

Round up

The Oxford Mathematics Annual Newsletter 2021



UNIVERSITY OF
OXFORD

Mathematical
Institute

Sir Roger Penrose wins Nobel Prize

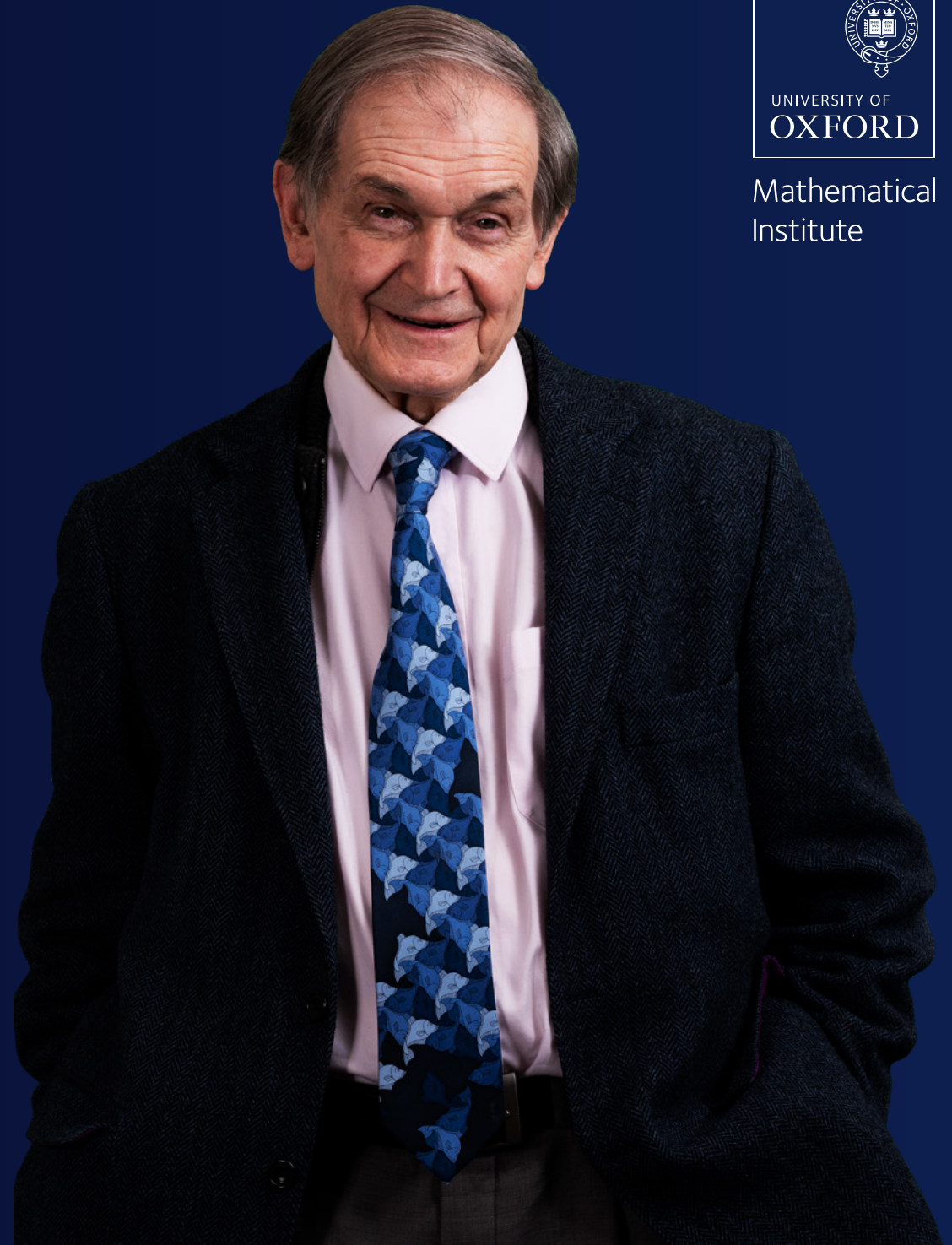
Oxford Mathematics and
the coronavirus

Ideas for a complex world

Equality, diversity and inclusion

Can maths help us to win
at Fantasy Football?

Oxford
Mathematics



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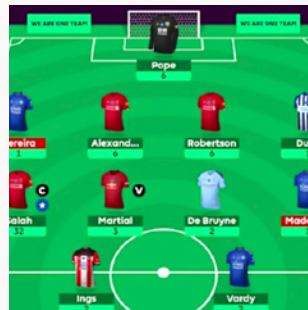
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Head of Department's letter

Mike Giles

I am writing this in early 2021, and like everyone else I am hoping this will be a better year than 2020. The coronavirus pandemic has been an enormous challenge for all of us. With the benefit of hindsight, there are definitely some things I would have done differently over the past 10 months. However, overall I am impressed and proud at how we have come through this period, adapting to the circumstances and managing to maintain our teaching, research and departmental operations, while at the same time looking out for everyone's health, both physical and mental.

At the beginning, we were lucky with the timing, managing to get to the end of Hilary Term 2020 just as the first infections affected a handful of students and staff, thankfully not seriously. We had already started to practice home working and had bought additional staff laptops, so when the first national lockdown came we moved to working from home surprisingly easily. However, staff with school-age children faced the substantial challenges of home-schooling, and staff and students living alone faced the challenges of isolation and loneliness, especially for those new to Oxford or without local support networks.

In Trinity Term we moved to online teaching, tutorials and revision classes. The third year (Part B) and fourth year (Part C) exams also went online after being extensively revised; we were very

concerned about how that would work in practice, but our students at home coped amazingly well with the challenges of using their mobile phones to photograph and upload their examination scripts, and surprisingly few had major internet problems. The first year exams (Prelims) were cancelled, and the second year exams (Part A) were delayed to the start of Michaelmas Term; I don't think the University had a good alternative to that but it was tough on the second-year students having their exams hanging over them for the summer, and then going straight from exams into the start of their Michaelmas Term lectures.

Over the summer we slowly started to re-open the Andrew Wiles Building, with the priority being the DPhil students, many of whom live in accommodation which, due to Oxford's high rents, are not spacious and do not provide good working conditions. With good ventilation, good adherence to social distancing and the use of face coverings we have successfully (so far!) avoided transmission of the virus within our building since the beginning of April. A huge amount of work went on over the summer investigating and documenting the best technological approaches for remote teaching, both pre-recorded lectures and tutorial and class teaching.

Even more effort then went into recording all of the lectures for Michaelmas. By the end of the

summer, when normally everyone would feel refreshed for the new academic year, instead there was a lot of weariness visible in the many online Microsoft Teams meetings we had become far too used to.

Michaelmas Term was tiring for everyone, added to by the unfortunate timing of an Athena Swan submission, (a framework which is used across the globe to support and transform gender equality within higher education and research) and the mammoth government REF exercise to evaluate the quality of our research. There was a spike of student infections at the start of term, mainly among first- and second-year undergraduates who never entered our building, but with the help of the University's own testing service that quickly subsided and we continued the choice of face-to-face or online classes for Part B and C students throughout the term. Of course the undergraduate admissions process moved entirely online, but through careful preparation by both us and the applicants that went ahead surprisingly well.

Over Christmas and the New Year most people had a good two-week rest; for too many that was the first proper break since April. Our Christmas present was the arrival of first the Pfizer vaccine and then our own Oxford–AstraZeneca vaccine. This gives us considerable optimism as we look towards Summer. However, the new coronavirus variant with its increased transmissibility has led to a new national lockdown with all teaching online until the end of Hilary Term.

At present the pandemic is dominating our lives, but by the time of the next Newsletter I hope to be in a position to reflect on Black Lives Matter and report on some of the actions being taken in

“the undergraduate admissions process moved entirely online, but through careful preparation by both us and the applicants that went ahead surprisingly well.”

response by the University and the Department; one first step discussed later in the Newsletter is the welcome appointment of Geoffrey Mboya as an MPLS Equality, Diversity and Inclusion Fellow for the Mathematical, Physical and Life Sciences Division here in Oxford. Also, elsewhere in this Newsletter we talk about the COVID-19 research of a number of colleagues, and the wonderful news of the award of the Nobel Prize in Physics to Sir Roger Penrose.

