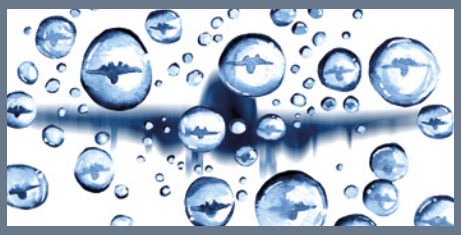
Round up

The Oxford Mathematics Newsletter • Spring 2019

UNIVERSITY OF OXFORD
Mathematical Institute

Mathematics and music



Latest research

Oxford Maths Festival

400 years of Savilian Professors of Geometry

Oxford Mathematics

Head of Department's letter

Mike Giles

On 1 September, Mike Giles, Professor of Scientific Computing and Professorial Fellow of St Hugh's College, took over from Martin Bridson as Head of the Mathematical Institute. Mike writes:

In preparing to write these few words, I looked back at the introductory words of my predecessors, Martin Bridson and before him Sam Howison, and one thing they commented on was the way in which the job involves responding to the wide variety of issues which arise, sometimes unpredictably. The sheer diversity of these took me a bit by surprise in my first term, constantly switching between teaching, research funding, undergraduate admissions, committee meetings, outreach activities, preparing for new academic appointments, etc.

On the teaching side, our new MSc, the Oxford MSc in Mathematical Sciences (OMMS), is off to a very good start with a first cohort of 36 students; this will increase to around 90 by 2023. We are also planning to increase the numbers on our MSc in Mathematical and Theoretical Physics, and our joint degree in Mathematics and Computer Science, and have begun discussions with Economics on a possible new degree in Mathematics and Economics.

Brexit is still looming large, and it is still hard to predict what the consequences for us will be. Another significant change for research funding is the creation of UKRI (UK Research and Innovation), which brings together the seven Research Councils, Innovate UK and Research England. This is increasingly channelling funding through major initiatives, such as the Industrial Strategy Challenge Fund and Prosperity Partnerships, so we are working to develop ideas for major research projects aligned with these opportunities.

Another big focus right now is on preparations for REF 2021, the next instalment of the Research Excellence Framework which determines the level of the core funding we receive from Research England.

So, on these and other fronts there's a great deal of variety to look forward to in the coming year.

Contents

Get in touch

We hope that you will enjoy this annual newsletter. We are interested to receive your comments, and also contributions for future newsletters. Please contact the editor, Robin Wilson, c/o lumbard@maths.ox.ac.uk

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Departmental News

Andrew Wiles appointed Regius Professor of Mathematics at Oxford

Oxford mathematician Sir Andrew Wiles has been appointed by Her Majesty the Queen to be Oxford's first Regius Professor of Mathematics. The Regius Professorship was granted to Oxford's Mathematical Institute as part of the Queen's 90th birthday celebrations. It is the first Regius Professorship awarded to Oxford since 1842, and one of only three Regius Chairs in mathematics in the UK (the others being at Warwick and St Andrews).

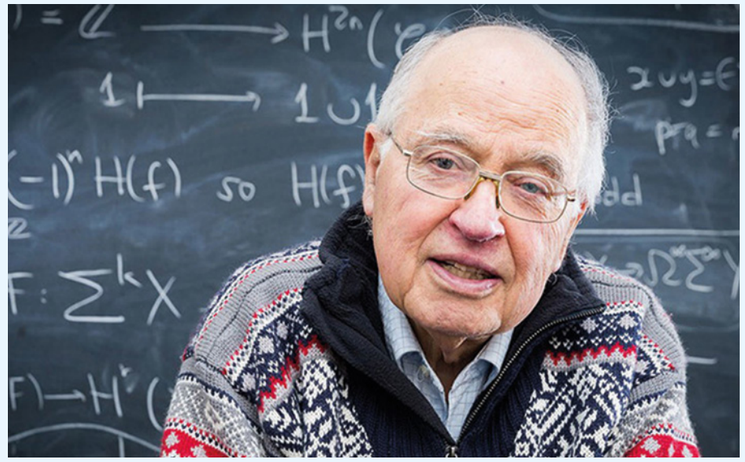
Professor Martin Bridson, former Head of Oxford's Mathematical Institute, writes: *The award of the Regius Professorship to Oxford recognised both our pre-eminence in fundamental research and the enormous benefits that flow to society from mathematics. It is entirely fitting that the first holder of this Professorship should be Sir Andrew Wiles. Nobody exemplifies the relentless pursuit of mathematical understanding in the service of mankind better than him. His dedication to solving problems that have defied mankind for centuries, and the stunning beauty of his solutions to these problems, provide a beacon to inspire and sustain everyone who wrestles with the fundamental challenges of mathematics and the world around us. We are immensely proud to have Andrew as a colleague at the Mathematical Institute in Oxford.*

In 2016 Andrew was awarded the Abel Prize, the highest honour in mathematics, for his stunning proof of Fermat's Last Theorem, a challenge that stumped mathematicians for 350 years. In recognition of this transformative work, he was also awarded the Copley Medal, the Royal Society's oldest and most prestigious award.

