as the envelope pulses known as "temporal solitons" envisioned as robust bits in a digital signal travelling through the fibre. The book is concerned with a deep semiclassical analysis of the inverse-scattering step. The authors develop a method that is a generalization of the variational principle exploited by Lax and Levermore in their study of the zero dispersion limit of the Korteweg-de Vries equation and they present a new generalization of the steepest-descent method introduced by Deift and Zhou. Topics treated in the book include holomorphic Riemann-Hilbert problems for solitons, semiclassical soliton ensembles, asymptotic analysis of the inverse problem, direct construction of the complex phase, the genus-zero Anstatz and the transition to genus two, and variational theory of the complex phase. In the Appendices, the reader can find Hölder theory of local Riemann-Hilbert problem and the near identity Riemann-Hilbert Problem in L^2. (mzahr)

J. Kock: Frobenius Algebras and 2D Topological Quantum Field Theories*, London Mathematical Society Student Texts 59, Cambridge University Press, Cambridge, 2003, 254 pp., £22,99, ISBN 0-521-54031-3, ISBN 0-521-83267-5*

An n-dimensional topological quantum field theory (TQFT) is a functorial rule that assigns to each (n-1)-dimensional closed manifold a vector space (the "state space") and to each n-dimensional cobordism between (n-1)-dimensional manifolds a homomorphism of these state spaces (the "propagator"). Recall also that a Frobenius algebra is an associative algebra carrying a non-degenerate invariant bilinear form. The present book is a self-contained exposition of one of the most fundamental results in this field saying that there is a one-to-one correspondence between 2-dimensional TQFT's and Frobenius algebras. The author also demonstrates that this equivalence follows from the fact that the category of two-dimensional cobordisms is the free monoidal category containing a commutative Frobenius object. The book is very well written and organized. I warmly recommend it as an introduction to basic techniques of algebraic geometry. It requires only a preliminary knowledge of algebra, category theory and geometry. (mm)

P. Kůrka: Topological and Symbolic Dynamics*, Cours Spécialisés, no. 11, Société Mathématique de France, Paris, 2003, 315 pp., EUR 55, ISBN 2-85629-143-0*

The book uses both abstract and practical approaches to explain basic and deep properties of topological and symbolic dynamics. In addition to that broad exposition, the content is also wide, as one can see from the following chapter titles: Dynamical systems (e.g., quadratic, chaotic, Feigenbaum, rotations), Topological dynamics (also entropy and ergodic systems), Symbolic dynamics, Minimal symbolic systems (including subshifts as substituitive, Sturmian, skew Sturmian, Toeplitz and others) and Cellular automata. The Appendix contains some mathematical background (compact metric spaces, topological and uniform spaces, compact groups, Perron-Frobenius theory, continuous fractions). Exercises are added to every chapter. At the end, one can find a list of 40 main theorems, a bibliography with 167 items, and both symbol and subject indexes. The book seems to be convenient both for specialists and starting mathematicians. Since the author used material from the book in his courses at several universities, the book is convenient for students as well. (mih)

S. K. Lando: Lectures on Generating Functions*, Student Mathematical Library, vol. 23, American Mathematical Society, Providence, 2003, 148 pp., $29, ISBN 0-8218-3481-9*

This little book introduces the reader to the use of generating functions. It is based on lectures given by the author at the College of Mathematics of the Independent University of Moscow. Reading the book does not require too much previous knowledge; a good calculus course is almost only what is needed. The book contains many worked out examples and more than 100 exercises. The first chapter is devoted to formal power series and elementary generating functions. The other chapters deal with some well-known sequences but the book also contains material on generating functions of several variables, formal grammars, Dirichlet generating functions and enumeration of graphs. The author does not develop an extensive theoretical background; he prefers to explain topics chosen by means of interesting examples. Brief comments and bibliographical remarks together with the index are useful. This nice book can be used for work in student seminars as well as a source of nice illustrative examples. It can be recommended for libraries and students. (jive)

F. W. Lawvere, R. Rosebrugh: Sets for Mathematics*, Oxford University Press, Oxford, 2003, 261 pp., £19,95, ISBN 0-521-01060-8*