To finish, I hope all of you and your families have kept well during these difficult times, and that we will be able to meet again in person in the not-too-distant future.



Sir Roger Penrose wins Nobel Prize

Nick Woodhouse

Former Head of Department and fellow mathematical physicist



“He was elected to a Royal Society Fellowship in 1972 and has received many prizes for his collaborations with Stephen Hawking”

Roger Penrose was presented with his Nobel Medal at the Swedish Ambassador’s residence in London in December.

Roger Penrose moved to Oxford to take up the Rouse Ball Chair of Mathematics in 1973, together with a Professorial Fellowship at Wadham College. Eight years earlier he had published a remarkable three-page paper with the title ‘Gravitational collapse and space–time singularities’. It had not passed unnoticed. Based on this, he was elected to a Royal Society Fellowship in 1972 and has received many prizes for his collaborations with Stephen Hawking. Finally, more than fifty years after publication, the paper was cited by the Nobel Prize Committee in awarding Roger half of the 2020 Prize in Physics for ‘The discovery that black hole formation is a robust prediction of the general theory of relativity’.

A remarkable paper and a remarkable story. The long gap and the fact that black holes are not mentioned explicitly in the paper may be puzzling, but the explanation lies in the context of his work and in the fact that the Physics Prize cannot be awarded for a theoretical discovery, however brilliant, until it has been confirmed by observation or experiment.

Roger’s paper opens with a reference to the discovery of ‘quasistellar radio sources’ (quasars). It had been suggested in 1964 that the source of a quasar’s enormous energy might be matter falling into a massive black hole in the centre of a galaxy. But it was still a highly controversial idea that black holes might actually exist. Moreover it was not even clear in 1964 that general relativity would allow black holes to form under reasonable physical assumptions. There were models of gravitational collapse that produced black holes, but only from highly symmetric initial conditions and with highly unrealistic assumptions about the gravitating matter. It was widely thought that the collapse of a real astronomical body would require impossible compression.

It was this theoretical problem that Roger's paper's solved. The remarkable observational work of his co-laureates, Reinhard Genzel and Andrea Ghez, has now demonstrated that our own galaxy does indeed have a black hole at its centre with a mass that is some four million times that of the Sun, thus opening the door for the award of the Nobel Prize for Roger's theoretical discovery and for their observational verification.

Roger is often described as a 'polymath', with his scientific and mathematical contributions spread over many fields. That is certainly true, but the 'polymath' label does not do justice to the coherence of his scientific outlook and to his extraordinary facility for seeing connections between seemingly diverse fields. His 1965 paper is a remarkable exploitation of one of the key ideas that runs through many of his contributions to geometry and theoretical physics – namely the central role of null geodesics.

When Roger arrived in Oxford, he was exploring through his 'twistor theory' a related circle of connections between conformal geometry, photon trajectories, and the way in which complex numbers enter relativity theory and quantum mechanics. The role of complex numbers in quantum mechanics was familiar, but Roger was struck by the fact that they also enter relativity through the natural identification of the celestial sphere with the Riemann sphere – natural, in the sense that it is independent of the motion of the observer. Twistor theory was motivated originally by the need to reconcile general relativity with quantum field theory, but it soon became apparent that the ideas had much wider application, notably through his frequent discussions in Oxford about four-dimensional geometry with Michael Atiyah and Nigel Hitchin.



Roger is often described as a 'polymath', with his scientific and mathematical contributions spread over many fields.

Roger quickly built up a large and very lively group of graduate students, postdocs, and visitors. Every Friday, the group gathered in his office for a 'lunchtime' meeting that often lasted into early evening. The meetings started with a question-and-answer session, Roger usually providing the answers with impromptu lectures on a huge range of topics. One in particular stands out in my memory, on Church's λ -calculus. I did not know until later that Roger had played a key part in the importation of the λ -calculus into the design of programming languages, when he worked for Christopher Strachey in the 1950s.

Several members of the group went on to achieve great distinction in areas that at first sight have little connection with the central motivation of twistor theory, but where a little digging shows the extraordinary breadth of Roger's vision at work. It was a wonderful and inspiring era. Today Roger is still working on these ideas, not least in the context of his 'cyclic cosmology', where conformal geometry is again centre stage.



Ideas for a complex world

Anna Seigal

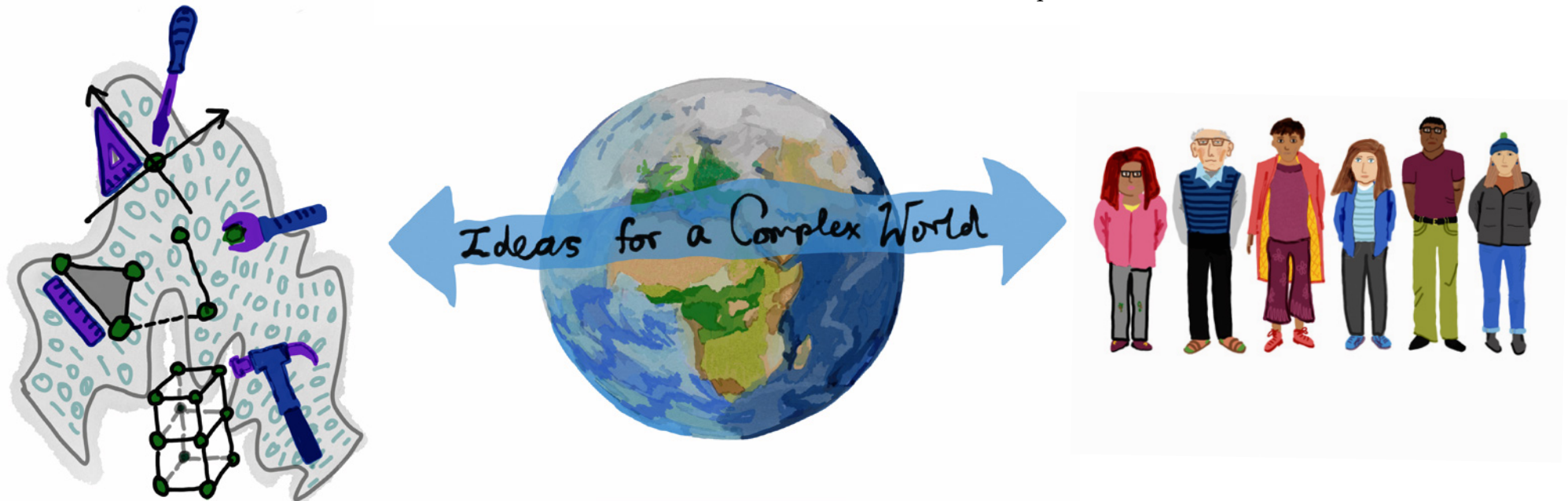
Hooke Research Fellow

Mathematics is entering people's lives in new ways, accelerated by the pandemic, whether in the political rhetoric of 'following the science', in the A-level results algorithm to predict grades, or in the mathematical models to decide lockdown restrictions.

Thinking back to the start of last year, it would be hard to imagine the role that mathematics has come to play in our lives. As a society, we are developing a vast quantitative toolbox: mathematical and statistical tools, which use data to build models and algorithms. These tools are used to tackle the complex problems that society is facing.

On a smaller scale are us, as individual human beings. We encounter complex situations in our day-to-day lives, and we have ideas for how to approach them. But there's a disconnect, where quantitative tools seem distant from our everyday lives.

Contrary to what we might expect, there are many connections between the ideas from our day-to-day lives and those in the quantitative toolbox. Mathematics helps us to abstract human ideas into quantitative tools.



Here's an example. When we think about someone we know, information about that person comes to mind, and we can use this information to describe personality differences between people. We can visualise this by imagining giving people scores across a few personality traits and plotting them on these axes.



