Oxford Mathematical Institute

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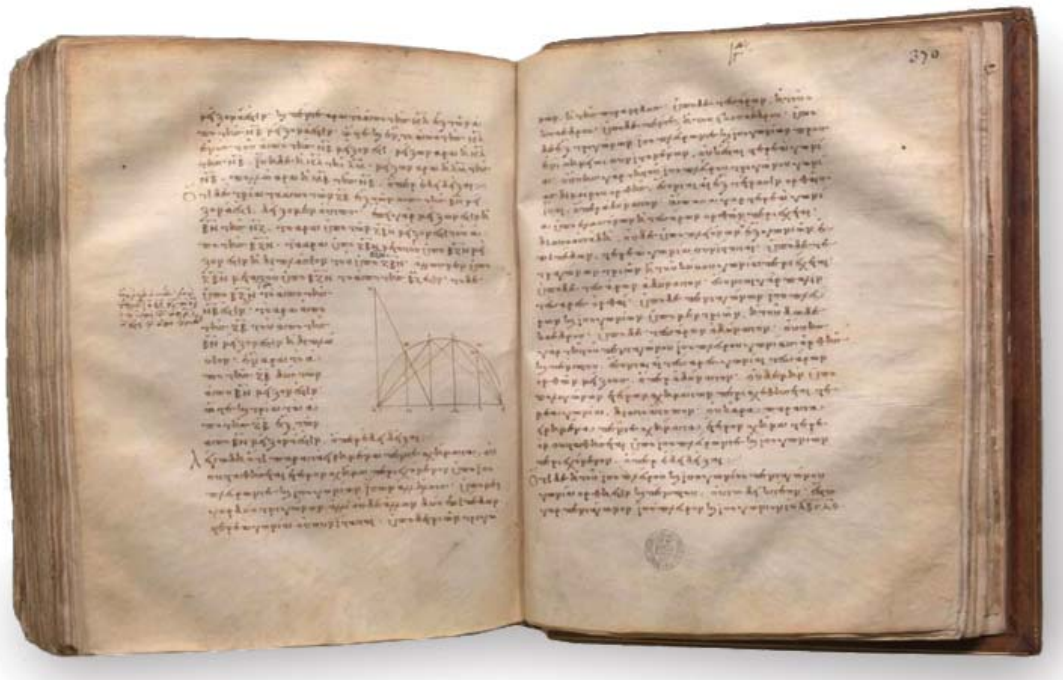
Newsletter

"Perhaps the most remarkable talk was by Bill Casselman concerning a broken piece of pottery dating from around 225BC and found on Elephantine Island on the Nile."

Euclid in the Bodleian

by Nigel Hitchin

Did Euclid exist or was he a committee like Nicolas Bourbaki? Why did he exert such a strong influence on mathematics for so long? How did he have such a fine sense of geometry that he realised the necessity of the parallel postulate two thousand years before it was proved to be necessary?



The oldest surviving manuscript of Euclid's Elements, held at the Bodleian Library.

The reader can view every one of those 386 pages in somewhat less detail on Octavo's website www.octavo.com/store/

We hope you enjoy receiving this annual newsletter. We would be very interested to hear your views and comments or to receive contributions from any Oxford Alumni.

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These were some of the questions posed during a meeting of mathematicians and historians on October 7th-8th 2005 at St Catherine's College, organised by the Oxford and the Clay Mathematical Institutes, together with the Bodleian Library and Octavo Digital Rare Books. The occasion was the publication of a digital version of the oldest surviving manuscript of *Euclid's Elements* which is held at the Bodleian and dates from 888AD. The manuscript itself was on view in the Divinity School at the beginning of the conference and later on participants were able to examine via computer screens the highly detailed work of Stephen the Clerk who for 14 gold coins transcribed this epoch-making work all those years ago in Constantinople.