Andrew's proof has subsequently opened up new fields of inquiry and approaches to mathematics. In his current research he is developing new ideas in the context of the Langlands Program, a set of far-reaching and influential conjectures connecting number theory to algebraic geometry and the theory of automorphic forms. Andrew will remain the Royal Society Research Professor of Mathematics at Oxford and a Fellow of Merton College.

Obituary: Sir Michael Atiyah 1929–2019

We were very sorry to hear of the death in January of Michael Atiyah. Michael was a giant of mathematics. He held many positions including Savilian Professor of Geometry here in Oxford, President of the Royal Society, Master of Trinity College, Cambridge, the founding Director of the Isaac Newton Institute, and Chancellor of the University of Leicester. He was awarded the Fields Medal in 1966 and the Abel Prize in 2004.



Sir Michael Atiyah

Michael's work spanned many fields. Together with Friedrich Hirzebruch he laid the foundations for topological *K*-theory, an important tool in algebraic topology which describes ways in which spaces can be twisted. His Atiyah–Singer index theorem, proved with Isadore Singer in 1963, vastly generalised classical results from the 19th century (the Riemann–Roch and Gauss–Bonnet theorems) and the work of his teacher William Hodge on harmonic integrals. It also provided an entirely new bridge between analysis and topology which could act as a mechanism for giving structure to identities in areas as far apart as number theory and group representations.

His later work was inspired by theoretical physics – and coincided with the arrival of Roger Penrose in Oxford. The two exchanged ideas and realised how modern contributions to algebraic geometry formed the appropriate framework for Penrose's approach to the equations of mathematical physics. As his ideas developed, at the urging of Ed Witten, Michael began to consider quantum field theory more seriously, and ultimately became one of the founders of what is loosely called 'quantum mathematics'.

Michael gave his time generously in the promotion of his subject. In May 2018 he gave a Public Lecture here in Oxford, entitled 'Numbers are Serious but they are also Fun'. It can be watched on the Oxford Mathematics YouTube Channel.

400 years of Savilian Professors of Geometry

Robin Wilson

2019 marks the 400th anniversary of the founding in Oxford of the Savilian Chairs of Geometry and Astronomy. But who was Savile, and which distinguished figures have been Professors of Geometry?

The current Savilian Professor of Geometry is **Frances Kirwan FRS**, who was appointed to the Chair in 2017. A former DPhil student of Michael Atiyah, she specialises in algebraic and symplectic geometry, and writes: **The Savilian Chairs of Geometry have always played an important role in the mathematical life of Oxford. I feel delighted and honoured to be part of this tradition.**

Sir Henry Savile was Warden of Merton College from 1585 until his death in 1622. An internationally renowned scholar and enlightened teacher of mathematics and astronomy, he regularly lectured on Euclid's *Elements*, Ptolemy's *Almagest*, and the 'new astronomy' of Copernicus. These lectures and his many other writings are preserved in the extensive Savile Collection in the Bodleian Library, and a fine memorial to him, flanked by Euclid and Ptolemy, can be seen in Merton College Chapel.

In 1619 Savile founded the Chairs of Geometry and Astronomy that bear his name and which were to have a profound influence on the teaching and development of these then-neglected subjects. For the Geometry position he first sent for Edmund Gunter, inventor of several navigational and astronomical instruments, who came 'and brought with him his sector and quadrant, and fell to resolving of triangles and doeing a great many fine things'. Said the grave knight, *'Doe you call this reading of geometrie? This is showing of tricks, man!'* and so dismisst him with scorne and sent for Briggs, from Cambridge.'

Henry Briggs, the first Savilian Professor, worked on eclipses and on navigation, and had recently become involved with the newly invented logarithms of John Napier. The inventor of 'logs to base 10', Briggs spent his early Oxford years producing a table of 30,000 such logarithms, calculated by hand to no fewer than 14 decimal places. He died in 1631, and is buried in Merton College Chapel.

Following the English Civil War of the 1640s the post was awarded to **John Wallis**, who had been a codebreaker for the Parliamentarians. In his 54 years as Savilian professor, Wallis made many important contributions to mathematics. His 1655 book on conic sections introduced the symbols for infinity and 'greater than or equal to', while his 1656 book, *Arithmetica Infinitorum* on infinite series, greatly influenced the young Isaac Newton in Cambridge a few years later. With his Oxford colleagues, Robert Boyle, Robert Hooke, Christopher Wren and others, John Wallis played an important role in establishing the Royal Society of London in the 1660s.