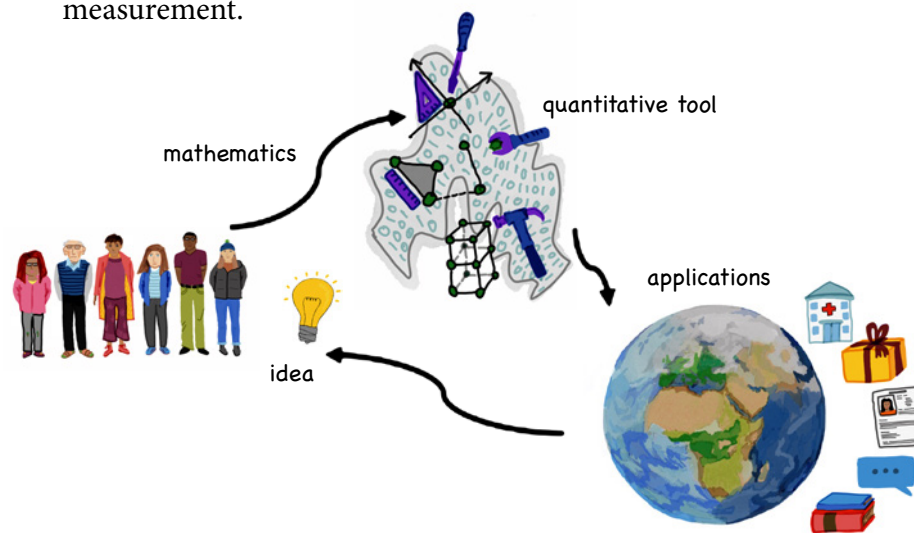
Some personality traits are more useful than others for identifying differences. In the first plot, the six people are all quite nice and friendly and the points are close together. In the second plot, the people are more spread out but lie along a line. In the third plot, the people are spread out in all directions. The personality traits of the third plot are a good summary of the differences among the six people.

The axes that spread people out best are key measurements. We translate complex data into key measurements all the time, even if we don't think of plotting data points. For a small number of people we can think up specific key measurements, but this is more difficult if we want to compare thousands of people, instead of just six. At these larger scales we can use a quantitative tool.

One popular tool to find key measurements is 'principal component analysis'. For data recorded in a matrix, we use linear

algebra (the theory of matrices) to find the key measurements. This tool could be used, for example, to compare genetic information of hospital patients in order to understand a new disease treatment, the schoolwork of students to predict their exam results, or the habits of social media users to predict how they may respond to an advertisement.

Not all data is well described by a two-dimensional matrix. In my research, I'm interested in multi-dimensional generalisations of matrices, known as tensors, and I use multi-linear algebra (the theory of tensors) to develop tools for tensor data. This extends the scope of our toolbox to applications where we seek to understand the interplay between multiple different types of measurement.



Find out more

Anna Seigal's Oxford Mathematics Public Lecture, *Ideas for a Complex World*, is available on YouTube.

[Watch lecture](#)

Interview with Jon Keating



“This is a much larger department. The breadth of mathematical interests and expertise is remarkable, and the intellectual environment is exceptional.”

Since September 2019 Jon Keating FRS has been Oxford’s Sedleian Professor of Natural Philosophy. From November 2019 he has also been President of the London Mathematical Society. Here he tells us about his career and these two positions.

Could you please tell us about your mathematical activities/ career before coming to Oxford?

I read Physics as an undergraduate in Oxford and then did a PhD in Theoretical Physics in Bristol with Sir Michael Berry. I was a Lecturer in Applied Mathematics at the University of Manchester, before returning to (simultaneously) a Readership in Applied Mathematics at Bristol and a Research Fellowship funded by Hewlett-Packard; I spent half of my time in the University and the other half on working at Hewlett-Packard’s Research Labs. I went on to become Professor of Mathematical Physics and, later, Henry Overton Wills Professor of Mathematics in Bristol. In addition, in Bristol I served spells as Head of Mathematics and then as Dean of the Science Faculty. For the past five years, I was also Chair of the Heilbronn Institute for Mathematical Research, a collaboration between the UK academic mathematics community and GCHQ, focused on developing new applications of discrete mathematics.

How do you view your position as Sedleian Professor?

Natural Philosophy describes perfectly my mathematical interests, which sit between Applied Mathematics, Mathematical Physics, and Pure Mathematics. It is, of course, daunting to be following on from such distinguished previous holders of the Chair. It is also exciting to have the opportunity to develop new applications of the mathematics on which I work.

In what ways is Oxford different from your previous places of work?

This is a much larger department. The breadth of mathematical interests and expertise is remarkable, and the intellectual environment is exceptional. There is a considerably wider range of courses, and the overall quality of the teaching provision is outstanding. There are more graduate students and early-career researchers here, and they add significantly to the environment.

Do you have any particular ambitions in this role?

My research interests over the past few years have focused on properties of random matrices and on their applications, which range from data science, machine learning, and mathematical finance, to neuroscience, numerical analysis, quantum physics, and number theory. My ambition is to establish a research group in this area in Oxford. I am also developing a new undergraduate course in Random Matrix Theory, which began this year.

What are your main responsibilities as LMS President?

To ensure that the Society emerges from the current pandemic in as healthy a shape as possible, and that during this highly challenging period we provide every support we can to the mathematics community. We are focusing in particular on helping early-career researchers, mathematicians with caring responsibilities, and sharing best practice in online teaching. We are also developing a new scheme to support aspiring mathematicians from disadvantaged backgrounds, with generous backing from one of our members, Dr Tony Hill, who is also an Oxford Mathematics alumnus. I manage to combine the two roles by making full use of my excellent administrative colleagues in Oxford and at the LMS!

Jon Keating with LMS prizewinners, including Oxford's Ben Green (back left) and Heather Harrington (next to Jon Keating)



Which mathematicians have particularly influenced you?

Michael Berry, Philip Drazin, Freeman Dyson, Peter Sarnak (who once posed a challenge that became the focus of my research for several years), and Uzy Smilansky (who, when I was an undergraduate, spent a sabbatical year in Oxford, during which he gave a wonderful lecture on chaos that I found hugely inspiring and which determined my choice of PhD advisor and subject).

How do you see your subject developing over the next few years?

Random Matrix Theory started as an applications-driven area of research. In the past couple of decades the focus has shifted to developing the fundamental mathematical foundations of the area. I now see the pendulum swinging back to applications. With the much deeper understanding we have of the subject, and with many new mathematical techniques at our disposal, I believe the possibilities relating to new applications are considerable. For example, in one of my recent papers we use supersymmetric matrix integrals to address a problem in machine learning.



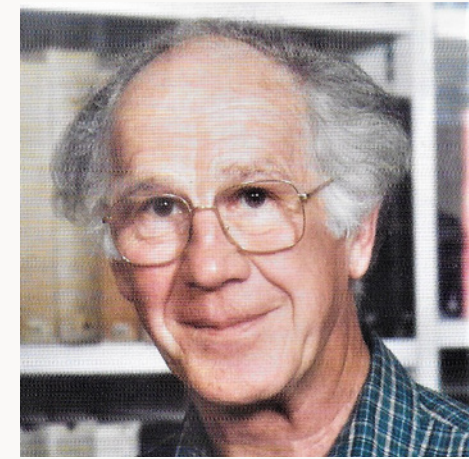
Ulrike Tillmann: LMS President Designate

Ulrike Tillmann FRS, has been appointed President Designate of the London Mathematical Society, in succession to Jon Keating. She takes up her appointment in November 2021. Ulrike has been at Oxford since 1992 and her research interests lie in algebraic topology – in particular, her work on the moduli spaces of Riemann surfaces and manifolds of higher dimensions has been inspired by problems in quantum physics and string theory, and more recently has broadened into areas of data science. In September 2021 Ulrike will take up the position of Director of the Isaac Newton Institute for Mathematical Sciences, the UK's national research institute for mathematics, while also continuing to work part-time in Oxford.



Fernando Alday: Rouse Ball Professor

Luis Fernando Alday has been appointed Oxford's Rouse Ball Professor of Mathematics. Born in Argentina and receiving his doctorate in Italy, Fernando was appointed a Professor of Mathematical Physics and Tutor in Mathematics at Hertford College in 2010. His research interests lie mainly in developing mathematical tools for understanding fundamental questions in quantum field theory and quantum gravity. Unlike Cambridge, where the Rouse Ball Chair is in pure mathematics, the Oxford Chair is in applied mathematics. Beginning in 1928 when Oxford's first Rouse Ball professor, E. A. Milne, was appointed, other holders of the Chair have been Charles Coulson, Roger Penrose and, more recently, Philip Candelas.