The discussions revolved around many aspects, mathematical, historical and philosophical. There were talks on Babylonian mathematics with its examples-based transmission of knowledge and the Nine Chapters of Chinese mathematics in the first century, which by the middle ages had also absorbed Euclid. The audience was also treated to a real-time translation of a proof in the Elements whose familiarity ("we construct the perpendicular bisector...") emphasised the timelessness of the material, though the truth is that 888AD is closer to our age than that of Euclid.

Perhaps the most remarkable talk was by Bill Casselman concerning a broken piece of pottery dating from around 225BC and found on Elephantine Island on the Nile. On it is written Euclid's construction of the regular icosahedron. What was it doing there? Which soldier or tax collector spent his spare time on one of the most challenging constructions in geometry?

Terror and Beauty

by Jonathan David Farley

It was a Tuesday morning, and I awoke into a nightmare. The phone rang; a friend spoke. "Turn on the television," she said.

You couldn't see it at first. This was before anyone knew it had been caught on camera. All you could see was a plane disappearing behind a building, and a burst of hellfire.

Terrorism is the watchword of the day, and the fear–regardless of whether the threat is real or imagined–requires an antidote: security. Of the $41.1 billion requested by the US Department of Homeland Security for 2006, $1.368 billion is slated for the Science and Technology Directorate.

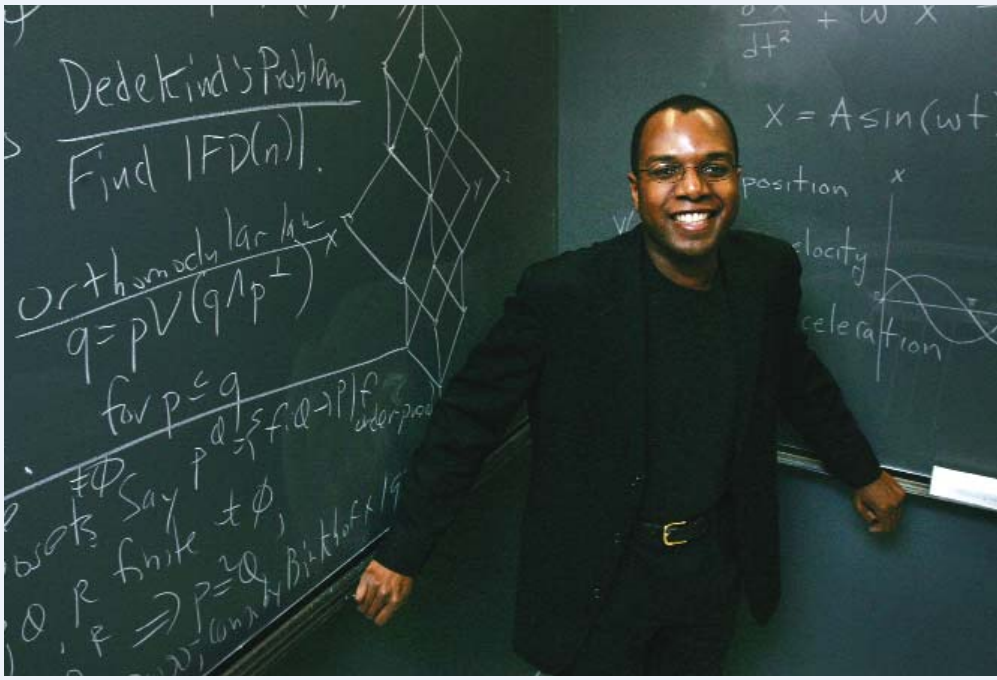
This is funding that mathematicians would normally have no access to – until now.

The opening line of the Oscar-winning movie *A Beautiful Mind* is "Mathematicians won the war": Bletchley Park is now a place of legend. During the Cold War, research in game theory heated up even as the first frost descended on the Soviet East.

Now there is a new war. What is the new mathematics?

At Los Alamos National Laboratory, the lab that built The Bomb, Cliff Joslyn uses Formal Concept Analysis (a branch of applied lattice theory) to mine data drawn from hundreds of reports of terrorist-related activity, to discover patterns and relationships that were previously in shadow.

