

### LONDON MATHEMATICAL SOCIETY EST, 1865

### NEWSLETTER

No. 470 June 2017

### MATHEMATICIANS AMONG NEW ROYAL SOCIETY FELLOWS

n 5 May 2017 the Royal Society released details of its newly-appointed Fellows. The London Mathematical Society would like to extend its warmest congratulations to its members Professors Mark Gross (Cambridge) and Lawrence Paulson (Cambridge) on being elected Fellows of the Royal Society. The LMS also extends its congratulations to Professors Subhash Khot (Courant Institute), Gordon Slade (University of British Columbia) and Andrew Woods (BP Institute Cambridge). Appointed annually, Royal Society Fellowships are awarded to the most eminent scientists, engineers and technologists from or living and working in the UK and Commonwealth. More information is available at http://tinyurl.com/n4o5tkm.

US mathematician Professor Whitfield Diffie (Stanford University) has been elected a Foreign Member.

• Mark Gross is a pure mathematician at the University of Cambridge specializing in mirror symmetry, which had its origins in string theory in the late 1980s. Mirror symmetry began with an observation that two very different geometric calculations gave the same result, leading to astonishing mathematical predictions entailing the equality of mathematically disparate objects. Since then, the quest to understand this mysterious correspondence has led to significant growth in a variety of different flavours of geometry.

- Subhash Khot is a theoretical computer scientist at the Courant Institute, whose unexpected and original contributions are providing critical insight into unresolved problems in the field of computational complexity. He is best known for his prescient definition of the 'Unique Games' problem, and leading the effort to understand its complexity and its pivotal role in the study of efficient approximation of optimization problems; his work has led to breakthroughs in algorithmic design and approximation hardness, and to new exciting interactions between computational complexity, analysis and geometry. He is a recipient of the Rolf Nevanlinna Prize by the International Mathematical Union, the Alan T. Waterman award by the US National Science Foundation, the MacArthur Fellowship, and the Simons Investigator Award.
- Lawrence Paulson is Professor of Computational Logic at the University of Cambridge, where he has held established positions since 1983. He has written nearly 100 refereed conference and journal papers as well as four books. He introduced the popular Isabelle theorem proving environment in 1986, and made contributions to the verification of cryp-

Cont'd on page 3.

@LondMathSoc

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tographic protocols, the formalisation of mathematics, automated theorem proving technology, and other fields. Specific accomplishments include a formal analysis of the ubiquitous TLS protocol, which is used to secure online shopping, and the formal verification of Gödel's second incompleteness theorem.

- Gordon Slade is a Canadian mathematician at the University of British Columbia, whose research is in the fields of probability theory and mathematical physics, especially statistical mechanics. He is wellknown for his work on the mathematical study of critical phenomena and phase transitions. With his collaborators, he developed the 'lace expansion' into a powerful and flexible method for the analysis of high-dimensional critical phenomena in many mathematical models of interest in physics, including the self-avoiding walk and percolation. In more recent work, he and his collaborators have developed a rigorous renormalisation group method for the analysis of the critical behaviour of spin systems and the weakly self-avoiding walk.
- Andrew Woods is BP Professor and Head of the BP Institute, University of Cambridge. His work is characterised by the development of simplified mathematical and experimental models of complex fluid flow processes covering a wide range of

phenomena from the dynamics of explosive volcanic eruptions, to geothermal power generation, carbon sequestration and oil recovery in heterogeneous porous rocks. His work on the dynamics of mixing in turbulent buoyant plumes and gravity currents has led to new insights about the ascent height of volcanic eruption columns and the run-out distance of ash flows, as well as constraints on the dynamics of hydrothermal and oil plumes in the deep sea.

#### Foreign member

Whitfield Diffie is a Consulting Scholar in the Center for International Security and Cooperation at Stanford and a Visiting Professor at Royal Holloway College, University of London. Diffie is best known for discovering the concept of public key cryptography, which underlies the security of internet commerce and all modern secure communication systems. After leaving Stanford University in the late 1970s, he became Manager of Secure Systems Research for Bell-Northern Research, the laboratory of the Canadian telephone system. In 1991, he moved to Sun Microsystems, rising to be Vice-President, Sun Fellow, and Chief Security Officer until 2009. Since leaving Sun, he has worked primarily as an advisor to innovative start-ups in the security field. Diffie received the 2015 Turing Award and in 2017 elected to the National Academy of Engineering.