Bryan Birch: Royal Society Medal

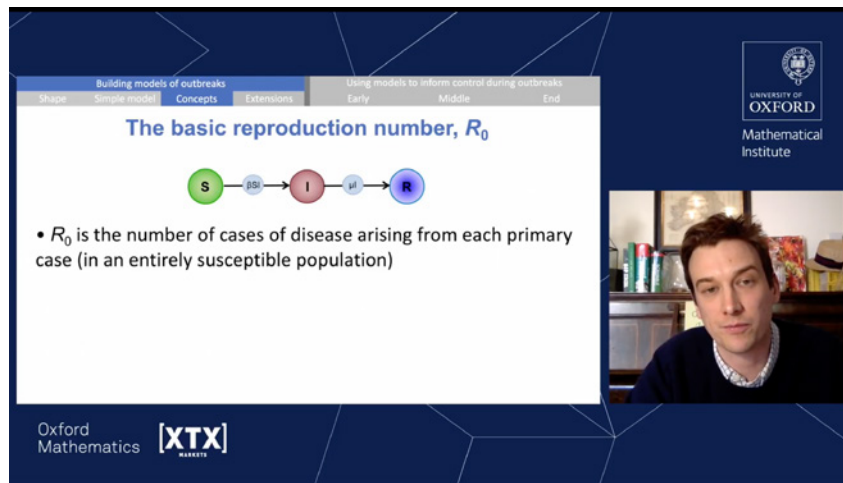
Bryan Birch FRS, Emeritus Professor, has been awarded the Royal Society's prestigious Sylvester Medal for 2020, for his work on the theory of elliptic curves, and in particular on the Birch and Swinnerton-Dyer Conjecture, one of the Clay Mathematics Institute's 'Millennium Prize Problems'. The Medal is named after J. J. Sylvester, Oxford's Savilian Professor of Geometry from 1883 to 1897.

Oxford Mathematics in the time of the coronavirus

Dyrol Lombard

External Relations Manager

In the innocent days of July 2019, Oxford Mathematician Robin Thompson co-authored a paper on the spread of infectious diseases, and how mathematics had a crucial role to play. Writing on the Oxford Mathematics website, he concluded that mathematical models will continue to play important roles for forecasting and guiding interventions during epidemics.



Robin Thompson's Public Lecture explains the mathematical modelling of infectious diseases.

[Watch lecture](#)

You're not kidding. The world has lived a mathematical model for over a year. We've learnt the new language of R-number, exponential growth, moving averages, and much more. But behind the shock is a more familiar story: the story of a diverse collection of individuals responding to a crisis, individuals with expertise across a range of areas, anxious to put their skills to use – only in this case these individuals are mathematicians, Oxford Mathematicians to be precise.

But back to Robin. As early as January, based on data from Wuhan in China, Robin was estimating that the risk of a serious spread of the disease was as high as 37%. He concluded, before the phrase 'test and trace' was common parlance, that 'rigorous surveillance was essential'. His research paper and its prophetic words won the *Journal of Clinical Medicine's* Outstanding Research Award 2020. Through his modelling and advice, Robin has continued to play an active role during the pandemic. In the summer he co-organised a major conference at Cambridge's Isaac Newton Institute on government interventions, and in May he gave a very successful Oxford Mathematics Public Lecture to explain the modeller's language to a non-specialist audience

Clearly the scientific community had been galvanised by the pandemic. This was laudable, but it brought its own issues: one pandemic led to another in the shape of thousands of research papers by academics from a multitude of disciplines. How to sort the wheat from the chaff? The usual model of peer review taking months proved itself unfit for purpose.

Step forward Oxford Mathematicians Alain Goriely and Philip Maini. In the UK, a group of modellers attached to the Royal Society decided to address the COVID-19 crisis by creating a new national initiative. Headed by Mike Cates in Cambridge, ‘Rapid Assistance in Modelling the Pandemic’ (RAMP) was born. In Oxford, Alain and Philip were asked by RAMP to set up a new mechanism to review research speedily and, when it proved valuable, to report to the various scientific committees and departments advising the government. ‘The Rapid Review Group’ was divided into six different subject panels and was staffed by an all-star team of 120 dedicated expert volunteers. It assessed critical scientific work within 24–48 hours, bypassing the typical months-long process offered by scientific journals. The Group is still very active, and its efforts are now funded by UK Research and Innovation, the Government’s research funding body.



Above:
Alain Goriely and Philip Maini

As the pandemic spread, understanding people’s movements and behaviour became critical to predicting that spread, and for devising ways to control it. Smartphone data was a new tool in the armoury. Oxford Mathematician Renaud Lambiotte and his colleagues identified call records as the best data source for capturing ‘live’ information about people’s movements. Each call record contains information about the time and the cell tower to which the phone was connected when the interaction took place. Such information can be used to infer, in real time, statistical aspects of population densities and trajectories. However, Renaud and the team went further, by calling for a more coordinated approach to this data in the light of the uncoordinated use of it across the world, and they also stressed the need for agreed privacy standards in the light of increased intrusion into individual lives.

Right:
Renaud Lambiotte’s Oxford
Mathematics Public Lecture,
Smartphones v COVID-19.
[Watch lecture](#)

Renaud also gave an Oxford Mathematics Public Lecture on the subject in June 2020.

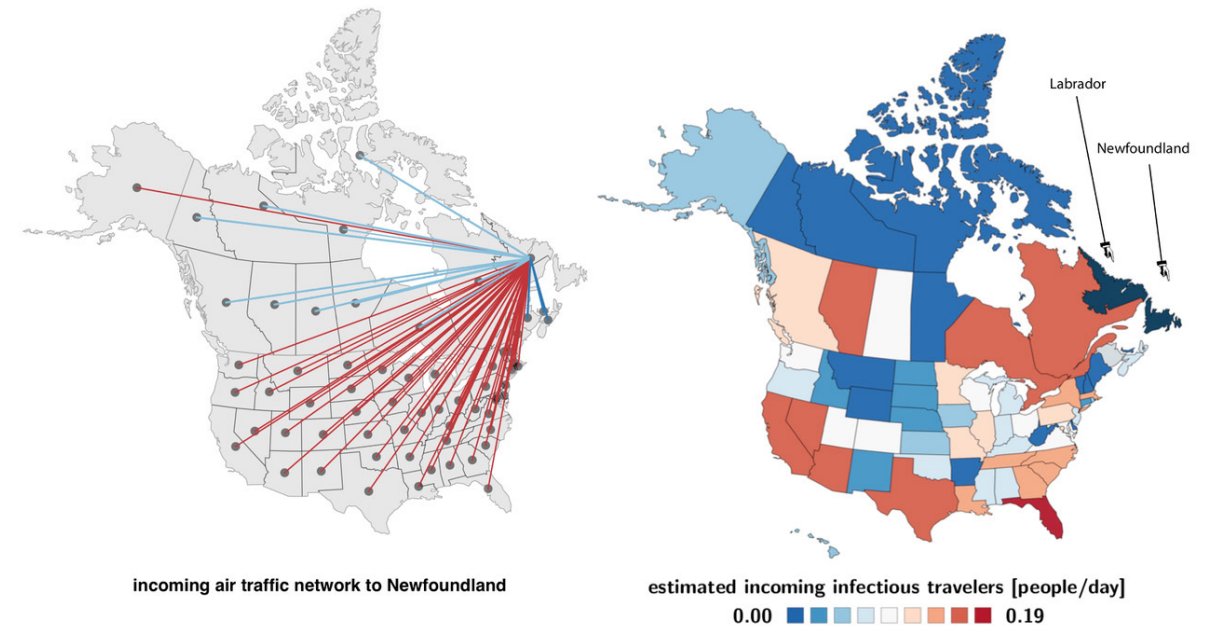
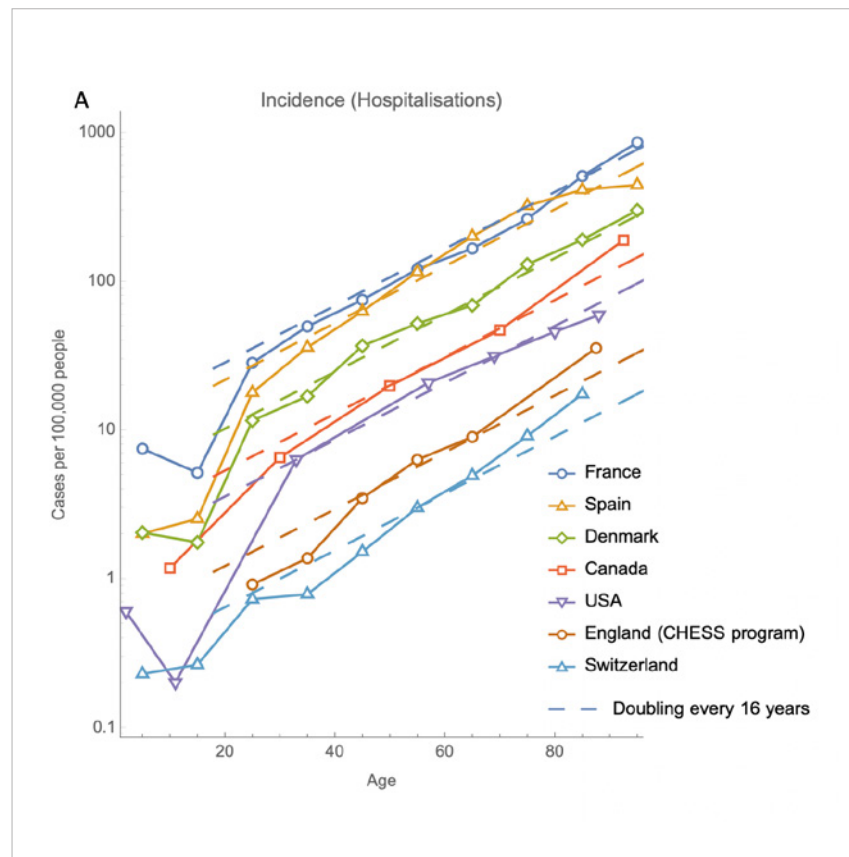