Lattice theoretical ideas developed at the Massachusetts Institute of Technology tell us the probability that we have disabled a terrorist cell, based on how many men we have captured and what rank they hold in the organization. It can even account for gaps in our knowledge of the structure of a terrorist cell by making assumptions about how the "perfect" terrorist cell must be organized. Boston student Lauren



Professor Jonathan Farley

McGough experimentally tested the accuracy of this model, essentially confirming what the theory predicts.

There is the ever-present threat of a dirty bomb being carried across the borders of the US or Europe. Which border do you guard? Which border do you want the terrorist to think is weak? Phoenix Mathematics, Inc. is using reflexive theory–a branch of mathematical psychology developed by the Soviet military–with Lockheed Martin to devise a quantitative way to help border patrols allocate personnel, and spread disinformation to the adversary.

Since 2001, tremendous amounts of information have been gathered regarding terrorist cells and individuals potentially planning future attacks.

There is now a pressing need to develop new mathematical and computational techniques to assist in the analysis of this information, both to quantify future threats and to quantify the effectiveness of counterterrorism operations and strategies.

Progress on these problems requires the efforts of researchers from various disciplines such as mathematics, computer science, political science, and psychology. By having researchers from diverse disciplines come to one place to conduct their research, greater progress will be made in developing scientific and analytical tools to deal with the problem of terrorism.

It's time to choose brains over brawn. For, against terror, beauty may succeed where brute force fails.

Professor Jonathan David Farley *is a mathematician and Science Fellow at Stanford University's Center for International Security and Cooperation. Seed Magazine has named him one of "15 people who have shaped the global conversation about science in 2005" (lattice@Stanford.edu). He completed his DPhil in Oxford in 1995.*

The Radcliffe Observatory overlooking the Infirmary site.

Plans for the New Institute

In the last newsletter, we told you that the University was on the verge of announcing the architect selected to lead the master-planning process for the Radcliffe Infirmary site, where the new Mathematical Institute is to be built.

The choice was made through a RIBA competition, which attracted a very strong field. It was won by Rafael Viñoly Architects, who are based in New York and have an impressive international practice, including a number of campus projects in the USA. Their vision for the site pays particular attention to the surrounding buildings and makes clever use of the sight lines to the Radcliffe Observatory, which is part of Green College, to the Oxford University Press building on Walton Street, and to the original infirmary building on Woodstock Road. The historic hospital buildings, which cover only a small part of the site, are listed and will be restored as part of the plan.

Our mathematics building will be completed in the first stage. Rafael Viñoly and his colleagues are currently working on the design, which will for the first time provide in one place all the space that the mathematicians need for teaching and research, including common facilities where undergraduates, graduate students and their lecturers can meet and exchange ideas. The University takes possession of the site in the summer of 2007, after the hospital has completed its move, and we are excited by the prospect of building starting very soon after that.

As well as making progress on the design, we have been making headway on fundraising. We have been very fortunate to have received an extremely generous and very significant gift on which we are confident we can build. We shall tell you more about that later.

Regional final of the UKMT Challenge Competition at Oxford.

Centre for Further Mathematics

One of the most obvious access issues facing school mathematics across the country is the disparity in the provision of Further Mathematics teaching. The pure mathematics content of the Further Mathematics (FM) syllabus includes a lot of ideas important to any mathematics or science degree – ideas such as induction, complex numbers, matrices and power series. Many schools struggle to provide teaching, either through a lack of specialist teaching or because the limited number of students interested doesn't justify teaching FM for financial reasons.

The *Further Mathematics Network* is a recent initiative being set up by MEI (Mathematics in Education and Industry) and the Mathematical Institute has appointed Tristram Jones-Parry, previously Headmaster and Head of Mathematics at Westminster School, as Centre Manager of the Oxfordshire FM Centre. Centre Managers visit students in their schools for lessons and other support comes in the form of the substantial mathematical material on the MEI websites which is available to students in the Network. Tristram has been teaching in five schools in the county since January, and there has been a great show of interest in the scheme: currently only around half of Oxfordshire schools are able to provide FM teaching.