The book introduces set theory as an algebra of mappings. This approach translates usual notions (sums, products, axiom of choice and others) to the language of mappings. The category S of abstract sets and mappings is defined using several axioms (S is a category; S has all finite limits and colimits; for any objects X and Y in S, there is a power X to Y; representation of truth values; S is Boolean; S is two-valued; axiom of choice). The category S of abstract sets and arbitrary mappings is a topos that is two-valued with an infinite object and the axiom of choice. This abstract approach includes all known situations in one simple frame. The material presented in the book is illustrated with many useful exercises. The book is suitable for advanced undergraduates or those beginning graduate studies. It gives a well-founded basis for the study of mathematics. The book consists of 10 chapters devoted to abstract sets and mappings; sums, monomorphisms, finite inverse limits; colimits, epimorphisms and the axiom of choice; mapping sets and exponentials; consequences and uses of exponentials; power sets; variable sets and models of additional variation; together with three appendices (logic, maximal principles, definitions, etc.). Many diagrams illustrate the book. It is an excellent book for those mathematicians who wish to study foundations of mathematics in an axiomatic form based on an algebraic approach. (ppy)

G. Link, Ed.: One Hundred Years of Russell's Paradox*, de Gruyter Series in Logic and its Applications, vol. 6, Walter de Gruyter, Berlin, 2004, 602 pp., EUR 168, ISBN 3-11-017438-3*

This is a collection of 31 papers based on invited lectures presented at the International Munich Centenary Conference in 2001. The contributors include historians of mathematics and researchers in set theory, mathematical logic, foundations of mathematics and philosophy of mathematics. This volume presents a unique opportunity to learn the views of prominent mathematicians and philosophers of science on the foundations of mathematics. Due to space limitations, I will mention only a sample of articles. Wodin's paper is a readable introduction to his Ω-logic, by which he is able to decide the continuum hypothesis. Friedman presents a set theory, in which the schema of comprehension is modified in a different way than in ZFC and which has the strength of ZFC augmented with a class of subtle cardinals. Hauser's paper is an interesting essay about the search for new axioms for set theory and the role of large cardinals in this process. A historical study by Peckhaus expounds what was known about paradoxes in set theory in Göttingen around the time of Russell's discovery of his paradox and mentions Zermelo's independent discovery of this paradox. (ppu)

***W. Lück: L^2-Invariants: Theory and Applications to Geometry and K-Theory**, A Series of Modern Surveys in Mathematics, vol. 44, Springer, Berlin, 2002, 595 pp., EUR 119, ISBN 3-540-43566-2*

The theory of L2-invariants is a new and fruitful branch of mathematics, which grew up from a cooperation of algebraic topology and functional analysis and which was already successfully applied in several other branches of mathematics. The book under review represents a fundamental monograph on the theory of L^2-invariants. It guides the reader from the very first definitions up to the centre of contemporary research. To a great extent, it is self-contained. Of course, the reader is assumed to have some preliminary knowledge (CW-complexes, manifolds and forms, Riemannian manifolds and sectional curvature, and some homological algebra) but the requirements are rather modest. The book is very clearly written, it contains many examples and we can find exercises at the end of each chapter. At the end of the whole book, there is an important chapter "Solutions of the Exercises". At many places in the book, the reader will find hints for further research. In particular, at the end of each chapter, there is a section "Miscellaneous", where it is also possible to find recommendations for further reading. Three chapters devoted to several conjectures concerning L^2-invariants are especially inspiring. The book will be of great interest to specialists but it can also be strongly recommended for postgraduate students. The long list of references has 535 items. (jiva)

***R. D. Mauldin, M. Urbański: Graph Directed Markov Systems: Geometry and Dynamics of Limit Sets**, Cambridge Tracts in Mathematics 148, Cambridge University Press, Cambridge, 2003, 281 pp., £37,50, ISBN 0-521-82538-5*