With the health crisis came the economic crisis, and from the start Oxford Mathematicians were anticipating and modelling the impact. As early as April, Doyne Farmer and his colleagues were identifying the impact of the pandemic on different sectors and workers in the USA, and were forecasting the new normal of a two-tier working world of largely protected home workers and more severely affected manufacturing and consumer-facing companies and employees. In May, Doyne and his team wrote a paper to advise on the best way to reopen an economy while keeping the R-number under control.

The range of our research has been huge. Helen Byrne, Heather Harrington and Anna Seigal are part of COMBAT, a team of 134 researchers across Oxford who are trying to understand the variability between patients in their immune responses and outcomes from acute COVID-19 infection. They have looked

at multi-modal molecular and immunological data sets from a range of patients with COVID-19, and are using state-of-the-art mathematical and computational techniques from topological data analysis, tensors and machine learning. Their ambition is to enable targeted interventions at an individual level.

Meanwhile Sam Palmer has looked at the role of T-cells in the immune system as a key factor in explaining why the elderly are more likely to catch, and suffer from, COVID-19. In turn, Alain



Goriely has worked with a colleague from Stanford University, advising the Newfoundland Government on whether to lift its travel ban – research that ended up in court as the Government successfully fought a challenge to the ban in front of the Province’s Supreme Court. Alain has since been called as an expert witness in yet another challenge to the same travel ban – and remarkably, thanks to their isolation, public policy and the travel ban, the epidemic is still under control in Newfoundland.

Mathematics has never been a narrow discipline. But in this crisis it has reached beyond science, to economics, and even to the law ... and ultimately into our everyday lives.

Above:
Maps of Newfoundland showing travel and infection rates (Alain Goriely).

Left:
Hospitalisations by age for Coronavirus patients (Sam Palmer).

Appointments...

We welcome the following new Faculty members.



Paul Balister (Memphis, USA)

Associate Professor of Combinatorics, and Tutorial Fellow of Wadham College

—
Research interests:

Probabilistic combinatorics and its applications to other areas of mathematics; random geometric graphs; extremal graph theory.



Dawid Kielak (Bielefeld, Germany)

Associate Professor of Pure Mathematics and its Interfaces, and Tutorial Fellow in Pure Mathematics at Hertford College

—
Research interests:

The intersection of geometric group theory with ring theory.



Justin Sirignano (Illinois, USA)

Associate Professor of Mathematics

—
Research interests:

Deep learning models for large financial datasets; asymptotic analysis of deep learning models, and convergence analysis of statistical learning algorithms.

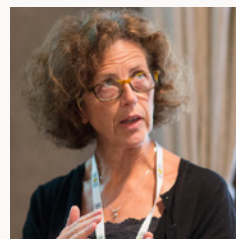
...and achievements

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

Konstantin Ardakov has been awarded the 2020 Adams Prize of the University of Cambridge for his work in algebra.

Martin Bridson FRS, James Maynard and **Endre Süli** have all been elected to The Academia Europaea.

Helen Byrne and **Benjamin Walker** have received Society of Mathematical Biology awards for 2021. Helen has become a Fellow of the Society, and Ben has been awarded the H. D. Landahl Mathematical Biophysics Award.



José Carrillo has been elected a member of the board of the European Society for Mathematical and Theoretical Biology.

Gui-Qiang G. Chen has been elected a Fellow of the European Academy of Sciences.

Alison Etheridge FRS, OBE and **Nick Trefethen FRS** are invited speakers at the European Mathematical Society's meeting, 8ECM, in Portorož, Slovenia, in June 2021; **Robin Wilson** is giving one of the invited Public Lectures.

Cristiana De Filippis has been awarded the Gioacchino Iapichino Prize for 2020 by the Italian National Academy.

Alain Goriely and Derek Moulton (pictured) have been awarded the 2019 PNAS (Proceedings of the National Academy of Sciences of the USA) Cozzarelli Prize in the Engineering and Applied Sciences category.



Heather Harrington has been awarded one of the Philip Leverhulme Prizes for 2020 for ‘outstanding researchers whose work has already attracted international recognition’.



Ehud Hrushovski has been elected a Fellow of the Royal Society.

Andrea Mondino has been awarded a Whitehead Prize for 2020 by the London Mathematical Society for his contributions to geometric analysis. **Erik Panzer** and **Richard Wade** have been awarded Royal Society University Research Fellowships for 2020.

Anna Seigal has been awarded the SIAM Richard C. DiPrima Prize for 2020; this prize recognises an early-career researcher in applied mathematics.

Robin Thompson has been awarded the Journal of Clinical Medicine Outstanding Research Award for 2020.

Other University awards

The University’s Mathematical, Physical, and Life Sciences Division (MPLS) has appointed **Geoffrey Mboya** an Equality, Diversity and Inclusion Fellow for 2020–21. See page 20.



Vicky Neale was awarded a 2020 PGCert Portfolio Prize, one of the Vice-Chancellor’s Education Awards.



