Oxford Mathematical Institute

Spring 2009, Number 7

Newsletter

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

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John Ockendon (right) and Chris Breward are shown over the KAUST site which opens for students in September →

Chris Breward and John Ockendon in Jeddah, proudly displaying the OCCAM award. On the right is Nick Harberd (Plant Sciences), who was awarded a Personal Investigator grant. ↓

How to boost global Applied Mathematics: The Oxford Centre for Collaborative and Applied Mathematics

In October 2007 the Global Research Partnership of the King Abdullah University of Science and Technology (KAUST) announced that they would fund four $25 million interdisciplinary centres engaged in path-breaking research. Unusually, both Applied Mathematics and Computational Science featured on the list of possible areas.

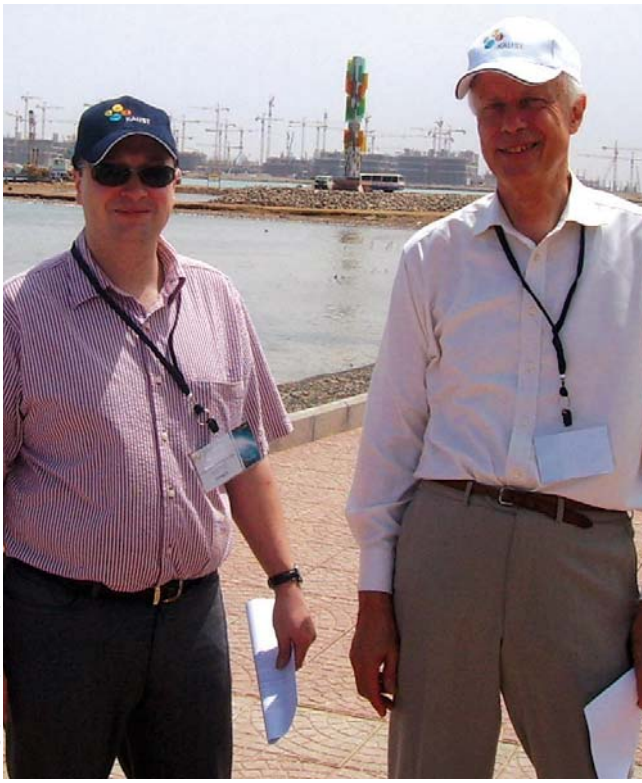
So four Oxford research groups – OCIAM and the Centre for Mathematical Biology in the Mathematical Institute, and Numerical Analysis and Computational Biology from the Computing Laboratory – set to work to write a proposal for the ***Oxford Centre for Collaborative and Applied Mathematics*** (OCCAM). Time was short and numerous hurdles had to be overcome, but in May 2008 it was announced that OCCAM was to be one of the four KAUST centres. The hectic activity that characterised the submission process was focused by the partners' joint vision of problem-driven interdisciplinary research and its reliance, in the 21st century, on global networking.

The centre's main aim is to promote interdisciplinary mathematics around the world and to address quantitative challenges in physical and biological sciences and from industry. It is run by members of the four core groups who made the bid.

OCCAM opened its doors in October 2008 with John Ockendon, as its Director and Chris Breward as Associate Director. The Centre is based in newly refurbished offices in the Gibson Building in the Radcliffe Observatory Quarter and is already buzzing with new appointments – four research fellows, eight postdocs and four graduate students – as well as seconded faculty from the core research groups.

There are still more appointments to come and there will be a grand opening at the end of June. Meanwhile the activity within OCCAM is already creating exciting collaborative links both within Oxford and further afield.

(For more details, see *www.maths.ox.ac.uk/groups/occam.*) n



Photograph © Stephen Conway

Photograph © Stephen Conway

Professor Graham Higman, FRS

Born 1917, died 2008; Graham Higman, who died last April, succeeded his former Balliol tutor and supervisor, Henry Whitehead, as Waynflete Professor of Pure Mathematics in 1960 after returning to Oxford as a reader in 1955.

Higman was one of the most significant British group theorists of the twentieth century. He strongly held the view that pure mathematics should be studied for its beauty rather than its utility, and he once remarked that finite group theorists were the natural successors to the classical geometers though his own work spanned both finite and infinite groups. His thesis on integral group rings, published in 1940, had arisen from a geometric question in algebraic topology. His mathematical career was then interrupted while, after registering as a conscientious objector, he served in the Meteorological Office in Northern Ireland and Gibraltar. When Max Newman was building the mathematics department at Manchester, Higman was appointed a lecturer as part of an intensely research-oriented group of young mathematicians.