The FM Centres nationwide are intended to provide more than just much needed teaching. The Oxfordshire Centre's committee contains members from the LEA and two local schools. It aims to improve links between universities and local schools, and to provide opportunities for mathematics students and teachers around the region. A programme of Masterclasses and Revision Days are already planned in the Mathematical Institute; the first of these events took place in March, where sixty students in years 10-12 from fifteen schools, attended a Masterclass on Coding and Cryptography jointly organised by Tristram Jones-Parry and Richard Earl, (Mathematical Sciences Schools Liaison Officer).

Further details about the scheme can be found on www.fmnetwork.org.uk

Dan Quillen retires

By Ulrike Tillman

In 1988, as a visiting graduate student, I attended a course on Cyclic Cohomology. Never before had lectures been as clear: new mathematics was created in front of our eyes, and even to the novice it all seemed logical and natural. The lecturer, white haired, in jeans and hand-knitted jumpers frayed at the edge, was Dan Quillen, Waynflete Professor of Pure Mathematics.

Dan was well known for his landmark contributions to homotopy: the proof of the Adams conjecture, his foundational work in rational homotopy theory and group cohomology to name just a few.

In 1978 he had received the Fields Medal as the chief architect of algebraic K-theory. Most of this work was done at the Massachusetts Institute of Technology (MIT). But having visited Michael Atiyah and Graeme Segal in Oxford many times, in 1985 Dan accepted the Waynflete chair that had been vacated a year before by Graham Higman. At first Dan worked on questions motivated by quantum physics, superconnections in particular. Later on he concentrated on the development of cyclic cohomology, and the lectures that I attended were followed by many more on the topic.

Cyclic cohomology is the principal algebraic structure that underpins K-theory and Alain Connes' non-commutative geometry. Dan's work in the subject started when Jean-Claude Loday gave a seminar in Oxford in the early 1980s. Dan was intrigued by the questions left unanswered, and as a result he and Loday wrote a paper interpreting cyclic cohomology as a relative K-theory. This is one of the foundational papers that graduate students – and I was no exception – carried around as a constant source of inspiration.

In the late 80's and 90's, together with Joachim Cuntz from the University of Münster, Dan

Dan was well known for his landmark contributions to homotopy: the proof of the Adams conjecture, his foundational work in rational homotopy theory and group cohomology to name just a few.

became the driving force behind the development of cyclic cohomology. In a series of nearly a dozen papers they lay out a purely algebraic, non-commutative theory of differential forms and establish their homological properties. Their work is marked by its clarity and completeness of results. Together these papers form a prime source of reference on the subject.

For many years, Dan has been an editor of the Oxford based journal "Topology", the leading journal in the field since its foundation by Michael Atiyah in 1962. Dan also has been part of the LMS-supported regional K-Theory Days. These were initiated some ten years ago by his former Oxford DPhil student Jazek Brodzki. On May 22nd, a special K-Theory Day was organised in honour of Dan's 65th birthday. Former students, collaborators and mathematical friends attended.

PS: In case you're wondering who knitted Dan's jumpers, of course it was his wife Jean whom he had met when they both were mathematics undergraduates at Harvard. They have six children and many more grandchildren. The move across the big pond was no doubt eased by the fact that as a concert violinist and violin teacher Jean found Oxford very amenable and full of opportunities.

George Mackey (1916-2006)

by Keith Hannabuss

One of the highlights of my first year as a graduate student (1966-7) was the series of lectures on Unitary Group Representations with applications to Physics, Probability, and Number Theory given by the Eastman Visiting Professor George Mackey. He lectured for two and a half hours each week throughout the academic year, covering a vast amount of material on finite group representations, von Neumann algebras, measure theory, ergodic theory, topological and Lie groups, before proceeding to the applications, which seemed to range through almost all areas of mathematics. This formed an excellent introduction to a wide range of advanced mathematical ideas.

Mackey returned to Oxford for the three week Research Symposium on Representations of Lie Groups in June/July 1977, where he was one of the main speakers, and made other shorter visits.