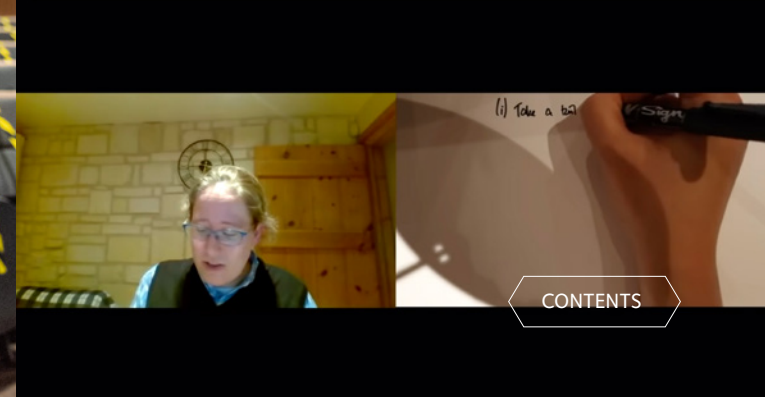
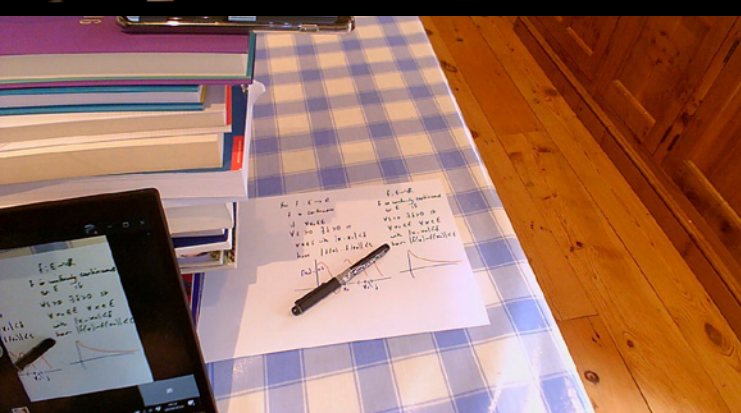
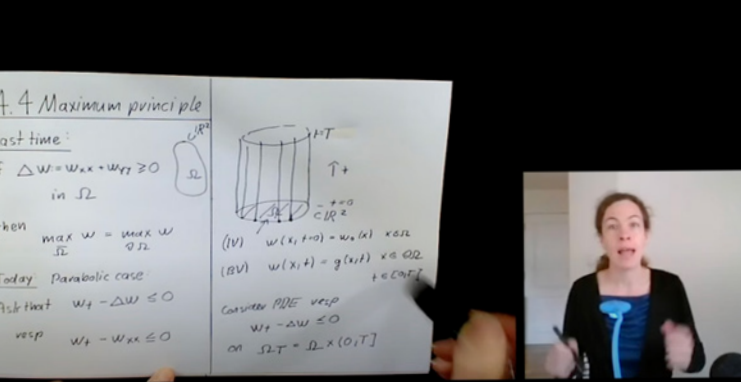
Doireann O’Kiely received an MPLS Early Career Impact Award for contributions to the manufacture of thin glass sheets.

And finally, US President Biden has named **Eric Lander** Director of Office of Science and Technology Policy and adviser on science. Eric was a Rhodes Scholar at Wolfson College from 1978 to 1980 and was awarded a DPhil degree for a thesis on algebraic coding theory and symmetric block designs, written under the supervision of Peter Cameron.

Recognition of distinction awards

Álvaro Cartea (Mathematical Finance), **Heather Harrington** (Mathematics), **Renaud Lambiotte** (Networks and Nonlinear Systems) and **Andreas Münch** (Applied Mathematics) have all been promoted to Professor.

The past year in Oxford Mathematics



Obituary:

Peter M. Neumann OBE

Martin Bridson

Whitehead Professor of Pure Mathematics



Peter Neumann was a remarkable man who crammed several lifetimes of work into one, inspiring those around him. The best of citizens and the kindest of men, Peter never seemed flustered as he moved cheerily among his many roles. Much is written elsewhere about the manifold ways in which he enhanced the lives of others, so here we focus on his life as an Oxford Mathematician.

Peter was internationally renowned for his profound and enduring contributions to mathematics and its history, but he was adamant that teaching was at least as important as research, and he dedicated much of his life to providing others with the ability to share in the joy that he found in mathematics. A famously dedicated tutor, he covered undergraduate scripts in green ink late into the night before tutorials. He brewed wickedly strong coffee to fuel those tutorials, and animated his famous Kinderseminar for graduate students with the same brew. Here, generations of Oxford algebraists and their fellow-travellers – including 40 of his own DPhil students – were encouraged to think broadly about mathematics and to give their first talks, gently coached and constructively criticised, always with great courtesy.

That same courtesy awaited speakers in the weekly Oxford Algebra Seminar, but the wisest of distinguished speakers in that context took careful guard when Peter interjected: pausing his fountain pen over his hardbacked notebook, he spoke with purpose – ‘I don’t understand...’ or ‘Could you help me...’ were sure flags that something just said conflicted with his ocean of knowledge, insight, and meticulous attention to detail.

Peter was a master of notes: he recorded budding ideas and concise records of talks in his notebooks, filed efficiently; he sent frequent missives to encourage, congratulate, or offer sympathy, to share ideas and references, and often to invite. All were signed Peter or P. The invitations were welcome above all: the anticipated joy of an evening with Peter was always augmented by a new tale and a sparkle of unexpected knowledge.

Peter was born in Oxford in 1940 while his mother, a refugee from Germany, was studying for her doctorate. He was raised in Hull. In 1959 he came to The Queen's College as an undergraduate, and apart from his 'year abroad' as a Junior Research Fellow at Merton (and sabbaticals overseas) he remained at Queen's for the rest of his life, becoming a JRF in 1964, a Tutorial Fellow in 1966, and an Emeritus Fellow in 2008. He loved the College and served it in every imaginable way, just as he served the Mathematical Institute.

Peter was appointed to a University Lectureship in 1967, shortly after the Mathematical Institute in St Giles opened. He had written his doctorate *A Study of Some Finite Permutation Groups* in 1966 under the direction of Graham Higman, the Waynflete Professor. Higman built a large school of algebra in Oxford and Peter became its fulcrum. His work achieved international acclaim and the University awarded him a DSc degree in 1976 (one of many

accolades). He remained 'Dr Neumann' throughout his career, refusing to ask for a titular professorship because he regarded the DSc degree as a more appropriate recognition of distinction.

Group theory (the study of symmetry) was, in its many guises, Peter's abiding mathematical passion. It was a thread that bound his professional life to his family: his parents, Hanna and Bernhard, were both giants in the field and the first of his 100 or so papers, 'Wreath products and varieties of groups', was written jointly with them in 1962. His passion for group theory also permeated his life as a historian of mathematics: part of his enduring legacy is his translation and commentary on the works of Évariste Galois, the founder of group theory, which Peter worked on in Paris during the first phase of his retirement in 2008. Peter's legacy as a historian is surveyed elsewhere, but it is important to record here that he was the driving force that made the History of Mathematics a permanent feature of Oxford's teaching and research.

'Retirement' was not the most apt of words in Peter's case. His foci shifted in this phase of his life but his dedication and enthusiasm, underpinned by the constant support of his wife Sylvia, herself a mathematician, were undimmed, even when he struggled with his health. 'As long as my diary permits it, I can fill in for a day, a week, a month or a term, if need arises,' he wrote spontaneously to a

list of young colleagues in 2014, offering to cover any teaching need. He continued to lecture first-year undergraduates – whose enthusiasm he adored – while quietly deflecting his stipend to the Institute's fund to support graduate students.

He retained a keen interest in contemporary group theory, but after retirement Peter spent more time nurturing a love of mathematics among school children, which is something that he cared deeply about. The OBE that he had been awarded in 2008 for services to Mathematics Education was earned many times over. His abiding legacy includes the UK Mathematics Trust, which he was instrumental in setting up, serving as its inaugural Chair from 1996 to 2004. And, as ever with Peter, leadership was matched by local action: when I was too busy to run the chess club at our local primary school, Peter took over and quickly started teaching extension maths as well, inspiring children from a wide range of backgrounds who loved 'The Professor', cycling up the hill to Headington on his butcher's bicycle, smartly dressed. That bicycle was an icon: he claimed to have his best ideas while cycling, and extolled the virtues of cycling to London for meetings.

Peter Neumann's achievements and legacy as an Oxford Mathematician are immense, and yet he was so much more.

Equality, diversity and inclusion in Oxford Mathematics

Geoffrey Mboya

EDI Fellow



In Michaelmas Term 2020 I was elected as one of the ten inaugural Equality, Diversity and Inclusion (EDI) Fellows by the University's Mathematical, Physical, and Life Sciences Division.

My responsibilities include participating in their termly Steering Group meetings, providing input and ideas for a divisional EDI action plan, and helping to implement actions, raise local awareness of EDI principles and activities, and enhance self-awareness and learning in EDI areas.

With my EDI Fellow's personal budget, and with departmental and divisional funding for spending on EDI activities in the building, I am seeking through Mfano Africa (a mentoring programme targeting pre-PhD mathematics students in Africa) to play a small part in building a critical mass of research capacity in Africa through volunteer mentors who give crash courses and one-hour talks, start a reading group or advise students through short mini-projects intended to introduce them to research frontiers, thereby improving their DPhil applications. Among the senior mentors whose courses are lined up at Mfano are Prof. Fengfan Yang of Nanjing University of Aeronautics & Astronautics and Prof. Edris Titi of Cambridge University.