The book is devoted to geometric and dynamic theory of limit sets generated by iterations of contracting conformal maps. A far reaching generalization of this concept developed in the book is called a graph directed Markov system (GDMS), a notion based on a directed multigraph and an associated incidence matrix, determining which edges may follow a given edge. For each edge, we then have a 1-to-1 contraction between two compact metric spaces. The theory presented in the book also covers many settings that do not fit into the scheme of conformal iterated systems. The book contains chapters on symbolic dynamics (this chapter is self-contained and can be read independently of the rest of the book), Hölder families of functions and F-conformal measures (with a connection to the thermodynamic formalism and the Perron-Frobenius theorem), conformal graph directed Markov systems (the central chapter, dealing both with basic and more refined geometric properties of limit sets), conformal iterated function systems (a study of the Radon-Nikodym derivative of an invariant measure with respect to a conformal measure), parabolic iterated function systems and the Haussdorff and packing measures. The two short Appendices deal with ergodic theory and geometric measure theory. Many issues and current research topics will be interesting for a broad community of researchers in the theory of dynamical systems. (mzahr)

***E. Mendelson: Introducing Game Theory and Its Applications**, Discrete Mathematics and Its Applications, Chapman & Hall/CRC, Boca Raton, 2004, 259 pp., $69,95, ISBN 1-58488-300-6*

The author's aim was to present an easy-to-read introduction to the basic ideas and techniques of game theory and the possibilities of its applications. The book is divided into 4 chapters. Chapter 1 introduces the reader to combinatorial games. A combinatorial game is defined from the point of view of the traditional classification as a finite two-person zero-sum game with perfect information and deterministic moves. The fundamental theorem for combinatorial games by Zermelo is proved, and examples of some simpler combinatorial games and paying techniques are presented. Chapters 2 and 3 contain the traditional theory of two-person zero-sum games and usual solution methods. Some of them are designed for games with a special structure (e.g. (m x n)-matrix games, in which either m or n is equal to 2 or m=n=2). After having introduced the concept of linear programming and presented the main ideas of the simplex method and the duality theory, the author explains how a general (m x n)-matrix game can be solved by the simplex method applied to a pair of special dual linear programming problems. Chapter 4 includes some fundamental approaches to solving non-zero-sum cooperative games with more than two players. Such concepts as the Nash equilibrium, Nash arbitration procedures, the Shapley value, imputations, and stable sets are defined and their main properties are investigated. The text includes numerical exercises as well as examples of applications. Since the understanding of some proofs and methods requires the knowledge of the finite probability theory, some basic facts from this theory are included in the first appendix attached to the text of the book after Chapter 4. The other two appendices contain some results from the utility theory and Nash's theorem. The book is concluded with answers to selected exercises and an extensive bibliography. It can be recommended to readers with a limited mathematical knowledge who are interested in game theory and its applications in economics, political science and biology. (kzim)

***M. Metcalf, J. Reid, M. Cohen: Fortran 95/2003 Explained, Numerical mathematics and Scientific Computation**, Oxford University Press, Oxford, 2004, 416 pp., £23,95, ISBN 0-19-852693-8, ISBN 0-19-852692-X*

The target audience of this book is new and existing users of Fortran, who need a readable textbook for teaching or learning. The book is also suitable, with its extensive index, as a handy reference for practitioners involved in scientific and numerical computing. It presents a clear and comprehensive description of the Fortran 95 language and the features that are new in Fortran 2003. The book is excellent. It is written in such a way that simple programs can already be coded after the first three chapters have been read. Subsequent chapters complete a description of powerful features of Fortran. The text is centered on topics that form the essentials of programming: concept of the module, aspects of procedures, array features, data objects, input/output features, object-oriented programming. The explanation proves that Fortran has progressively enhanced its power and kept it competitive with several generations of its rivals. The text details all new features including interoperability with the C programming language. (jifel)

***O. Nevanlinna: Meromorphic Functions and Linear Algebra**, Fields Institute Monographs, vol. 18, American Mathematical Society, Providence, 2003, 136 pp., $49, ISBN 0-8218-3247-6*

The main topic treated in the book is a study of properties of the resolvent $(I–zA)^{-1}$ of a matrix A, considered as a vector-valued meromorphic function in the complex plane. The tools used in the description are naturally related to tools used for the investigation of meromorphic functions. In particular, the value distribution theory developed by Rolf Nevannlina (great-uncle of the author) is very useful for the considered question. The main point is that while eigenvalues of a matrix may move considerably under a small perturbation by a low rank matrix, the growth of the resolvent, considered as a matrix-valued meromorphic function, is much more stable. The book starts with a summary of basic value distribution theory, which is needed later. Its generalization for matrix-valued meromorphic functions is based on the notion of the total logarithmic size of a matrix. It makes it possible to study the behavior of the growth of the resolvent under low rank perturbations. The book also contains applications to rational approximations, the Kreiss matrix theorem, power boundedness and convergence of the Krylov solvers. The last chapter compares defects in the value distribution theory and defective eigenvalues of matrices. The book will certainly be valuable to mathematicians interested in numerical linear algebra but it also offers attractive information for a general mathematical audience. (vs)