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### LMS WOMEN IN MATHEMATICS DAY Warwick University Tuesday 27 June 2017

The second 2017 London Mathematics Society Women in Maths Day will be held at Warwick University on Tuesday 27 June, 2017.

The day provides the chance to meet and network with women who are active and successful in mathematics, and features research talks from a wide range of mathematical subject areas as well as a panel discussion. A poster session will be held over lunch and there will be a prize for the best Women in Mathematics Day poster. Posters developed for other conferences are very welcome, and poster boards will support up to A1 size posters. In addition, each poster presenter will have the opportunity to give a one slide 'taster' to advertise their poster to the participants.

The event is open to all and may be of particular interest to women mathematicians, particularly those at an early stage of their career.

Registration for the event is free, and limited travel funding is available to support undergraduates, postgraduates and postdocs to attend. We encourage attendees to request additional travel funding from their departments where appropriate. We are keen to enable attendance from further afield in the UK, and will make every effort to assist with this.

Further information, and to register, visit the conference page http://www2.warwick.ac.uk/fac/sci/maths/research/events/2016-17/ nonsymposium/wim



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### LMS POPULAR LECTURES 2017

LONDON (UCL Institute of Education) Wednesday 28 June 19:00 BIRMINGHAM (University of Birmingham)

Wednesday 20 September 18:30

### **David Tong** (University of Cambridge) The Unreasonable Effectiveness of Physics in Mathematics

For centuries there has been a close relationship between mathematics and theoretical physics. For the most part, this involved physicists gleefully using ideas previously developed by mathematicians. In the past few decades, that relationship has taken a surprising twist: in their quest to understand Nature, physicists have developed new tools, such as quantum field theory and string theory, which are providing insight into questions in pure mathematics



### **Jason Lotay** (University College London) Adventures in the 7th Dimension



In 7 dimensions there exist special shapes that may help us unlock the mysteries of the universe. Looking for this unique geometry is challenging, but nature holds a possible solution (specifically, bubbles and thermodynamics). This lecture will take us on a mathematical journey across multiple dimensions, exploring their role in art, science and popular culture.

**LONDON:** Commences at 7.00 pm, refreshments at 8.00 pm, ends at 9.30 pm. Admission is free, with ticket. Register by **Thursday 22nd June**.

**BIRMINGHAM:** Commences at 6.30 pm, refreshments at 7.30 pm, ends at 9.00 pm. Admission is free, with ticket. Register by **Thursday 14th September**.

You can register online at: www.lms.ac.uk/events/popular-lectures

### FERRAN SUNYER I BALAGUER PRIZE 2018

The prize will be awarded for a mathematical monograph of an expository nature presenting the latest developments in an active area of research in mathematics. The monograph must be original, unpublished and not subject to any previous commitment edition.

The prize consists of €15,000 and the winning monograph will be published in Birkhäuser series *Progress in Mathematics*.

Deadline for submission is **1 December 2017**. For further information visit the website at http://ffsb.iec.cat.

#### Ferran Sunyer i Balaguer Prize 2017

The 2017 prize was awarded to Antoine Chambert-Loir (Université Paris-Diderot Paris 7), Johannes Nicaise (Imperial College London) and Julien Sebag (Université Rennes 1).

### **ROLLO DAVIDSON AWARD 2017**

The Rollo Davidson Trustees have pleasure in announcing the award of the 2017 Rollo Davidson Prize jointly to:

Jian Ding (University of Chicago) for his achievements on mixing and cover times and on the random k-SAT conjecture.

Nike Sun (University of California at Berkeley) for her achievements in probability theory and specifi-

cally on the random k-SAT conjecture. Further details of the Bollo Davidson Trust



Jian Ding

Nike Sun

may be found at www.statslab.cam.ac.uk/ Rollo/.