As a pilot project in the Summer of 2021, Mfano Africa plans to airlift two promising African students to Oxford for an unrivalled opportunity to build their research experience and receive training on putting together mathematics graduate applications. (The word 'airlift' is motivated by the historic Kennedy Airlift, which supported promising East African students to receive

college and university education in the US and Canada from 1959 to 1963.) As Oxford Mathematician Balász Szendrői has noted: “This project is a great way to bring some eminent African students to Oxford, create opportunities for these students, and explore ways to interact with their wider communities.”

The success of this pilot project would create a guidepost for future implementation of the 7th Action of Oxford’s Race and Equality Charter which seeks to increase the proportion of postgraduate research applications from well-qualified graduate students from low- and middle-income countries, and an aim of the Mathematical Institute’s Good Practice Statement of promoting mathematics to all prospective students, regardless of gender or background.



In addition, in my role as Mathematics EDI Fellow, I’ve proposed strategies for improving the Oxford study experience for student parents and suggested improvements on wording and target audiences for open position advertising, with the aim of seeing the Institute appoint its first black faculty member.

A world history of mathematics

Christopher Hollings

Clifford Norton Senior Research Fellow in the History of Mathematics

Much of the mathematics that is done throughout the world today is essentially European in style, a legacy of colonialism. However, other parts of the world have had, and continue to have, their own mathematical traditions, though in many cases records are sketchy. The Department commissioned a series of posters, to be displayed in the Andrew Wiles Building and online, in which I provide a taste of the different types of mathematics that have appeared throughout the world, and to show that these are as much a part of the story of mathematics as European contributions.



Find out more

The full poster series is available from our website. [Download here](#)

400 years of the Sedleian Professors

Christopher Hollings

Clifford Norton Senior Research Fellow in the History of Mathematics



In 2021, Oxford's Sedleian Chair of Natural Philosophy marks its 400th anniversary. Founded by a bequest from Sir William Sedley (c.1558–1618), it is one of the University's oldest Professorships.

Like similar positions established around the same time (such as the Savilian Chairs of Geometry and Astronomy), its purpose was to provide centrally organised lectures on a specific subject, in this case natural philosophy.

During the first century of its existence, the Chair was held by physicians such as Thomas Willis, who emphasised medical topics in their teaching. For much of the 18th century, on the other hand, the Sedleian Professors were theologians, whose links to natural philosophy are less clear, but by the end of that century, the Chair was occupied by the astronomer Thomas Hornsby. Following his tenure, it passed into the hands of applied mathematicians, where it remained.

Since the mid-20th century, the Sedleian Chair has been a high-profile research post, rather than a teaching position, and has been held by prominent applied mathematicians; the current holder is Jon Keating (see page 9). An edited volume on the history of the Sedleian Chair, to be published by OUP, is currently in preparation.

Top row: Jon Keating (2019–), Thomas Willis (1660–75), Augustus Love (1899–1940) / Bottom row: John Ball (1996–2019), George Temple (1953–68) (left), Sydney Chapman (1946–53)

Can maths help us to win at Fantasy Football?

Joshua Bull

Postdoctoral Research Associate

Winner of the official 2020 Fantasy Premier League

Fantasy Premier League (FPL) is an increasingly popular way of adding extra stress and disappointment to a weekend of watching football, with around 7.5 million people worldwide playing the official game last season. Players choose a squad of professional footballers from across the league, and score points based on their real-world performances. This has led to some fierce debate around how much of the game is just luck and how much is having a keen sense of strategy. Consistently strong players have reputations for creating elaborate statistical models, or for being strategic thinkers: among the top players this year were World Chess Champion Magnus Carlsen, who finished tenth, and myself, an Oxford Mathematician, who ended up as the overall Champion.

‘Oxford Mathematician wins Fantasy Football’ is an excellent headline, and naturally led to much speculation about how maths might help to improve one’s game. This felt like a perfect opportunity to hit the back of the net by giving an Oxford Mathematics Public Lecture about maths and Fantasy Football, which has now been viewed by over 100,000 people.

The slide is titled "FPL Captains" and features a bullet point: "Points from your captain are doubled!". It displays two Liverpool player cards for Mohamed Salah. The first card shows a score of 16 and is labeled "Not Captained". The second card shows a score of 32 and is labeled "Captain Points are doubled!". To the right is a diagram of a football pitch with player names and positions: Pope (GK), Pereira, Alexand..., Robertson, Dunk, Salah, Martial, De Bruyne, Woodcock, Ings, Vardy, Martin (GK), Greene..., Lundstr..., and Davis. The slide also includes the Oxford Mathematics logo and the XTX Markets logo. In the top right corner, the University of Oxford Mathematical Institute logo is visible. A video inset in the bottom right shows a woman with glasses speaking.

So, can maths tell us how to win Fantasy Football? Betteridge’s law suggests that any headline ending in a question mark can be answered by the word “no”, and this one is no exception: I was at least as lucky as I was well prepared. However, there are certainly interesting mathematical ways to investigate FPL. I repurposed some of the techniques I use in my Mathematical Biology research and used them to compare different strategies. Ultimately we found some quite interesting results... but if you want to find out how to improve your play, you’ll have to watch the lecture!



Find out more

Joshua’s Oxford Mathematics Public Lecture, *Can maths tell us how to win at Fantasy Football?*, is available on YouTube. [Watch lecture](#)

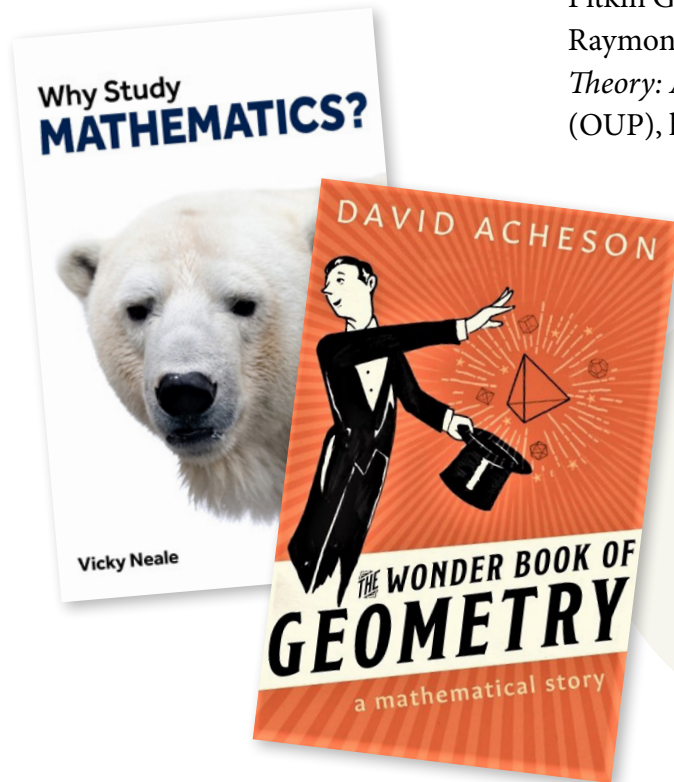
New books by Oxford Mathematicians

Vicky Neale and David Acheson, two of Oxford's most engaging and accessible speakers and writers, have produced new books for a general readership.

In *Why Study Mathematics?* Vicky describes the experience of studying mathematics at University and discusses the many benefits of a mathematics degree.

In *The Wonder Book of Geometry* (a New Scientist 'Don't Miss' Book of the Week, and a BBC Science Book of the Year), David takes us on a geometrical tour from Ancient Greece to the present day, demonstrating why geometry is the spirit of mathematics.

Other recent books for general audiences include Robin Wilson's Pitkin Guide on *Isaac Newton* (with Raymond Flood) and *Number Theory: A Very Short Introduction* (OUP), his 50th book.



Alumni

Have you written any book that relates to maths? If so, send us the details and we'll include a selection next year.

Helping future students

In the Outreach team we've been concerned about the effect of school closures on the brightest maths students, some of whom were preparing to apply for Oxford. Following the success of our online open days in the summer of 2020, we launched a weekly online MAT livestream, with James Munro, our Admissions and Outreach Coordinator going live for two hours every Thursday to solve Oxford Mathematics Admissions Test (MAT) problems, with help from a hundred or so prospective applicants in the online audience.