His most important early work was on infinite groups, first in joint work with Bernhard and Hanna Neumann on HNN-extensions, and later his theorem that any finitely generated group can be embedded in a finitely presented group if and only if it is recursively presented. The latter was of especially wide interest since he needed to work at the boundaries of logic to establish the concept of relations being 'recursively enumerable'.

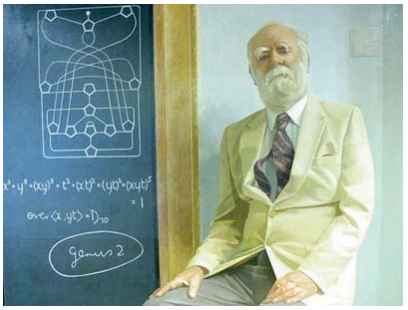
It was in his Manchester years, too, that Higman worked on the Burnside Problems, leading ultimately to his celebrated joint paper with Philip Hall in 1956. This paper has proved the foundation for ideas that have influenced finite group theorists ever since, and it is probably no accident that a remarkable but simple idea that lies at its heart is numbered Lemma 1.2.3.

Higman spent the year 1960–61 in Chicago at a time when there was an explosion of interest in finite simple groups, following Thompson's thesis which had seen an almost unimaginable extension of the Hall–Higman methods; it was during that year that the Odd Order Theorem was proved. Higman realised that this represented the future of the subject, but he never fully embraced it. Ever the maverick, he embarked on a programme of odd characterisations of simple groups that fuelled many a thesis, but neither these nor his own work formed part of the core attack on their classification. However, his particular expertise led to his construction of two of the sporadic groups, the third Janko group and Held's group.

He had numerous students; to each he gave individual attention, not with scheduled meetings, but with the instruction that one should appear for tea, attend colloquia and his advanced class, and come to see him when one had something to say or ask. He might be sitting calculating at his glass blackboard, but he would always put that aside to help the student and many of his own ideas, sketched on that board, would find publicity only under the student's name; Higman did not suggest joint authorship and he surely could not have tolerated the Research Assessment Exercise.

Some found him intimidating, not least by his choice of words. He once remarked that there were three types of student, those who wrote their own theses, those for whom he wrote their thesis and they understood it, and those who for whom he wrote their thesis but they did not, while to one former student he said in public at an ICM, "When I asked you a question, I didn't expect you to prove a theorem". Friends were not exempt; Bill Boone, after giving a lecture entitled "A logical approach to HNN-extensions", was firmly told, "And for a logical and intelligible account, read the original paper."

Higman knew when he had proved a good result; in Chicago he had written a paper entitled Suzuki 2-groups, but Michio Suzuki at his retirement



conference called them Higman 2-groups. As Martin Powell exclaimed when first shown Norman Blamey's portrait, "That's the Graham we all know and love – I've proved a good theorem, you lot do better!" Many a seminar speaker was faced by this portrait, hung in the Higman Room that was established to mark his retirement.

Higman was the second son of a Methodist minister and took his upbringing seriously, becoming a local preacher in 1936 and officiating regularly until 2001. When his wife, Ivah, died in 1981, Higman himself gave the funeral address; then, as since, he thought deeply about the role of the after-death in Christianity. Some recall a phrase "One of the murkier areas of Christianity".

That address, like most of his lectures, was given without notes. His lectures contained an even flow of prose and mathematics, with the use of the adjoining board for details, and his advanced classes often contained his most recent thinking – occasionally he arrived late if some detail had not quite worked out in the way he hoped. Only once did he diverge, to comment on the day after the 1964 General Election that "this can also be done on the left, as seems fashionable these days".

His retirement was spent preaching and bird watching. His health gradually deteriorated over his last ten years, but he came to two lectures at the conference held in January 2007 to mark his ninetieth birthday. He was not seen in public again.

This is an abridged version of the Obituary by Michael Collins that appeared in The Independent.