***R.J. Nowakowski, Ed.: More Games of No Chance**, Mathematical Sciences Research Institute Publications 42, Cambridge University Press, Cambridge, 2003, 535 pp., £40, ISBN 0-521-80832-4*
The volume is based on talks given at the Combinatorial Games Theory Workshop and Conference held at the Mathematical Sciences Research Institute of Cambridge University in 2002. It presents recent developments achieved in non-stochastic game theory by the joint efforts of mathematical and computer science methods. The book is divided into five parts. The first one, *The Big Picture*, contains a description of developments of theoretical nature. Topics in lattice and group structure of (finite) games (D. Calistrate, M. Paulhus, D. Wolfe and D. Moews) form most of its content. The leading theme of *The Old Classics* chapter is exiting original research on chess and go endgames (N. Elkies, B. B. Spight, T. Takizava and D. Wolfe). Newer games enter *The New Classic* chapter. Two player games on cellular automata (A. Fraenkel) and one-dimensional 'phutball' (J. Grossman, and R. Nowakowski) are examples. The *Puzzle and Life* section presents results on puzzles that can be represented as a game, the coin-moving puzzles (E. Demaine, M. Demaine, H. Verrill) and Conways' game of life (D. Eppstein) being described in detail. The proceedings are crowned by *Unsolved Problems in Combinatorial Games*, by K. Guy and R. Nowakowski, and *Bibliography of Combinatorial Games* (919 references), by A.S. Fraenkel, that make the book extremely attractive for everybody interested in the mathematics of games. (jst)

***O. Roth, S. Ruscheweyh, Eds.: Helmut Grunsky Collected Papers**, Heldermann, Lemgo, 2004, 530 pp., EUR 45, ISBN 3-88538-501-5*
The book was published on the occasion of the 100th anniversary of the birthday of Helmut Grunsky. It gives evidence of the scientific activity of an outstanding German mathematician in the period 1930–1983. Two interesting articles complete the picture of the personality of H. Grunsky. The first one, written by Ch. Pommerenke, gives a survey of the Grunsky contribution to function theory, which was his main field of research (Grunsky dedicated 35 of the 45 articles to various topics on this theory). The second one, written by R. Siegmund-Schultze, describes a part of the Grunsky biography on the background of the political climate during the nazi regime. In addition to very profound results on function theory, the reader can find papers discussing some generalizations of the usual diffusion model and interesting survey papers on new results in the theory of Riemann surfaces (1959) and on the main notions in analysis from the point of view of their historical development (1960). (oj)

***Á. Seress: Permutation Group Algorithms**, Cambridge Tracts in Mathematics 152, Cambridge University Press, Cambridge, 2003, 264 pp., £47,50, ISBN 0-521-66103-X*
The algorithmic approach to permutation groups is one of the major areas of computational group theory, and it is also among its best developed parts. The book provides a rigorous exposition of the theory covering the present state of art. The main purpose is to describe the development of the past decade characterized by a significant convergence between theory concentrated on asymptotic analysis, and practical approach concerned with implementation. The convergence is represented by nearly linear-time complexity problems, which are the major theme of the book. The reader will find several dozen algorithms given mostly in narrative. The goal is to present the mathematics behind algorithms, and implementation details are omitted with some well motivated exceptions. Most of the algorithms are freely available in the well known GAP system. The ten sections include an introduction, a complexity overview, and a chapter dedicated to algorithms for black-box groups. The remaining seven sections discuss different problems for groups given by a generating set of permutations. From the theoretical point of view a significant part of the book is devoted to variants of Sim's method relying on notions of base and strong generating set. The volume is an authoritative treatment of the subject and will be of lasting value to anybody interested in computational group theory. (shol)