Sir Henry Savile

John Wallis's portrait in Oxford's Examination Schools

Edmond Halley

Wallis was succeeded in 1704 by **Edmond Halley**, who held the Savilian Chair of Geometry for 38 years. His house in New College Lane records his residence there, in a building used for Savilian professors for 200 years. Although mainly remembered for predicting the return of the comet that bears his name, Halley established his mathematical credentials with a fine edition of Apollonius's *Conics*, published in 1710.

For the next 100 years, the Savilian Professors of Geometry were mainly astronomers who made few contributions to mathematics – for example, **John Smith**, who held the position for 30 years, spent most of his time in Cheltenham and wrote on 'The Use and Abuse of the Cheltenham Waters'.

The next mathematician of note was **Henry Smith**, who made major contributions to the theory of numbers, introduced the 'Smith form of a matrix', and published a 'Cantor set' eight years before Cantor did.

Henry Smith's successor was the brilliant but eccentric **James Joseph Sylvester**, who was appointed in 1883 at the age of 69. Sylvester made major contributions to invariant theory and combinatorial mathematics,

Edmond Halley's edition of Apollonius's *Conics*

A contemporary caricature of Henry Smith

and introduced the word 'matrix' to mathematics. An enthusiastic poet, his inaugural Savilian lecture in the Sheldonian Theatre included a sonnet dedicated 'To a Missing Member Of a Family Group of Terms in an Algebraical Formula'. Sylvester attempted, largely without success, to establish a research tradition in a university still mainly concerned with teaching.

It was in the 20th century that the Savilian professors became increasingly involved with research activities. **G. H. Hardy**, in particular, spent eleven of his most productive years in Oxford, writing over 100 papers on a range of mathematical topics and running regular advanced classes in pure mathematics. He also argued the need for a mathematical institute. Although he was not a geometer, Hardy always insisted on giving a series of lectures on geometrical topics. His successor, E. C. Titchmarsh, declined to be involved in geometrical pursuits, and since then the designation 'Savilian Professor of Geometry' has been taken to include any area of pure mathematics. Meanwhile, the research tradition has been continued by all the later Savilian professors: **Michael Atiyah**, **Ioan James**, **Richard Taylor**, **Nigel Hitchin** and **Frances Kirwan**.

James Joseph Sylvester

G. H. Hardy

Events
The 400th anniversary of the Savilian Chair of Geometry will be celebrated in the autumn with an exhibition at the Bodleian Library and a special one-day meeting in Oxford of the British Society for the History of Mathematics. Further information about the Savilian professors can be found in the book *Oxford Figures* (ed. J. Fauvel, R. Flood and R. Wilson), Oxford University Press, 2013.

Comings and goings

John Ball
Sir John Ball FRS has retired as Oxford's Sedleian Professor of Natural Philosophy and Director of the Oxford Centre for Nonlinear Partial Differential Equations. He was a Fellow of The Queen's College.

For his distinguished contributions to the world of mathematics, John was elected a Fellow of the Royal Society in 1989, and received its prestigious Sylvester Medal in 2009. He was President of the London Mathematical Society from 1996 to 1998, and President of the International Mathematical Union from 2003 to 2006. An interview with him can be viewed on the Oxford Mathematics YouTube Channel.

Sedleian Professor of Natural Philosophy
Jonathan Keating FRS, Henry Overton Wills Professor of Mathematics at the University of Bristol, has been appointed to the Sedleian Chair of Natural Philosophy in succession to Sir John Ball. He has wide-ranging interests, but is best known for his researches into random matrix theory and its applications to quantum chaos, number theory and the Riemann zeta function. In September he takes up his Oxford appointment, and two months later he will become the next President of the London Mathematical Society.

The Sedleian Chair is one of Oxford's oldest professorships, having been founded in 1621. Recent holders have been George Temple (1953–68), Albert Green (1968–79) and Thomas Brooke Benjamin (1979–96). Like them, Jon Keating will be a Fellow of The Queen's College.

Nick Woodhouse
Professor Nicholas Woodhouse has retired as President of the Clay Mathematics Institute, a position that he has held since 2012. A Fellow of Wadham College, he led Oxford's Mathematics Department from 2001–10. His research interests are in geometric quantisation theory and twistor theory, and he has written a number of books on the subject. He is succeeded as President of the Clay Mathematics Institute by Professor Martin Bridson, Waynflete Professor of Pure Mathematics.