Mathematical Institute news

Nick Woodhouse *Chairman of the Mathematical Institute*

Photograph © Rob Judges

The past year has been another busy one for the Institute.

Research Assessment Exercise
December saw the publication of the results of the Research Assessment Exercise, the first since 2001. This huge undertaking, in which every department in the country is invited to put forward the four best 'research outputs' of each of its faculty members, has a very significant impact on the reputations and funding of universities. It had taken much of our time in 2007, as we all worked to get our lists of outputs and other material in order. For those in the department who sat on the expert assessment panels, it also consumed much of 2008.

The result came as a relief, indeed as a cause for celebration. In 2001, there was a grade for each unit assessment – in our case, pure mathematics and applied mathematics – and the results were simple to interpret. This time there are 'profiles' rather than a single numerical score. Like most higher education correspondents and many others, we have succumbed to the temptation to translate this more complex data set into a league table. The results are very pleasing, however you do the analysis, but I shall do no more than remark that Oxford mathematics did very well indeed.

OCCAM The year has seen other very exciting and significant developments. More is said on page 1 about the launch of the Oxford Centre for Collaborative and Applied Mathematics, which has provided a huge boost for Oxford applied mathematics and is tribute to the pioneering work of John Ockendon and Alan Tayler, who founded OCIAM thirty years ago.

Charles Simonyi Chair Marcus du Sautoy has been appointed as Richard Dawkins's successor in the Charles Simonyi Professorship for the Public Understanding of Science (see page 5). Marcus has already done a great deal to promote public appreciation of mathematics and it is a very positive step for our discipline that a mathematician should be appointed to this prominent chair. He brings to his new task the insights from his own research as well as infectious enthusiasm and a gift for making accessible deep and elusive ideas.

New Institute Building With the opening of OCCAM and John Ball's Centre for Nonlinear Partial Differential Equations, we are now in three buildings. While the design of our new building makes its stately progress through the maze of the planning system, we can at least enjoy the more destructive phase of the project. The sprawl of hospital buildings around the old Radcliffe Infirmary has now disappeared, and a large pile of rubble occupies the site of our forthcoming Institute Building. n

IMA Gold Medallists

Photograph © Sarah Walters

Hugo Hammersley, June Tayler, Julian Hammersley and John Ockendon in front of the three gold medals.

In 1982 the Institute of Mathematics and its Applications instituted a gold medal to be awarded to one or two distinguished applied mathematicians every other year. In total 17 medals have now been awarded and of these medallists, three have been members of The Oxford Centre for Industrial and Applied Mathematics. The three OCIAM winners were Alan Tayler in 1982, John Hammersley in 1984 and John Ockendon in 2006.

In December 2008 friends and relations of the prize winners were invited to a party at which a handsome plaque containing the three medals was unveiled. June Tayler (Alan's widow), Julian and Hugo Hammersley (John's sons) and John Ockendon have given the medals to OCIAM on indefinite loan and the plaque is fixed firmly to the wall in the OCIAM Library.

Photograph © Sarah Walters

Approximation Theory and Practice

Nick Trefethen *Professor of Numerical Analysis*

Did you know that it's perfectly feasible to interpolate 1,000,001 data values by a polynomial of degree 1,000,000? The power of high-order polynomial interpolation is being exploited by the *chebfun project* based in the Oxford Numerical Analysis Group.

Two tricks are needed to make the process practical:

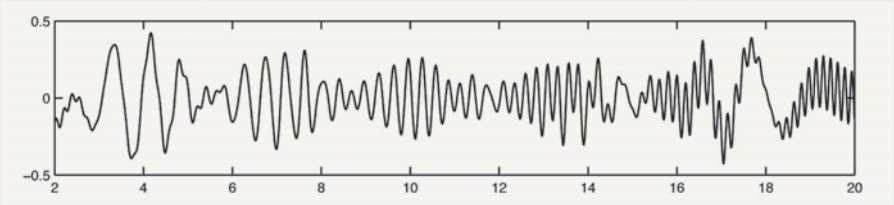
- the interpolation points must be clustered near the boundary and (as you might guess from the name) we use Chebyshev points: for the interval [−1, 1], these are $x_j = \cos(j\pi/n)$, for $0 \le j \le n$.
- the interpolant must be evaluated by a barycentric formula published by H.E. Salzer in 1972.