### **OLGA TAUSSKY-TODD LECTURE 2019**

#### **Call for Nominations**

The Olga Taussky-Todd Lecture is held every four years at the International Congress on Industrial and Applied Mathematics (ICIAM). This honour is conferred on a woman who has made outstanding contributions in applied mathematics and/or scientific computation. The lecture is named in tribute to the memory of Olga Taussky-Todd, whose scientific legacy is in both theoretical and applied mathematics, and whose work exemplifies the qualities to be recognized.

The officers and board of ICIAM now call for nominations for the Olga Taussky-Todd Lecture, to be given at the ICIAM 2019 Congress, to take place in Valencia, Spain from 15 to 19 July 2019. Nominations should be made electronically through the ICIAM website at http://tinyurl.com/nxgawht. The deadline for nominations is **30 September 2017**.

### MATHEMATICS POLICY ROUND-UP

June 2017

#### RESEARCH

#### **Executive Chair Designate of Research England**

David Sweeney, HEFCE's Director of Research, Education and Knowledge Exchange, has been appointed Executive Chair Designate of Research England.

Subject to Parliamentary approval of the Higher Education and Research Bill, Research England will be established as one of nine Councils within UK Research and Innovation (UKRI) and will open its doors in April 2018 More information is available at http:// tinyurl.com/kg97fbh.

### Review of knowledge exchange in the Mathematical Sciences

EPSRC and the Knowledge Transfer Network (KTN) are supporting an independent review of knowledge exchange in the Mathematical Sciences. The aim of the review is to establish a roadmap for knowledge exchange in the Mathematical Sciences to inform the community of practitioners and users, funders and government.

The Review Board, to be chaired by Philp Bond, a visiting professor in the Departments of Engineering Mathematics and Computer Science at the University of Bristol, and a visiting fellow in the Oxford Industrial and Applied Mathematics Centre, will be in place by summer 2017. The Board will also be supported by the review committee of experts from academia, business & knowledge exchange professionals, which was selected through an Expression of Interest process.

The terms of reference for the review:

- To collect evidence from UK Higher Education Institutes (HEIs), funders, knowledge exchange experts, learned societies and research users, both in the public and private sector, on the current state of knowledge exchange in the Mathematical Sciences.
- To seek examples of best practice for Mathematical Sciences knowledge exchange from within and outside of the UK.

- To consider and review models of support, incentivising, promoting and providing governance of knowledge exchange activities for the Mathematical Sciences.
- To explore similarities and differences in the operation of knowledge exchange in the Mathematical Sciences in comparison with other STEM subjects.
- To establish a roadmap for knowledge exchange in the Mathematical Sciences and to make recommendations to stakeholders.
- To disseminate findings widely and to summarise these findings in a public report.

#### HIGHER EDUCATION

#### Exiting the EU: challenges and opportunities for higher education report

The UK's impending exit from the EU has created significant uncertainty in higher education because of the extensive links between UK universities and those on the continent. The House of Commons Education Select Committee has stated that: 'If the government does not address the specific concerns within the HE sector, there is a risk that Brexit will damage the international competitiveness and long-term success of our universities'.

The Select Committee has suggested in its report, a number of areas that the government should prioritise, and also made recommendations for new directions outside of the negotiations. More information is available at http://tinyurl.com/kk9z2tt.

#### OTHER

### Industrial Strategy: Science and STEM skills report

In January 2017 the government published its Industrial Strategy Green Paper. Two of the 10 'strategic pillars' it listed covered 'science, research and innovation' and 'developing skills'. This short report is 'intended to bring that work together, to feed into the govern8

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ment's consultation on its Green Paper'. The full report is available at http://tinyurl.com/ lzgrvfv.

#### Evidence in UK government policy making

As part of CaSE's (Campaign for Science and Engineering) work on science advice in government, it has published a report — Improving use of evidence in UK government policymaking — in collaboration with University College London. The report explores current structures, processes and practice and looks for opportunities to strengthen and improve them across government. The report makes 14 recommendations to improve the use of evidence in UK government policymaking under three themes: architecture; supply and demand; and evaluation and accountability. More information is available at http:// tinyurl.com/kbxas3n.