Research: Hooke and Titchmarsh fellows

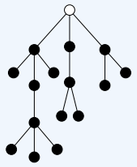
In order to realise its ambition of bringing the world's most talented mathematicians at all career stages to Oxford, the Mathematical Institute has invested in some high-profile research fellowships – the Hooke Fellowships (named after Robert Hooke) in applied mathematics, and the Titchmarsh Fellowships (named after E. C. Titchmarsh) in pure mathematics, Here, two of our current fellows outline their current interests; fuller details can be found on the Institute's website.

David Hume
(Titchmarsh Fellow)
A continuum of expanders

A *network* (or *graph*) is a collection of vertices (points) and edges (lines connecting two vertices). They are used to encode everything from transport infrastructure to social media interactions, and from the behaviour of subatomic particles to the structure of a group of symmetries. A common theme throughout these applications, and therefore of interest to civil engineers, advertisers, physicists, and mathematicians (amongst others), is that it is important to know how well connected a given network is.

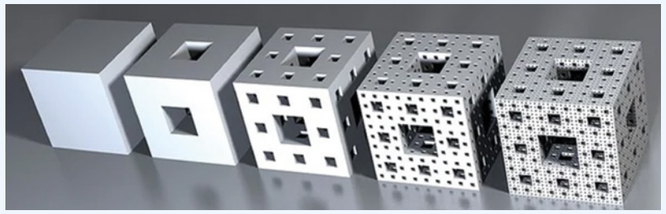
Given a network, its *cut size* is the smallest number of vertices that we need to remove so as to disconnect the network; for example, trees are poorly connected (with cut size 1), while complete graphs are highly connected (see pictures to the right).

In my current work I explore how cut sizes behave for certain networks (specifically, Cayley graphs of finitely generated groups) that are 'negatively curved at large scale': this area is of particular interest in group theory, and plays a key role in recent proofs of important conjectures in low-dimensional topology. For such a negatively curved group, the cut size seems to be related to the dimension of an associated fractal 'at infinity'. With John Mackay and Romain Tessera, we have established this link for an interesting collection of such networks, and are working on developing the mathematical machinery that is needed to generalise our results.

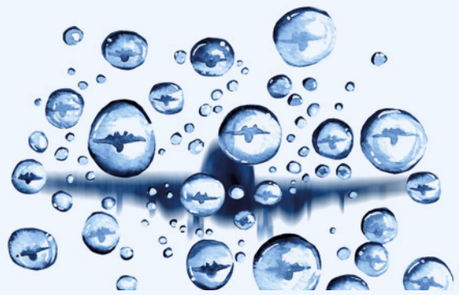


Above: A tree and a complete graph.

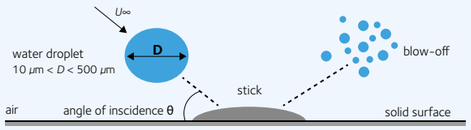
Below: The associated fractal at infinity of a typical 'negatively curved' group is topologically a 'Menger sponge'.



Radu Cimpeanu
(Hooke Fellow)
What happens when aircraft fly through clouds?



On a cloudy or rainy day, aeroplanes have to fly through very humid conditions. Tiny drops of water hit the surface of the aircraft and start accumulating, forming thin liquid films and rivulets. Once a certain altitude is reached, temperatures fall sharply and these patches of water may quickly freeze and become a real danger. In fact, after human error and mechanical failure, icing is one of the main hazards.



Attempting to understand the detailed effects in this scenario leads to what applied mathematicians call a *multi-scale problem*. Here, one needs to model and account for the complex high-speed air flow around the aircraft, while trying to investigate the detailed dynamics surrounding physical processes such as violent drop impact, with features changing at the sub-micron scale inside the capture region on the aircraft surface. If we add further physical effects such as temperature, a rich and difficult landscape emerges, which can be dealt with only through a combination of mathematical tools.

Advances made through matched asymptotic and complex analytical arguments, as well as the development of state-of-the-art computational tools capable of addressing the significant topological changes in the flow, help us to unravel the individual droplet deformation, break-up, and subsequent fragmentation, thereby transferring this insight into quantifiable features for experimentalists and engineers. The developed drop impact models address key questions at a fundamental level, with the conclusions of the study extending towards the improvement of anti-icing techniques at a time of expansion and diversification of the relevant sectors in the industry.

Mathematics and music

James Sparks

In November a capacity audience enjoyed an Oxford Mathematics Public Lecture on the links between mathematics and music, followed by a stunning performance of J. S. Bach's *Goldberg Variations* by the City of London Sinfonia. The talk was presented by James Sparks, Fellow of Oriel College and the Mathematical Institute's Director of Graduate Studies. James writes:

Mathematicians have always been drawn to mathematical structures that are simple, natural, and elegant to define, but which turn out to have a hidden depth and complexity. Such structures are often regarded as beautiful, and uncovering them has kept countless mathematicians occupied for decades.