***P.N. de Souza, J.-N. Silva: Berkely Problems in Mathematics**, third edition, Problem Books in Mathematics, Springer, New York, 2004, 587 pp., EUR 39,95, ISBN 0-387-00892-6*
The book is a compilation of problems with solutions, which have appeared on the written examinations in Berkeley since 1977. The 3rd edition has been updated and includes the exams up to the fall 2003 term. (Reviews of previous editions have appeared in this *Newsletter*, Issues 30 and 43.) (in)

***J.P. Spinrad: Efficient Graph Representations**, Fields Institute Monographs, vol. 19, American Mathematical Society, Providence, 2003, 342 pp., $95, ISBN 0-8218-2815-0*
Representations of graphs of various types, very often of geometric flavour, are studied both for practical applications or motivation and for nice theoretical and algorithmic graph properties. Many such classes allow elegant characterizations and for several of them, basic optimization problems (such as maximum clique, maximum independent set, chromatic number, etc.) can be solved in polynomial time. In some cases, the latter is known only when a representation (which itself may be hard to find) is given. This book presents a fantastic encyclopedia of graph classes defined via representations, their properties, relations and algorithms. The range is so overwhelming that a short review cannot even list them. Let us just mention that the reader will find here thorough information about basic intersection defined classes (interval or chordal graphs), about many of their generalizations (strongly chordal graphs, AT-free graphs, chordal bipartite graphs and many more), about inclusion and visibility representations of different types, or about more recently introduced classes such as interval filament graphs. Presenting efficient algorithms requires the description of some useful techniques and the reader will learn, for instance, about join and separator decompositions and the concept of clique-width. Though the title may not indicate this, many NP-hardness results are also quoted. It is only natural that a book of this extent cannot be fully self-contained. However, the bibliography is very extensive and the "Survey of results on graph classes" on the last twenty pages is so well organized, that everyone can find easy directions to material containing full proofs when necessary. Many research problems and exercises make this book suitable both for researchers in the area and for graduate students. It is recommended to anyone interested in algorithmic graph theory. (jk)

***H. Tijms: Understanding Probability: Chance Rules in Everyday Life**, Cambridge University Press, Cambridge, 2004, 380 pp., £18,99, ISBN 0-521-54036-4*

Using elementary examples, the author describes how probability applies to our daily lives. The concepts of probability theory are motivated by interesting and insightful practical situations. Many examples deal with lotteries and casino games. The style of the book is informal but precise. Before deriving the corresponding formulas, the author suggests to use simulations to give the reader insights into such key concepts as the law of large numbers. The first part of the book describes fundamentals of probability theory, whereas the second part is an introduction to mathematical statistics. The examples presented by the author show that uncertainty often leads to quite different results than analogous deterministic rules. If random influences are neglected and the calculations are based on fixed parameters then the result may be far from the real outcome. This is illustrated in the section "Pitfall for averages": If a gentleman would like to place $100,000 in an investment fund with the average rate of return being 14% and he wants to withdraw from the account an amount at the end of each year over some 20 years, he gets a quite different result if he calculates with a fixed yearly return of 14% or if the rate of return is considered to be a random variable with expectation 14%.

From many interesting examples, I would like to mention the following one called "A coincidence problem": Two people, perfect strangers to each other, meet. Both of them live in the same city and each has 500 acquaintances there. Assuming that for each of the two people the acquaintances represent a random sample from the inhabitants of the city, what is the probability of the two people having at least one acquaintance in common? Would you guess that this probability is as large as 22%? To summarize, the book is an easy and interesting read and a source of many examples, problems, and exercises. The publication can be recommended as a supplementary text to introductory courses on probability theory and mathematical statistics. (ja)

P. Walker: Examples and Theorems in Analysis*, Springer, Berlin, 2004, 287 pp., EUR 34,95, ISBN 1-85233-493-2*

The author presents a book on analysis in which theorems and examples are equally important. The material contains fundamental notions: sequences, continuous functions, integration, series and some applications chosen to illustrate the usefulness of the previously covered subjects. The last chapter contains an invitation to further study of Fourier series and integrals, distributions and asymptotics. The content of the first six chapters is standard with some modifications in approach to the material. Appendix A (6 pp.) is devoted to the Fubini theorem and Appendix B (25 pp.) contains hints and solutions for exercises. There are further hidden important facts, such as the arithmetic-geometric mean of two positive numbers, the rising sun lemma, the Chebyshev's convexity theorem, Wallis' formula, and hyperbolic functions. Most of the book can be covered in a one-semester course for beginners. It is a good textbook for students that are willing to invest some work to obtain a more complete picture of the material and to master basic methods of work in mathematical analysis. (jive)