After doing his doctorate with Marshall Stone, most of Mackey's professional career was spent at Harvard, where he eventually became Landon T. Clay Professor in 1969. He published some 70 research papers, five books, and several other scientific articles.

Mackey's early work on dual topological vector spaces is still fundamental to work in that area, and also paved the way for Grothendieck's theory of nuclear spaces. His beautiful 1951 paper with Kaplansky on Ulm's theorem extended a classic result on finite abelian groups. That was one of only three joint papers, the other two being with Kakutani in 1944 and 1946.

His major contributions were in extending the idea of induced characters for finite groups to induced representations of locally compact topological groups, and for a series of remarkable results which in some cases (such as Mackey's Subgroup Theorem) had not even been known in the finite case. To do this he had to overcome formidable measure-theoretical difficulties which had no analogue in the known cases, but it turned out that in many cases the measure theory is more important than the topology. His methods, sometimes known as the Mackey machine, were quite concrete, so that they both established the theorems, but also provided the techniques to tackle particular examples.

His major contributions were in extending the idea of induced characters for finite groups to induced representations of locally compact topological groups...

In a remarkable 1963 paper, anticipating ideas later appearing in the theory of stacks and in Connes' noncommutative differential geometry, he showed how Cech cohomology of a topological space could be encoded in a measurable groupoid, and how a space could inherit a near manifold structure from an ergodic foliation. Similar themes appeared in the conjecture later proved by Glimm that the measurable action of a group on a space was type I if and only if it was smooth.

Mackey's theory of induced representations also offered an interpretation of the quantum mechanical commutation relations as an expression of the Euclidean symmetry of the theory. Just before his arrival as Eastman Professor, Mackey had published his Mathematical Foundations of Quantum Mechanics, including an axiomatic formulation of quantum theory, which led others to develop the theory of quantum logic. The theorem of his student Gleason, classifying the probability measures on subspaces of Hilbert spaces in dimension >=3, has recently been rediscovered in the context of quantum computation. Unlike others, Mackey regarded the axioms not as fundamental, but just a concise description of the similarities and differences between classical and quantum theory.

George Mackey had a mischievous sense of humour. I remember one occasion when, asked which of his many distinguished former students was best known, he replied that was probably Tom Lehrer.

New people

This year has seen an unusually large number of new appointments in Mathematics and six new Lecturers started in October 2005. They bring a remarkably varied range of experience and expertise to the Mathematical Institute.

Victor Flynn is a CUF Lecturer and Fellow of New College. After a first degree in New Zealand, in Mathematics, Philosophy and Latin, he came to Cambridge on a Prince of Wales Scholarship for his PhD in the area of Arithmetic Geometry. He was a lecturer at the University of Liverpool, before being promoted to Professor and was Head of Pure Mathematics there for four years. When not working, Victor spends time on the water: sailing, rowing and windsurfing.

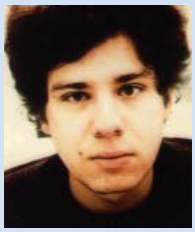
Anne Henke is a University Lecturer and Tutorial Fellow at Pembroke. She read Mathematics at the universities of Frankfurt, Edinburgh and Heidelberg, and obtained a DPhil in Oxford in the area of Representation Theory under the supervision of Dr Karin Erdmann. She held Postdoctoral positions at Kassel and at the Weizmann Institute of Sciences, before she took up a lectureship at the University of Leicester. Last year she held a Leverhulme Research Fellowship and visited the Universities of Chicago and San Diego, before spending 6 months as visiting professor at the EPFL in Lausanne. In her free time, Anne plays oboe, enjoys going to concerts and art galleries, or can be found climbing summits in the Alps.

Michael Monoyios is a University Lecturer in Financial Mathematics and a Fellow of Lady Margaret Hall. He obtained BSc Physics and PhD Theoretical Physics degrees from Imperial College, London followed by a Royal Society Postdoctoral Fellowship in Theoretical Physics at the Niels Bohr Institute, Copenhagen. He then became a trader of interest rate derivatives for Security Pacific Hoare Govett, London before returning to academia as a Research Associate at Imperial College. From 1996-2004, at Brunel University he was a Senior Lecturer in Mathematical Finance. His research interests include: optimal hedging in incomplete markets; transaction costs and numerical solution of singular control problems; model uncertainty; information problems.