Combining these leads to methods as efficient and robust as the much more famous Fourier techniques for periodic problems.

The chebfun project is a software system built on these facts and on the remarkable way in which MATLAB has grown to codify generations of advances in numerical linear algebra. The system overloads MATLAB commands for vectors and matrices so that they apply to functions and operators, with everything implemented by Chebyshev interpolants. For example, suppose we type

```
f = chebfun('sin(x^2)*besselj(0,x) +sin(x)*besselj(1,(20-x)^2)',[2 20]).
```

The resulting chebfun f matches $\sin(x^2)\, J_0(x) + \sin(x)\, J_1((20-x)^2)$ on the interval [2, 20] to about 15 digits of precision and can be manipulated by dozens of familiar MATLAB commands. We can plot it with plot(f), as shown below.



The command length(f) reveals that f is actually a polynomial of degreee 492. Here are its maximum, integral, total varation, and tenth zero counted from the left, all computed to about 15-digit precision in a fraction of a second using just the right numerical algorithms (how would you do these things?):

```
max(f)                          norm(diff(f),1)
ans = 0.422423192472707         ans = 40.021432099272715

sum(f)                          r = roots(f); r(10)
ans = -0.010800293307751        ans = 5.025153047777319
```

The chebfun team, funded by EPSRC, currently consists of myself, post-doc Rodrigo Platte, DPhil student Ricardo Pachón, regular visitor Toby Driscoll from Delaware, and two MSc students. Users are beginning to pop up around the world. Our vision is a computational tool that feels symbolic, like Maple or Mathematica, but runs at the speed of numerics. The system already handles piecewise smooth functions, infinite domains, and ODE initial-, boundary-, and eigenvalue problems. For details, or to download, google chebfun.

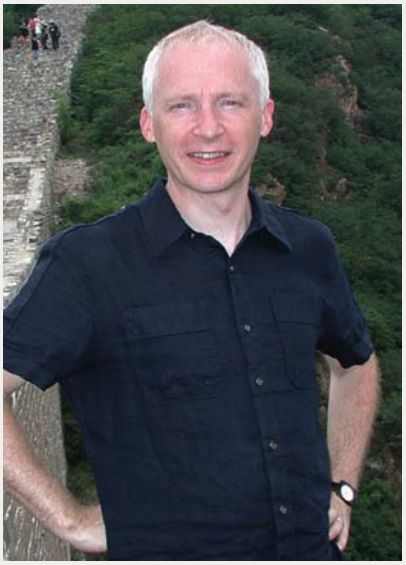
Triadophilia

Philip Candelas *Rouse Ball Professor of Mathematics*

In String Theory, which many consider to be the 'best buy' as a theory of the fundamental interactions of physics, there is a much discussed difficulty known as the 'Landscape problem'. String Theory is first formulated as a theory in ten dimensions and six of these are supposed to 'curl up' into a small manifold; the most popular of these are the so-called 'Calabi-Yau manifolds'. It does no harm at this level to think of this as being somewhat like a small sphere, but it is important that it can have a more complicated shape with many 'handles'. Even though the Calabi-Yau manifold is too small to be observed directly, it leaves its mark on the laws of particle physics. There are a great many possibilities for the number of different CY manifolds, perhaps hundreds of millions or even more, and each one leads to a different theory in the observable world. A small number of these are like our world, but most are very different.

The 'Landscape' consists of these possibilities and the 'Landscape problem' is to explain how the theory can have predictive power if, as many imagine, all these possibilities are equally likely and it might be just a matter of luck as to why the world is as it is. The Oxford contribution (of myself, Xenia de la Ossa, Yang-Hui He and Balász Szendrői) is to point out that most of these CY manifolds are very complex: when one plots the topological type of the manifold against its complexity, the plot looks like a wedge that is very densely populated, but the tip, which consists of the simplest manifolds, is very thinly populated. Moreover, among the few manifolds that populate this tip, there is at least one that has the particle content of what is taken to be the Standard Model of particle interactions. The debate therefore may be not so much as to why our world is chosen over the multitude of others, but why we live at the tip of the distribution.