Last autumn I had the enormous privilege of working with the City of London Sinfonia on a *Bach and the Cosmos* concert series. We toured the UK across seven venues, with three different programmes featuring music by, or inspired by, Johann Sebastian Bach. As a mathematician and former Cambridge organ scholar, I've always been fascinated by the connections between mathematics and music, and Bach's music in particular. Each programme featured a talk about these various connections, interspersed with musical excerpts and performances of complete works. The tour started in our very own Mathematical Institute with Bach's *Goldberg Variations*, arranged for string orchestra by Dmitry Sitkovetsky. Before a complete performance of this monumental work, I began by talking about the aesthetic and artistic side of mathematics, and conversely the abstract and mathematical side of music. My introductory words can be found on the Oxford Mathematics YouTube Channel.

Right: James Sparks's Oxford Mathematics Public Lecture

Below: James Sparks talks on mathematics and music at the Queen Elizabeth Hall in London.

I also talked about the important role played by creativity in mathematics, something that isn't always appreciated by non-mathematicians. The way that mathematicians create, especially in the early stages of an idea, is often very non-linear and intuitive, with more linear and methodical reasoning usually coming in later. In music I think that composers often work in much the same way, and that they do so for similar reasons: in both mathematics and music one is simultaneously trying to create and discover interesting and beautiful structures within a constrained and abstract system. Symmetry also plays a key role in both, not just aesthetically, but also as a tool for building and discovering structure, and as an organisational principle.

I think that Bach's music shares many aesthetic qualities with beautiful mathematics. Bach would often start with a simple but elegant musical idea, and from it systematically build a large and complex musical work. He did this by using strict musical forms, such as canons and fugues. In these compositions Bach took his elegant starting pattern of notes, and applied various 'musical maps' to it – that is, maps that take the original pattern of notes to another pattern, changing it in some way, but also preserving its form. The rich and intricate textures of Bach's music result from applying these maps repeatedly, in a carefully constructed manner. I talked about this using several of the *Goldberg Variations* as illustrations, accompanied by excerpts played by the City of London Sinfonia.

Writing music like this involves a great deal of analytical skill, and is very similar to solving a mathematical problem. It is very much a process that is part creation, part discovery: having fixed a musical idea, the laws of harmony control how it can fit together using these different types of repetition. The skill of the composer is not only to discover the hidden music within a theme, but also to create the right theme in the first place. Mathematics works in much the same way! Bach's genius meant that he was able to use this approach to create beautiful music that also has a more abstract mathematical beauty. For me, it is that combination that makes his music so special.

Appointments…

We welcome the following new Faculty members.

Anna Ananova
(Imperial, London)
Departmental Lecturer
Research interests: pathwise integration, functional Ito calculus, rough path theory, pathwise optimal control and model-free finance.

André Henriques
(Oxford)
Departmental Lecturer
Research interests: Mathematical physics, studying conformal field theory with tools from operator algebras.

Jason Lotay
(UCL, London)
Professor of Pure Mathematics
and **Fellow of Balliol College**
Research interests: differential geometry, particularly Riemannian manifolds with special holonomy, and related geometric flows.

…and Achievements

This has been another excellent year for awards and achievements, with a diverse range of prizes and recipients.

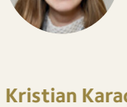
Sir John Ball FRS has received the 2018 Leonardo da Vinci Award from the European Academy of Sciences.

Helen Byrne has been awarded the 2018 Leah Edelstein-Kesket Prize by the Society of Mathematical Biology.

Xenia de la Ossa has been awarded the Dean's Distinguished Visiting Professorship by the Fields Institute in Toronto, Canada, to work on the homological algebra of mirror symmetry.

Mike Giles and **Alain Goriely** have been appointed Fellows of the Society for Industrial and Applied Mathematics (SIAM).

Ian Griffiths has won a Vice-Chancellor's Innovation Award for his work on the mitigation of arsenic poisoning.



Heather Harrington has been awarded a Whitehead Prize by the London Mathematical Society for her researches into mathematical biology.

Kristian Karadjiev has been awarded the Graham Hoare Prize by the Institute of Mathematics and its Applications for an article on 'Connecting the dots with Pick's theorem'.

Jochen Kursawe has been awarded the 2018 Reinhart Heinrich Prize by the European Society for Mathematical and Theoretical Biology.

Ursula Martin CBE and **Vicky Neale** have won Suffrage Science Awards celebrating women in science.