Alex Scott is a CUF lecturer and a Fellow of Merton College. He was a student and then junior research fellow at Trinity College, Cambridge, before moving to University College London, as lecturer and then reader. His interests are in the broad area of combinatorics, and its connections with computer science, probability theory and statistical physics.

Balazs Szendroi is a Faculty lecturer and Fellow of St Peter's College. His research interests are on the geometry and algebra of some spaces of interest in string theory. More precisely, algebraic geometry

of Calabi-Yau manifolds: classification, symmetries, structures such as bundles and curves on such manifolds. Before coming to Oxford he held a Zeeman Lectureship at Warwick followed by a Marie Curie Fellowship at Utrecht. He is a frequent visitor to the Alfréd Rényi Institute of Mathematics in Budapest.



Pierre Tarres is University lecturer and Fellow of St Hugh's College. He mainly works on self Interacting Random Walks (SIRWs), particularly reinforced random walks, and their relationship with stochastic algorithms. SIRWs are random processes evolving in an environment constantly modified by their own behaviour. Depending on the nature of this self-interaction, the processes can be self-repelling or self-attracting, in other words more likely to stay away from or to come back to the places already visited before. He has proved a conjecture of Pemantle and Volkov that on the integers Z the vertex reinforced random walk almost surely eventually gets stuck in five random points. More recently, in a joint work with V. Limic, he has shown that on any graph of bounded degree the strongly edge reinforced random walk with nondecreasing weight function ultimately only visits one edge back and forth with probability one, as was conjectured by Sellke in 1994.

Gabrielle Stoy to retire

Gabrielle Stoy will retire this year. She first came to Oxford to do a DPhil with Graham Higman and has been a Tutorial Fellow at Lady Margaret Hall for forty years. Generations of undergraduates will remember her lectures on Algebra. In 1987 she was the first woman to be Junior Proctor and she subsequently served for 9 years on the Hebdomadal Council. She has acted as chair of the Curators of the Examination Schools for many years

Gabrielle will be moving to Boston on retirement where her husband Joe is currently based.

Research Fellowship for Ruth Baker

Ruth Baker was appointed to an RCUK Fellowship in Mathematical Biology in October 2005. This post gives her 5 years as a Research Fellow and then converts into a lectureship with a tutorial fellowship at St Hugh's. Ruth did her undergraduate and postgraduate studies in Oxford. She works in the Centre for Mathematical Biology on pattern formation in developmental biology. She has been awarded a Lloyds Tercentenary Foundation Fellowship for 2005-2007 and she is spending the current year in the Max Planck Institute in Leipzig.

Photo © Rob Judges

A Knighthood for John Ball

Professor Sir John Ball, Sedleian Professor of Natural Philosophy, received a knighthood in the New Year Honours list for services to Science. John Ball is currently President of the International Mathematical Union (IMU), which promotes co-operation between mathematicians around the world and he is very active in supporting the advancement of mathematics in developing countries.

"The mathematical challenge knows no geographical boundaries. The most important factor is the opportunity", says Professor Ball. "The one thing that's changed a lot is the internet. Previously, if you were in a disadvantaged part of the world, you had no chance at all of accessing the material you needed. Though there are still problems with slow internet connections and so on, it is hugely better. It is a very good time to try and press on this issue". Because mathematics is central to disciplines such as physical sciences and economics, it is of fundamental importance to the future of prosperity of developing countries. In addition, researchers regard the advancement of maths in the developing world as vital to the future health and growth of the profession.

Other achievements by Members of the Institute

Dr Bernd Kirchheim was awarded a Whitehead Prize of the London Mathematical Society for his fundamental work in real analysis.

Professor Philip K. Maini has been awarded a honorary guest professorship at the University of Electronic Science and Technology of China, Chengdu (home of the giant panda).