> Dr John Johnston Joint Promotion of Mathematics

### LMS COUNCIL DIARY

#### 31 March 2017: A personal view

The meeting of Council on 31 March was a trial of a new agenda format, following discussions at February's Strategic Retreat. Three committees provided updates on key strategic matters. First June Barrow-Green, the Chair of the Library Committee, reported that a nomination for a blue plaque for Philippa Fawcett at No. 2 Gower Street had been submitted to the English Heritage Blue Plaque Scheme. Further, she noted that there is on-going work to display mathematical models at De Morgan House, in particular 3-D prints of the Henrici models from Oliver Labs and a loan of mathematical models from the Science Museum.

Women in Mathematics Committee Chair Eugenie Hunsicker then highlighted current activities, including a 'Success Stories' project being developed to produce an online resource of stories to demonstrate the diversity in mathematical careers, grants awarded to support Women and Girls in Mathematics events, and a photo exhibition of European women mathematicians currently touring the UK.

Speaking on behalf of the Research Policy Committee, Ken Brown informed Council that the Mathematical Sciences Directory had just had its soft launch, with the aim of facilitating networking and collaborative research, as well as the gathering of anonymised data for preparing evidence-based reports for national policymakers and funders. Ken Brown also reported that the EPSRC Strategic Advisory Team for mathematics had met in March to discuss the aftermath of the 'Balancing Capability' exercise, the Knowledge Exchange Review, the Global Challenges Research Fund, the mid-term review of the Centres for Doctoral Training (CDTs) and the possibility of another CDT call, and the Alan Turing Institute.

The budget was another key item on the agenda of this Council meeting. The Treasurer presented the financial review for the first half of 2016-17 and gave the good news that the number of memberships had increased and that income from conference facilities was greater than expected. The Treasurer then presented the Operational Plans for 2017-18, and it was noted that the Society would receive its next forecasting report from Wiley in May, which would provide more accurate information as to publications income.

Finally, Council discussed the three new Committees that would be formed after an agreed restructuring that includes the disbanding of Programme Committee and Research Meetings Committee. The General Secretary presented proposals for the membership of the new Society Lectures and Meetings Committee (SLAM), the Research Grants Committee, and the Early Career Research Committee. It was agreed that for the moment the Chair of SLAM would be the Programme Secretary. After the meeting, some members of Council stayed on for a reception with the Executive Committee of the International Mathematical Union.

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### HAYMAN'S LIST



In 1967, Prof Walter K. Hayman (Imperial College) published a slim volume entitled *Research Problems in Function Theory* [3]. Walter, who came to Britain from Germany in 1938, has over 200 publications to his name, including five textbooks and a definitive proof of the asymptotic Bieberbach conjecture. He has received honorary degrees from universities in four countries, and he co-founded the British Mathematical Olympiad in 1967 with his wife Margaret Hayman. At the age of 91, Walter is almost the oldest member of the LMS, and has been a Fellow of the Royal Society for over sixty years. He has met most mathematical greats of the twentieth century, is a descendant of Mendelssohn, and has published a very colourful autobiography entitled *My Life and Functions*.

Research Problems in Function Theory contains 140 conjectures in seven areas of function theory, including meromorphic functions, Nevanlinna theory and functions in the unit disk. These conjectures are put forward in succinct numbered form, many of them by Hayman, but also gathered from mathematicians including Erdös, Turán and Collingwood. One example is:

**Problem 7.7:** Let 
$$f(z) = \sum_{k=0}^{\infty} a_n z^n$$
 be regular in  $|z| < 1$ ,

$$f_n(z) = \sum_{k=0}^n a_k z^k,$$

and let  $\Gamma_n$  be the modulus of the largest zero of  $f_n(z)$ . Then Kakeya showed that  $\underline{\lim}_{n\to\infty}\Gamma_n(f) \leq A$ , with A = 2. What is the best possible value of A? Clunie and Erdös [1] have shown recently that  $\sqrt{2} < A < 2$ .

This problem was solved by the US mathematician J. Buckholtz [2] in 1970, who gave a method to find A to any desired accuracy, with  $A \approx 1.8$ .