J. M. Weyman: Cohomology of Vector Bundles and Syzygies*, Cambridge Tracts in Mathematics 149, Cambridge University Press, Cambridge, 2003, 371 pp., £55, ISBN 0-521-62197-6*

The main aim of this monograph is to calculate syzygies of some algebraic varieties. Chapters 1-4 have a preparatory character. They contain a lot of material, starting with commutative and homological algebra, introducing an important concept of a Schur functor, devoting great attention to the Grassmannians and flag varieties, and culminating with the Bott theorem on cohomology of line bundles on flag varieties. The theoretical core of the book is represented in Chapter 5, where the basic idea of the geometric technique of calculating syzygies is described. The most important role played here is by the direct image of a Koszul complex. The remaining Chapters, 6–9, are then devoted to applications. The above-mentioned technique with various necessary modifications is applied to determinantal varieties (for generic, generic symmetric and generic skew symmetric matrices), higher rank varieties (the three cases as above), nilpotent orbit closures of the adjoint action of a simple algebraic group on its Lie algebra, and to resultant and discriminant varieties. The book is designed for specialists and postgraduate students in the field. It will bring the reader into the center of contemporary research. It is very nicely written but it requires a solid background from algebra, algebraic geometry and sheaf theory. It is very pleasant that it contains many examples and many exercises. As mentioned above, to read it may require certain preparation and effort but the reading is very interesting and the book can be strongly recommended. (jiva)

E. Zeidler, Ed.: Oxford Users' Guide to Mathematics*, Oxford University Press, Oxford, 2004, 1284 pp., £27,50, ISBN 0-19-850763-1*

This remarkable book is the revised translation of the German edition published in 1996. On almost 1300 pages, Eberhard Zeidler offers a fascinating panoramic overview of mathematics, ranging from elementary results to advanced and sophisticated parts of contemporary mathematics. The book is a beautiful illustration of the fact that mathematics is much more than a dry collection of formulas, definitions, theorems and manipulation with symbols. The historical background of results and theories is explained in many places throughout the book and an emphasis to significant applications is given. The introductory chapter is a 200-page reference book on basic mathematical notions usually required by students, scientists and other practitioners. The following three chapters are devoted to analysis (375 pages), algebra (125 pages) and geometry (150 pages). A short chapter on logic and set theory follows this. The last three chapters are devoted to the following fields of applications of mathematics: calculus of variations and optimization, stochastic calculus, numerical mathematics and scientific computing. The eight chapters are divided into 62 sections and 367 subsections. More than 20 pages at the end of the book are devoted to a detailed sketch of the history of mathematics. Throughout the book, there are many tables, illustrations and indications on software systems making it possible to carry out many routine jobs in mathematics on a standard PC. Also, a rich bibliography is included.

In order to show that the book is by no means a dry collection of mathematical facts, a selection (necessarily limited) of several subtitles can be offered: the perihelion motion of Mercury, fast computers and the death of the sun, mathematics and computers – a revolution in mathematics, rigorous justifications of the Cartan differential calculus and its applications, vector analysis and physical fields, conservation laws in mechanics, applications of ODE's to electrical circuits or chemical reactions, the two body problem, laws of Kepler, shock waves and the conditions for entropy of Lax, the Hamilton-Jacobi equations, applications to geometric optics, electrostatics and Green's functions, applications to quantum mechanics, dynamics of gases, sound waves, applications to hydromechanics, number theory and coding theory, A. Weil and Fermat's last theorem, the Dirac equation and relativistic electrons, spin geometry and fermions, the necessity of proofs in the age of computers, wavelets, data compression and adaptivity, etc. The book is aimed at a wide readership: students of mathematics, engineering, natural sciences, and economy, practitioners who work in these fields, school and university teachers. No doubt professional mathematicians will also find the book very useful. This fascinating book can be strongly recommended to anybody who applies mathematics or simply wants to understand important concepts and results from both classical and modern mathematics. (in)