Gergely Röst has been given an inaugural András Gács Award at the Eötvös Loránd University in Budapest for motivating students to pursue mathematics.

Andreas Sojmark has been awarded the Bar-Ilan Young Researcher Prize in Financial Mathematics.

Nick Trefethen FRS has been awarded Honorary Degrees by the Universities of Fribourg (Switzerland) and Stellenbosch (South Africa).

Francis Woodhouse has been given the H. D. Landahl Mathematical Biophysics Award by the Society for Mathematical Biology.

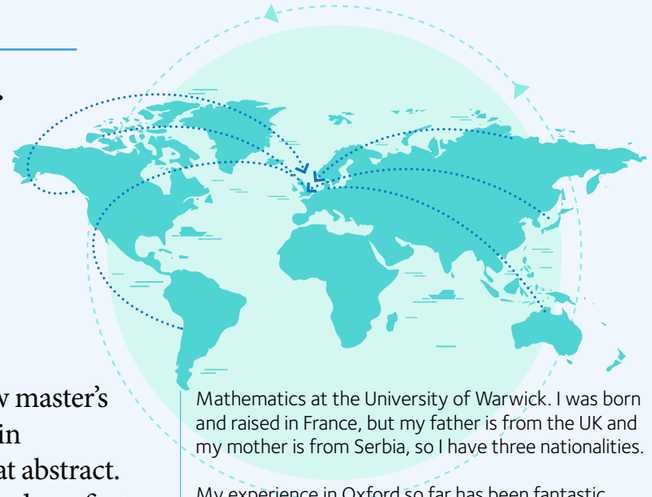
Student Intake 2018

New undergraduates: This year saw the arrival of 180 men and 93 women from 33 nationalities, ranging from Afghanistan to Syria, Kazakhstan to Greece, and Malaysia to Pakistan. 70% of the UK entry was from state schools.

New graduates: We also welcomed 43 new DPhil students – 13 from the UK, 15 from the EU, and the remainder from Argentina, Australia, China, India, Israel, Kenya, Mexico, Norway, South Africa and the USA.

OMMS – first cohort for the new MSc degree

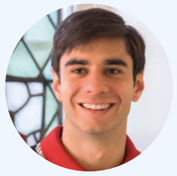
Dr Kathryn Gillow
OMMS Course Director



At the time of last year's *Round up,* our new master's programme, OMMS (the Oxford Masters in Mathematical Sciences), was still somewhat abstract. This changed in October when we welcomed our first cohort of 36 students onto the course. They came from 17 countries with degrees from 32 institutions, bringing a new diversity to the current fourth-year population which they joined. This new MSc course will help us to attract outstanding mathematicians from around the world to Oxford at an early stage of their careers.

OMMS is a joint venture with our colleagues in the Department of Statistics, and our students can study courses chosen from the fourth-year programmes in both departments, as well as some computer science modules. Some of our first cohort have chosen to specialise in particular areas of interest, while others embrace the opportunity that OMMS provides to experience a truly eclectic mix of courses. A key feature of the OMMS course is the dissertation, and these projects are now under way on a varied range of topics. We look forward to seeing the finished dissertations after Easter.

Here are some comments from three of the first OMMS students:



Xavier Gonzalez

Xavier Gonzalez writes:
I have recently graduated *summa cum laude* in Mathematics from Harvard University. As an undergraduate I studied modular forms under the direction of Professor Ken Ono, one of my role models. Having won a Rhodes scholarship, which funds international students for postgraduate study at Oxford, I am now an OMMS student at Balliol. I knew that I wanted to continue my study of mathematics while also exploring applied mathematics, statistics, computer science, and physics, and OMMS was the perfect fit. I have also joined the Oxford Maths Ambassadors, and get involved with outreach events.

I enjoy the Mathematical Institute, where there is always something exciting going on. I love the wide range of options and diversity of thought in OMMS, and will reflect on my OMMS experiences as I decide how to spend my second Rhodes year in Oxford.

Chloe Colson

Chloe Colson writes:
I'm an OMMS student at St Catherine's College. Before coming to Oxford, I completed a Bachelor's degree in Mathematics at the University of Warwick. I was born and raised in France, but my father is from the UK and my mother is from Serbia, so I have three nationalities.

My experience in Oxford so far has been fantastic. Studying mathematics is my primary reason for being at Oxford, but I have enjoyed the social aspect of college life here. I also enjoy sports and spend much time running and cycling round Oxford.

One notable aspect of OMMS is how it has brought together people with very diverse personal and academic backgrounds. I feel that this has enriched my learning experience here, while enabling me to make a diverse group of friends.