This year, for the fiftieth anniversary of the publication of the original book, Walter and I are hoping to publish an update to *Hayman's List*. There have been six updates over the years, with each detailing progress on existing problems, as well as adding more conjectures to the list. At the moment, *Hayman's List* stands at 515 problems, in nine areas of complex analysis.

For this update, we are backtracking from citations for the original book, or its updates, but I would also like to ask for your



W K Hayman

help in finding other solutions that are out there, that may not mention the original titles. If you know of any such developments, please let me know at my email address below.

Eleanor Lingham Sheffield Hallam e.lingham@shu.ac.uk

1. J. Clunie, P. Erdös, On the partial sums of power series, Proc. Roy. Irish Acad. Sect. A 65 (1967), 113-123

2. J. Buckholtz, Zeros of partial sums of power series II, Michigan Math. J. 17 (1970), 5-14

3. W.K. Hayman, Research problems in function theory, Athlone Press, London, 1967



### LMS GENERAL SOCIETY MEETING 30 June 2017 BMA House, London

Opening of the meeting and LMS business, including the announcement of the 2017 Prize winners and Honorary Members (open to all)
Sheehan Olver (Imperial) The Sokhotski–Plemelj theorem, singular integrals, and solving PDEs
Tea/Coffee
Gwyneth Stallard (Open University) Complex analysis and complex dynamics: fruitful interactions
Close of meeting; LMS & guests return to Russell Square

To register, please email Imsmeetings@Ims.ac.uk



### LMS GRADUATE STUDENT MEETING 30 June 2017 BMA House, London

- 10.00 Coffee and Registration
- 10.30 Dan Nicks (Nottingham) Julia sets in higher dimensions
- 11.30 Tea/Coffee
- 11.45 Graduate student talks
- 13.15 Lunch
- 13.55 Prizes awards
- 14.00 Jean-Marc Vanden Broecke (UCL) Applications of complex variable techniques to nonlinear free surface flows
- 15.00 Close of meeting

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To register, please email Imsmeetings@Ims.ac.uk

### **EUROPEAN NEWS**

#### **Central European University under threat**

The Hungarian Government recently introduced a draft motion to the Hungarian Parliament which would effectively put an end to the Central European University, Budapest. For further information see www.ceu.edu/ category/istandwithceu. To support the international protest campaign in support of CEU go to www.change.org and search for CEU.

> David Chillingworth LMS/EMS Correspondent

### CANADIAN MATHEMATICAL SOCIETY



2017 is the 150th anniversary of the Canadian Federation, and many special activities are taking place Canada across throughout the year mark to this very special occasion. Canada Day, on 1 July, will feature а wide

array of events in all provinces and territories, and particularly on Parliament Hill in Ottawa.

2017 is also a busy year for the Canadian Mathematical Society (CMS).

The CMS summer meeting is being held in conjunction with the 2017 Mathematical Congress of the Americas, which will take place in Montreal from 24 to 28 July. The meeting features more than 70 special sessions, eight prize lectures and 26 plenary lectures, as well as two public lectures, a career panel, a job fair, and social and cultural activities (mca2017. org).

The CMS winter meeting will take place at the University of Waterloo from 8 to 11 December.

The 6th Biennial Canadian Discrete and Algorithmic Mathematics Conference (CanaDAM) will be held at Ryerson University, Toronto, from 12 to 15 June.

One of the responsibilities of the

CMS Student Committee is the annual Canadian Undergraduate Mathematics Congress (CUMC). The 2017 CUMC will take place in Montreal from 19 to 23 July.

The Society's two flagship research republications — the Canadian Journal of Mathematics and the Canadian Mathematical Bulletin — continue to publish top research articles with an enviable reputation for high quality, on-time publication. The Society's educational journal — CRUX — provides a wealth of material for an international audience of problemsolvers, particularly at the Olympiad level.

The Canadian Open Mathematics Challenge (COMC) is written in November, with almost 7,000 high school students competing. The top students are invited to participate in the Canadian Mathematical Olympiad (CMO) the following March. Performances at the CMO and other competitions are used to select six high school students to represent Canada at the International Mathematical Olympiad in July.