Marcus du Sautoy and the Charles Simonyi Chair



For some years Marcus du Sautoy has been a familiar figure on our television screens and over the radio waves. In 2005 his BBC–Open University documentary *The Music of the Primes* appeared on BBC4 and was later repeated on BBC2, attracting a total audience of around two million. In 2006 he presented the Royal Institution Christmas lectures to 13- and 14-year-olds, and these attracted large TV audiences. His radio broadcasts have ranged from discussions of symmetry or mathematics and music to appearances on *Desert Island Discs* and *The Today Programme*, and recently he presented a Radio 3 documentary about the Baroque arts and sciences. An account of his recent BBC4 series *The Story of Maths* appears below.

Marcus du Sautoy has recently been appointed to the Charles Simonyi Chair for the Public Understanding of Science, following the retirement of Richard Dawkins. Here he presents his views about his appointment:

The Simonyi Chair encapsulates for me the two things I have dedicated my working life to over the last decades: high-level academic research combined with a passion for communicating the excitement of my subject to a broad spectrum of society.

For me, science is about discovery but it is also about communication. A scientific discovery barely exists until it is communicated and brought to life in the minds of others.

I am deeply committed to continuing my own research which seeks to uncover some of the deep eternal mysteries of number theory and symmetry. But at the same time, I am passionately dedicated to giving as many people as possible access to the exciting and beautiful world of mathematics and science that I inhabit and revealing to them why it is such a powerful way to understand the world.

A mathematically and scientifically literate society is essential given the huge role science now plays in our world. But my belief is that message can best come from someone actively involved at the cutting edge of their science. The role of Simonyi professor is rather like an ambassador for science helping to create dialogue between the scientific community and society at large.

I think that mathematics is a fantastic choice of topic for the Simonyi chair. Mathematics is the language of science. It is at the heart of physics, chemistry and much of biology which makes it a great platform for engaging the public in science.

I am particularly excited by the challenge of profiling the fantastic science we do in Oxford. Having been involved in Oxford science since I came to Oxford as an undergraduate in 1983, I believe we have one of the greatest centres of scientific excellence in the world and it is important to tell people about our success.

Richard Dawkins has done a fantastic job in the last 13 years in bringing the wonders of evolutionary biology to the public. This appointment, I think, marks a new direction for the Simonyi chair and I am excited by the attention it will provide for mathematics. Of course I am bracing myself for questions about my views on God, but this is a job about communicating the wonders and excitement of science.

The Story of Maths

As reported in last year's *Newsletter*, Marcus du Sautoy made a series of four high-profile one-hour BBC TV programmes, in association with the Open University, in which he traced the development of mathematics from its origins in Egypt, Mesopotamia, China, and India to the present day.
There were four programmes:
The language of the universe, *The genius of the East*, *The frontiers of space*, and *To infinity and beyond.*

These programmes were broadcast several times on BBC4 in October, achieving large audiences, and in January they were presented on BBC World to an estimated world-wide audience of 200 million. It is hoped that they will be re-broadcast again before too long.

Marcus in Königsberg

To accompany the series, Robin Wilson has written an Open University 10-week introductory course for those wishing to learn 'the maths behind the programmes'; this course was presented last winter with spectacular success, and will be presented again in May and October (visit *www.openuniversity.co.uk/storyofmaths* for details).

Appointments...

Prof Paul Bressloff (*University of Utah*) to a University Research Professorship in Applied Mathematics. *Research interests*: mathematical neuroscience, biological physics, partial differential equations, stochastic processes, dynamical systems.

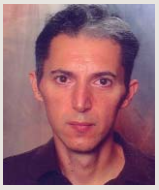
Dr Hanqing Jin (*University of Oxford*) to a University Lecturership in Mathematical Finance and a Fellowship at St Peter's College. *Research interests*: mathematical finance, behavioural finance and applied stochastic analysis.

Dr Kobi Kremnizer (*University of Chicago*) to a University Lecturership in Pure Mathematics and a Fellowship at Oriel College. *Research interests*: geometric representation theory.

Dr Andreas Münch (*University of Nottingham*) to a Readership in Applied Mathematics and a fellowship at St Catherine's College. *Research interests*: Dynamics of thin liquid polymer films, and the role of slippage, non-classical shocks, quantum dots / epitaxial growth, liquid flows with free capillary surfaces, viscous particulate flows.