In 2021, with the schools closed again, we've launched an exciting new project which we've called the *Oxford Online Maths Club*. We're using livestream broadcasts and email newsletters to send out to any 16–18-year-olds who are thinking of studying mathematics at university, or who are about to start a maths course later this year. We're excited to expand the range of maths that we're covering, looking in particular at links

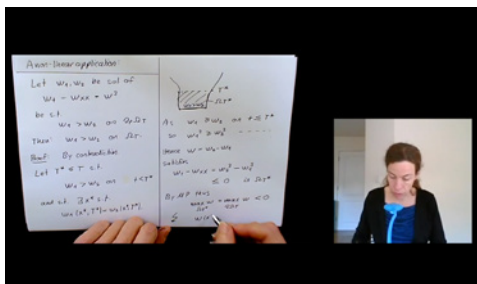


between the A-level syllabus that our participants are currently studying and the university curriculum that they may study one day. Anyone with suggestions of interesting maths we should be broadcasting to 16–18-year-olds, or anyone who'd like to join us live as a guest presenter, is welcome to get in touch with us at oomc@maths.ox.ac.uk.

Undergraduate lectures for the world

For two years we've been putting a selection of Oxford Mathematics undergraduate lectures on YouTube. These comprise individual lectures from courses, and they've proved very popular – a popularity that the wise YouTube algorithm noticed, leading to over 12 million views so far (and 97% 'likes').

However, in December 2020 we went a step further by putting up a whole course – Ben Green's *Metric Spaces*, in 11 online lectures. Why? Well, why not? A whole course gives a fuller flavour of the Oxford student experience, and we will follow this up with more lectures in 2021.

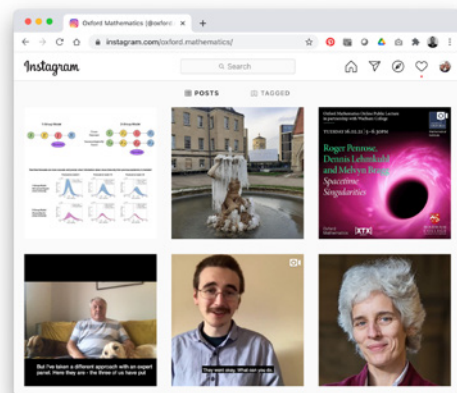


Melanie Rupflin's second-year lecture on Differential Equations on the Oxford Mathematics YouTube channel.

Social media

While social media understandably provoke concern, there's no doubt that in the right hands they can be a force for good. Certainly, for us in Oxford Mathematics, they've been invaluable in disseminating our research, promoting our public lectures, and drawing in aspiring students via our online student lectures, as well as putting us in touch with a range of voices from around the world.

Our policy is not to 'retweet' endlessly or to 'over-tweet'. We have 280,000 YouTube subscribers and 40,000 social media followers. Why not join the dialogue? See links on the last page.

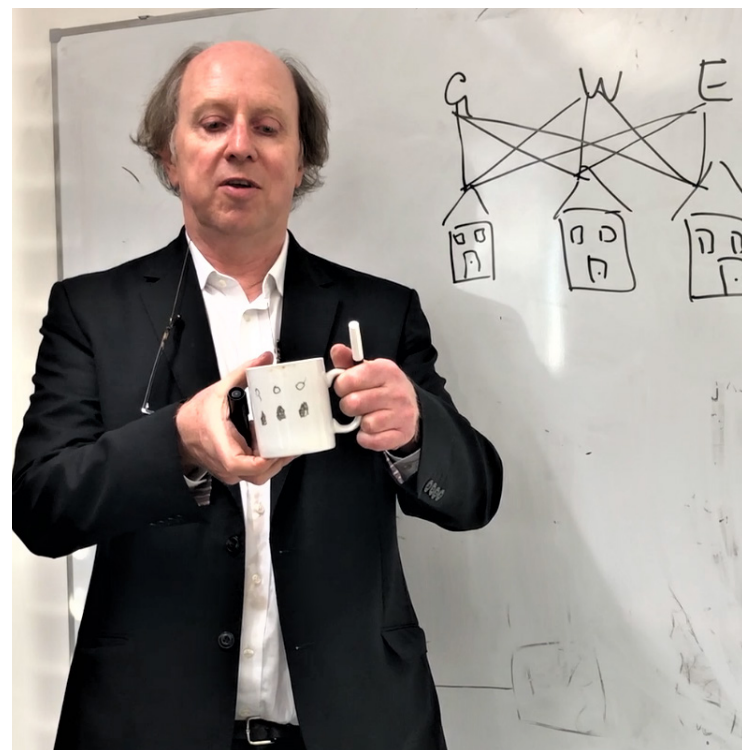


#WhatsOnYourMind

In 2019 Sam Cohen had an idea: Why not ask Oxford Mathematicians to talk for one minute about what's on their minds?

So we got out our iPhones, bought a cheap tripod, and invited colleagues to take a break from all that maths and to talk about it instead.

The result has been nearly 40 films watched by many thousands across social media. Some talk about their research, some let their thoughts wander. Arguably, the star of the show has been Sam Howison with a series of films that range from winners and losers in tennis to the joys of coffee. You can find them on our Facebook or Instagram pages.



Sam Howison demonstrates the Utilities Problem.

Public Lectures

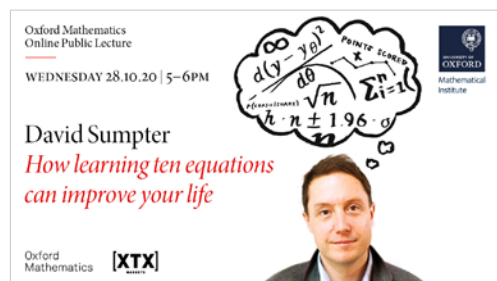
We've kept things simple in a difficult year. We began with two Public Lectures on the pandemic, the first a widely recognised tour de force of the mathematical modeller's art by Robin Thompson. We then had a summer silence as the world gradually drowned online. Our return in the Autumn was Covid-lite as we told the world how maths can help us to win fantasy football (see page 23), and how it can make us better people. Or at least, how we can try...




Oxford Mathematics Online Public Lecture
13.05.20
Renaud Lambiotte
Smartphones vs COVID-19
Wednesday 5–6pm
Oxford Mathematics **XTX**



Oxford Mathematics Online Public Lecture
THURSDAY 08.10.20 | 5–6PM
Tim Harford
How to make the world add up
Oxford Mathematics **XTX**



Oxford Mathematics Online Public Lecture
WEDNESDAY 28.10.20 | 5–6PM
David Sumpter
How learning ten equations can improve your life
Oxford Mathematics **XTX**



Oxford Mathematics Public Lecture
27.05.20
Philip Maini
Squirrels, Turing and Excitability – Mathematical Modelling in Biology, Ecology and Medicine
5pm
Oxford Mathematics **XTX**



Oxford Mathematics Online Public Lecture
TUESDAY 08.09.20 | 5–6PM
Joshua Hull
Can maths tell us how to win at Fantasy Football?
Oxford Mathematics **XTX**



Oxford Mathematics Online Public Lecture
THURSDAY 19.11.20 | 5–6PM
Anna Seigal
Ideas for a complex world
Oxford Mathematics **XTX**



Our Graduate Student Campaign

The Oxford Mathematics 2020–21 Appeal aims to provide the financial support vital to our academic future – namely, funding for the next generation of Graduate Students. Those students, free from financial pressure, will provide the youthful energy and talent which will drive mathematical research in Oxford and around the World. Could you contribute to that future?

The appeal, launched in October

2020, has already raised £25,000 from nearly 100 generous donors. With your help, we can further boost the Oxford Mathematical Institute Fund which is dedicated to the funding of scholarships for graduate students. If you would like to donate you can [make a gift online](#).

If you would like to know more about leaving a gift to Oxford Mathematics in your will, please contact Caitlin Tebbit – caitlin.tebbit@devoff.ox.ac.uk

A final thought

2021 is the product of consecutive prime numbers (43 and 47).
The last time this happened was in 1763, and the next time
will not be until 2491.

Also, 20-21 is obtained by concatenating two consecutive
integers, and the next such year that's also a product of
consecutive primes will not happen until:

794018604377235322848433897872605582794018604377235322848433897872605583



Mathematical
Institute

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

maths.ox.ac.uk



Design: [William Joseph](#)