My interests lie in mathematical biology, especially in the areas that relate to human biological sciences. Being able to choose from the Mathematics, Statistics and Computer Science departments has allowed me to tailor my studies to my interests and goals. After this Master's course, I wish to pursue a PhD degree. My hope is to be able to conduct research in the field of mathematical biology, in order to make meaningful contributions to the global community.

Jason Wong

Jason Wong writes:
I did a BSc degree in Mathematics at the University of Warwick, before moving to St Hugh's for OMMS. I was born and raised in Hong Kong, but have lived in the UK for the last seven years. I am proud to call both places home.

My interests loosely lie in the field of statistical learning. I am particularly interested in efficient algorithms for estimating parameters and making predictions from complex data sets. The design and study of such algorithms involve numerical analysis as well as high-dimensional probability and statistics. I was thereby drawn to the OMMS programme by the sheer breadth and depth of its courses. I don't think there are many courses where you can learn about both statistical machine learning and computational algebraic topology!

The academic work in Oxford is intense, but people here are more approachable than I imagined. I am the OMMS student representative and also sing in the Chapel Choir at St Hugh's.

I hope next to work as a research scientist before possibly pursuing doctoral studies. OMMS has exposed me to much contemporary mathematics developed to address modern challenges, such as small but high-dimensional data sets. This gives me a sense of the fluidity of mathematics and of its relevance in today's world.

Oxford Maths Festival

Mareli Grady
Schools Liaison Officer (Statistics)
and Outreach Events Coordinator (Maths)

Bubbles, origami, dodgy dice and self-supporting bridges – over two days last April the Oxford Maths Festival, free and hosted by Oxford Mathematics, showcased the creative, fun and surprising sides of mathematics.

Adults and children alike were entertained, challenged and enthused by a variety of activities in central Oxford and in the Mathematical Institute. Our visitors learned about polyhedra and Sierpinski triangles using the medium of balloons, tried to find the shortest route between cities, had fun with bubbles, and played with tangrams. They also learned about Bayesian methods and the application of statistics to proteins, watched the double pendulum in its mad spin, and assembled Penrose tiles. They were delighted by a game of chocolate trickery, tied themselves up in knots, and tried to work out logic puzzles.

On the second day, visitors to the Mathematical Institute took part in hands-on activities, went to workshops on topics as diverse as cryptography, symmetry, catenary arches and problem-solving, and attended lectures on sport, risk, pi, and the mathematics of Lewis Carroll. They also tried their hand at making something beautiful and mathematical in the craft session and challenged each other to mathematical board games.

The festival was wholly staffed by volunteer staff and students, some of whom had never engaged in this type of event before. All reported enjoying the experience of sharing their enthusiasm for mathematics with others.

The Mathematical Institute hopes to make the Oxford Maths Festival an annual event, and is currently seeking the sponsorship to allow this to happen. If you would like to support the event, please visit https://mathsfest.web.ox.ac.uk and contact us.

The next Oxford Maths Festival will take place here in the Andrew Wiles Building on 11–12 May 2019. We'd love to see you.

A visit to Rio

James Maynard

Six Oxford mathematicians – **Mike Giles, Richard Haydon, Peter Keevash, Jochen Koenigsmann, Miguel Walsh** and **myself** – were invited speakers at the International Congress of Mathematicians (ICM) in Rio de Janeiro last August.

The ICM is the world's largest mathematics conference and has met every four years since 1897 (except for a couple of small breaks during the wars). It aims to have lectures covering the most important developments across the entirety of mathematics over the previous four-year period.

The conference was eventful – and not just in a mathematical way! Unlike typical more specialised maths conferences, the ICM is a great place to hear an overview of the key developments in areas of mathematics outside of one's particular expertise. One highlight is the awarding of the Fields Medals (last year given to Caucher Birkar, Alessio Figalli, Peter Scholze and Akshay Venkatesh) and the accompanying talks on the work behind the medals. Unfortunately, Birkar's medal was stolen just after being awarded, but a replacement was readily available, so he has been the only mathematician to have received two Fields Medals!

It is a great honour for a mathematician to be invited to speak at an ICM. The number of Oxford mathematicians that were invited to speak, and the breadth of subjects represented – from stochastic modelling to decidability and combinatorial matchings – demonstrate the continuing strength of mathematics in Oxford.

Where are they now?

Where do our former tutors go when they retire? Here we catch up with two of them: **Mary Lunn** of St Hugh's College and **Ian Grant** of Pembroke College.

Mary Lunn

Following my retirement in 2007, like many academics I have kept my hand in a little. Work with Glasgow and Newcastle Universities involved diversity of bacteria in water treatment plants. We had a grant which ran an experiment in the laboratory, and which used DNA techniques to consider abundance of ammonia oxidising bacteria which are essential to keep these plants running.