Dr Jan Obloj (*Imperial College London*) to a University Research Lecturership in Mathematical Finance. *Research interests*: derivatives pricing and hedging, portfolio optimisation, martingale theory and embedding problems for stochastic processes.

Dr James Oliver (*University of Oxford*) to a University Lecturership in Applied Mathematics and a fellowship at Jesus College. *Research interests*: fluid dynamics and its applications to free and moving boundary problems in industry, engineering and biology, with applications ranging in scale from ship slamming to cell mobility.



Dr Panagiotis Papazoglou (*University of Athens*) to a University Lecturership in Mathematics and a Fellowship at The Queen's College. *Research interests*: geometric group theory, large scale geometry and topology.

...and farewells

We are sorry to say goodbye to **David Acheson** (Jesus/Keble), **Peter Neumann** (Queen's) and **Graham Vincent-Smith** (Oriel) who retired last summer.

Photograph © Phil Trinh

David Acheson

Peter Neumann

Graham Vincent-Smith

Tom Witelski has left to take up an Associate Professorship at Duke University, USA, and Christoph Melcher has left to take up a Chair in Applied Analysis at RWTH Aachen University in Germany.

Photograph © Marc Atkins

Ulrike Tillmann elected a Fellow of the Royal Society

We were delighted when Ulrike Tillmann, Professor of Mathematics and Fellow of Merton College, was included in the list of new Fellows of the Royal Society for 2008. Her work is in algebraic topology, where her researches combine original thinking in homotopy theory with strong geometric insight to give new understanding of large classes of topological structures. She introduced homotopy theoretic techniques to the study of topological and conformal field theories: this led to penetrating and definitive results in the study of spaces of Riemann surfaces, and spaces of manifolds more generally. Her work is also related to modern developments in the physics of topological field theories. She describes her approach to research and teaching as follows:

I think of a theorem – that this must be true – and then try to prove it. You need to see the whole way through: that is how I tend to work. I try to sketch a proof, and complete a little bit and go home happy. That's how I work: I try to see the whole thing and then come back and fill in the details. You need the whole community of mathematicians: we also teach, and mathematics is a conversation that goes backwards and forwards between people, and also between the generations. I think that's important – to have this continuity of ideas.

SIAM Student Chapters beyond the USA: The Oxford Experience

Thomas Woolley

In January 2008, the University of Oxford became the first UK institution, and only the fourth outside the USA (the other three being in Spain, Italy and Turkey), to form a *SIAM* Student Chapter.

The Society for Industrial and Applied Mathematics (*SIAM*) publishes many journals and books, holds conferences across the world, and motivates interest and communication through its chapter scheme. The success of the chapter model is based on the fact that, as well as connecting students with the wide variety of resources offered by *SIAM*, it provides an excellent opportunity for students and faculty to interact. Our main goal is to construct a network of people, from all backgrounds and disciplines, who are interested in mathematics and its applications.

Specifically, we promote the ideals of *SIAM* through a few large-scale events each year. The highlight this year was the second Oxford *SIAM* Student Chapter Annual Conference, held in Somerville College in February; the plenary speakers were David Acheson (Jesus College) and Nick Higham (University of Manchester), together with the usual entertaining range of doctoral and postdoctoral students. The conference was sponsored by Winton Capital Management, who are leaders in research-led managed futures trading. We're looking to make the conferences more national (and even international if the opportunity arises!), and you are cordially invited and positively encouraged to attend next year's conference (for details, see *http://people.maths.ox.ac.uk/~siamstudentchapter/Conference.html*).

Another goal is to encourage more chapters to form in Europe and elsewhere; aside from the minor inconvenience of converting the funds provided by *SIAM* from US dollars to local currency, it makes no difference where the chapter is based!

International evening at the Mathematical Institute

An international evening was held in the Mathematical Institute in January, attended by many students.

International food was enjoyed by those who attended the event.

After an impromptu address by the Chancellor, Chris Patten, and a discussion about international stereotypes, Marcus du Sautoy gave an amusing presentation outlining his recent TV programmes *The Story of Maths* (see page 5) and describing some of the horror stories that took place during the round-the-world filming.