Mathematics in Madrid

The International Congress of Mathematics will be held in August 2006 in Madrid. This global jamboree for all mathematicians is held every four years under the auspices of the International Mathematical Union (IMU).

A large contingent of Oxford mathematicians will attend this meeting. Invited speakers are Marcus du Sautoy, Peter Donnelly (Statistics) and Endre Suli (Computing Laboratory). Marcus du Sautoy will also take part in a round table debate on *Should Mathematicians care about communicating to broad audiences?* John Ball as President of the IMU, will take a leading role at this meeting and will chair a round table debate on '*Are pure and applied mathematics drifting apart?*'

A Doctoral Training Centre in Systems Biology

Mathematical Biology is growing at a tremendous rate! The BBSRC has just awarded Oxford almost 4 million pounds to fund a new Doctoral Training Centre (DTC) in Systems Biology over the next 6 years. This will provide a comprehensive training programme for graduates to undertake research careers in the new and exciting interdisciplinary field of systems biology.

Professor Philip Maini, Director of The Centre for Mathematical Biology, will be a key player in this activity which also includes faculty members from Biochemistry, Computing Laboratory and Chemistry. The DTC will form part of the new 8 million pound Oxford Centre for Integrative Systems Biology which will create 6 new faculty positions including 4 in mathematics/statistics.

80th birthday celebration for Professor J. A. Green

A conference was held in the Mathematical Institute in March to celebrate Sandy Green's 80th birthday.

Green is best known for his work on modular representation theory. The subject had been developed earlier by Brauer, but while Brauer had concentrated on modular characters as a method to refine character theory, it was Green who placed the emphasis on a study of the underlying modules, and that is prevalent today. Earlier, he had determined the complex characters of the general linear groups, and later he went on to study quantum groups via Hall algebras. For all this work, he was awarded the de Morgan Medal of the London Mathematical Society in 2001.

Sandy Green's first appointment was at Manchester in the 1950s; and he moved first to a chair at Sussex and then to Warwick when the Mathematics Institute opened in 1965. He and Margaret moved to Cumnor Hill on his retirement from Warwick in 1991, and he has been a regular figure at seminars in Oxford ever since. In 1992, he was a member of the General Board's Review Committee for Mathematics, as a result of whose recommendations the Institute became a formal department of the University.

Garden Party

This year the Mathematical Institute Garden Party will be held on June 17. There will be a lecture by Robin Wilson on "How hard is a hard problem?"at 4pm followed by a reception in Somerville College.
Tickets cost £10 and if you would like to attend this event please contact Laura Mildenhall on mildenha@maths.ox.ac.uk or write to her at the Mathematical Institute.

Sudoku puzzle corner

This year's Maths Institute best-seller must have been Robin Wilson's *How to Solve Sudoku*, which sold 140,000 copies in six months and has already appeared in eight languages. Robin wrote it in eleven days last summer, and quickly followed it with, *Hidden Word Sudoku*. He is delighted that so many people around the world are deriving such pleasure from doing combinatorial mathematics.

Here is an example of a hidden word sudoku puzzle. Fill in the empty cells in the puzzle below so that each of the nine letters below the puzzle appears just once in each row, column and 3 x 3 box, and a mathematical word will appear in one of the rows or columns.

				E				T
N	H				P			S
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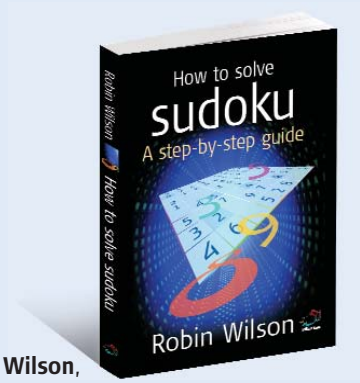
A E G H N O P S T



Robin Wilson, *How to solve sudoku: a step-by-step guide*, Infinite ideas, 2005; ISBN 1-904902-62-6

Hidden word sudoku, Infinite ideas, 2005; ISBN 1-904902-74-X