In the Oxford Statistics Department I have had two MSc students each year, with the main intention of enabling them to analyse data and produce comprehensible reports on their analysis. These projects form a part of their assessment.

We are sorry to announce that Daniel Lunn FRSS, Mary's husband, died in February. He was a well-loved Fellow and Tutor at Worcester College.

Ian Grant

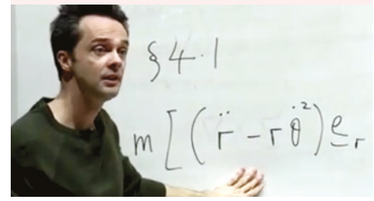
My wife Beryl and I retired in 1998, moving to a retirement complex in Cambridge in 2012. I have continued active building on the embryo project proposed first by David Mayers and myself at a Workshop in Orsay in 1970. The General-purpose Relativistic Atomic Structure Program (GRASP) is now used worldwide and is a major tool of the Computational Atomic Structure consortium (CompAS), based on Malmö and Lund in Sweden.

I am now a permanent visitor to the Atomic Astrophysics group here in Cambridge, and spend much of my time there and on a major update of my 2007 monograph which underpins the CompAS project. After twenty years of retirement I feel privileged to be able to continue in active research.

Outreach and demystifying Oxford

One of the challenges that Oxford faces is to make itself approachable, not only to aspiring students but to a wider world that can see us as remote, or worse. In response we are showing exactly what we do in an unedited form.

For Oxford Mathematics this has comprised live streaming a first-year lecture on dynamics, filming a tutorial, and making public some examples of the problem sheets that students work on. Again, social media have proved a vital tool for showing us in this workaday mode. Coupled with our extensive school visits and dedicated events for schools, it all adds up to an education that might not seem so incomprehensible or remote. We plan to do much more.



Research and social media

Mathematical research reflects issues that society faces today – understanding the materials around us, understanding our bodies, and even our online behaviour – but it is also about pushing the boundary of mathematics for its own sake.

Sometimes this research has real-world applications. The topology of data, as well as its volume, is a case in point. However, our research is also carried out for the pleasure of the intellectual challenge. As a consequence you might think that the pure side of our research attracts less attention, especially on social media – but far from it! Our 'pure' mathematics case studies are among the most popular items on our social media pages. We can confidently report that there is a huge appetite for mathematical knowledge.

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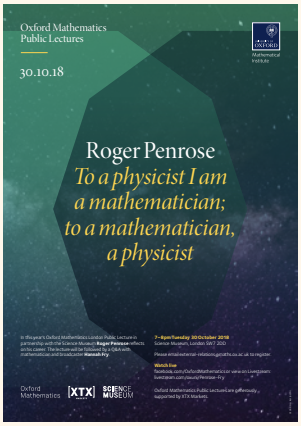
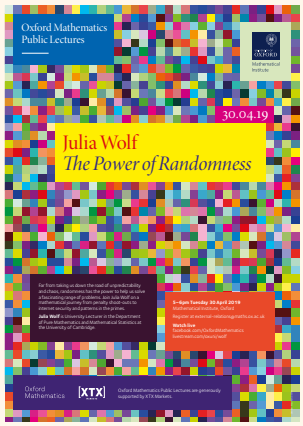
Public Lectures





Oxford Mathematics Public Lectures are a mixed bag, by which we mean that they mix universal themes with tough maths, attracting the curious, the academic and (via our large cohort of schools) the aspiring. They also attract a large online audience, the wider public that Oxford needs to attract (and perhaps convince). On average, 30,000 viewers watch some part of each live broadcast, and this year we have also hosted lectures in London and Solihull as well as in Oxford.

This year's highlights have included Sir Roger Penrose presenting his latest cosmological research and confessing to not being proficient at multiplication, Persi Diaconis telling us that there is nothing random about tossing a coin, and Hannah Fry discussing the good, the bad and the downright ugly of algorithms. Most of the lectures are available on our Oxford Mathematics YouTube Channel.

Musette bags

Yes, that is what they are officially called and they are currently our Number One bestseller. You can buy all our merchandise from the University Shop (oushop.com).

Alumni Weekend and Garden Party

There is no Oxford Mathematics Garden Party this year as we are concentrating on widening our range of Public Lectures, both in Oxford and across the UK. We shall be in London and Newcastle in the Autumn, and we will be hosting alumni receptions after some of our lectures.

However, we would encourage you to join the many alumni who will attend the University Alumni Weekend on 20–22 September 2019. This will take place in the Mathematical Institute. www.alumni.ox.ac.uk/alumni_home