Oxford Maths Students on *Countdown*

Junaid Mubeen won the 59th series of *Countdown* on 12 December 2008 on the last programme to be hosted by Des O'Connor and Carol Vordermann. He has been a mathematics student at St Anne's College since 2003, completed an MMath degree in 2007, and is now studying for a DPhil. His supervisor, Professor Charles Batty, said 'I shall be delighted if he is as successful in his mathematical research as he has been in his television appearances'.

Carol Vordermann's replacement on *Countdown* is Rachel Riley, another Oxford mathematics graduate.

With permission from ITV

Junaid Mubeen, with Carol Vordermann and Des O'Connor

MP40: Calling all Maths Philosophers – join us for a birthday celebration!

This year there's even more reason to visit Oxford for the annual Maths Garden Party, as it is being combined with a celebration of 40 years of the Oxford course in Mathematics and Philosophy. Everyone who matriculated on this course is invited to mark its 40th anniversary on the weekend of 4–5 July 2009, during a programme of special events that will fit around the Saturday afternoon lectures and reception to which all mathematicians are invited.

Dana Scott and Angus Macintyre

The lectures will be given by the first two holders of the chair in Mathematical Logic, Dana Scott and Angus Macintyre, in the Martin Wood Lecture Theatre, Clarendon Building, at 4 pm on 4 July. After the garden party, there will be a celebratory dinner at St Anne's College, exclusively for Maths Philosophers and their partners. On 5 July there is a programme of lectures at the Philosophy Centre at 10 Merton Street, given by graduates of the course who have gone on to academic careers. Staff who have taught on the course are also being invited to take part in these events.

You can find out more about these celebrations and book for all, or some, of the events at http://www.maths.ox.ac.uk/events/mp40. Please also pass this information on to any fellow Maths and Philosophy graduates with whom you are in touch, who might not have received this *Newsletter*.

Mathematical Institute Garden Parties

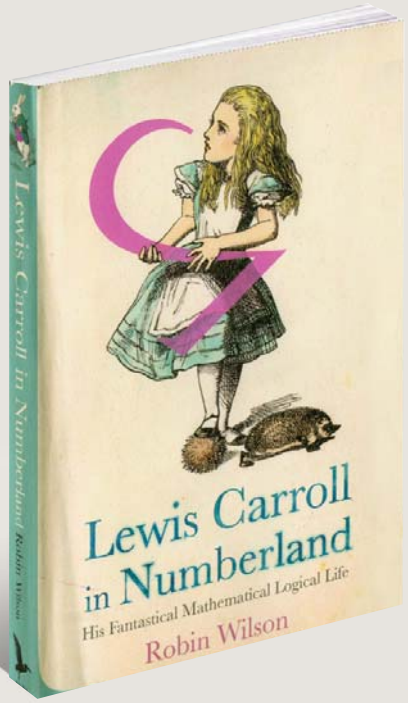
Last July's Mathematical Institute Garden Party was held at St Anne's, and was preceded by interesting talks on *The Poincaré conjecture* (recently solved by Grigory Perelman) by Professors Marc Lackenby and John Ball.

This year's event will take place on **Saturday 4 July**, with a lecture at 4 pm in the Martin Wood Lecture Theatre, Clarendon Building, by Professors Dana Scott and Angus Macintyre, as part of the MP40 gathering (see left), followed by the Garden Party at St Anne's.

Lewis Carroll in Numberland

One of this year's new popular maths books is Robin Wilson's ***Lewis Carroll in Numberland***, describing for a general audience the mathematical activities of Charles Dodgson, who wrote the Alice books *(Alice's Adventures in Wonderland* and *Through the Looking-glass)* while a mathematics lecturer at Christ Church. The book contains much information about 19th-century Oxford, and features Dodgson's preoccupations with algebra, logic, Euclidean geometry, the mathematics of voting, and mathematical puzzles. It has received rave reviews in such publications as the *New York Review of Books* and the *American Scientist*.

The book appeared last summer and will be issued in paperback in July. The author will be talking about Dodgson and his mathematics at this September's alumni weekend.



Sudoku puzzle corner

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 × 3 box, and a mathematical word will appear in one of the rows or columns: the hidden word may appear forwards or backwards, down or up.

		R	A					O
		O	T			H		M
							L	
H	I			M				
	T						G	
				I			M	T
	G							
L		A			H	M		
O					I	R		

A G H I L M O R T

***Solution to last year's puzzle*:**
SPHERICAL (row 2 backwards)