In 2017, Math Team Canada will be training at Casa Matemática Oaxaco (Mexico) with members of the Mexican team before continuing to the 58th annual IMO in Brazil. This initiative includes support and cooperation from the Banff International Research Station (BIRS).

In 2017, the CMS Math Camps, which are hosted at various universities across Canada, will feature over 20 regional, national and specialty camps, with over

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Math Team Canada training in Banff

1,000 students and volunteers involved. For many years, the revenues generated by the Society's publications have enabled the CMS to undertake other activities, particularly those with an educational focus. Many societies are facing decreases in publications revenues, hence, the past model is not sustainable going forward.

The CMS has undertaken a significant fundraising campaign to support and possibly widen the scope of its current activities.

The Society values the longtime reciprocal relationship with the London Mathematical Society (LMS). CMS membership is available to members of the LMS at a 50% discount. Membership in the CMS provides numerous benefits including discounts on meeting registration fees and subscription and publication rates.

Further information is available on the CMS website (cms.math.ca).

Dr Graham Wright CMS Executive Secretary exec-secretary@cms.math.ca



Public lecture

### **GENDER DIVERSITY IN MATHEMATICS**

#### Report

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The University of St Andrews Department of Mathematics and Undergraduate Maths Society held a Gender Diversity in Mathematics Event on Wednesday 19 April 2017. The goal of the event was to start a discussion on what we as a larger community can do to support women and gender minorities in maths. We welcomed two external speakers. Eugénie Hunsicker (University of Loughborough and Chair of London Mathematical Society's Women in Mathematics Committee) and Jay MacKenzie (University of Glasgow and member of TransPride Scotland). We also had a panel discussion with the two speakers, Michail Papthomas (University of St Andrews and Chair of the department's Equality and Diversity Committee) and Andrew Mitchell (University of St Andrews and School President-elect). There were about 30 people in attendance including three members of staff, several graduate students, and a number of undergraduates.

diversity, we quickly found that many of the issues that were being discussed applied to a wider class of people and that there were many steps that could be taken to make our St Andrews mathematical community more open to everyone.

The issue of confidence and Impostor Syndrome took up the majority of our discussion. While these are primarily associated with women, almost everyone in the room had experienced it. It was suggested that a social space for students and lecturers would allow students to be more comfortable with each other and see that everyone struggles with mathematics in some regard. Other suggestions included a specific social activity for people with social anxiety or ASD and the introduction of gender-neutral toilets as a mark of commitment to the trans community.

The event received LMS funding for Undergraduate Mathematical Society Meetings.

Isabella Scott School President of Maths & Stats



While the event was ostensibly about gender

Panel members (I to r) Michail Papathomas, Jay Mackenzie, Isabella Scott, Eugenie Hunsicker and Andrew Mitchelland



Panel discussion underway



Meeting the speakers



Invited speaker Jay Mackenzie

### MATHEMATICS SOCIETY AT THE UNIVERSITY OF CENTRAL LANCASHIRE

#### Report

The Mathematics Society at the University of Central Lancashire (UCLan) hosted its second seminar on the 7 March 2017. The seminar, presented by Dr Jessica Banks from the University of Hull, was titled *Euclidean*, *spherical and hyperbolic geometry with a brief diversion to knot theory*.

The seminar was thoroughly engaging providing connections with astrophysical sciences. Dr Banks demonstrated the different geometries through an application which showed a game of pool on different surfaces. We then considered some questions in classical knot theory, particularly William Thurston's theorem whereby every knot is either a torus knot, satellite knot or hyperbolic. The seminar concluded with a question and answer session where Dr Banks provided a great depth of understanding into geometry.

The seminar was well received, with over 55 participants from various areas of research in the university: mathematics, physics, computing and engineering. It was a mutual feeling that the



Society Board members (I to r) Davinder Dhillion, Amy Cottom, Rimsha Tariq and Curtis Greer with Jessica Banks

content started with simple ideas and theories and progressed into more depth but still making it thoroughly understandable. We thank Dr Banks for such an interesting insight into her research.

The seminar received LMS funding for Undergraduate Mathematical Society Meetings.

> Rimsha Tariq Outreach Representative UCLan Mathematics Society

### **RECORDS OF PROCEEDINGS AT LMS MEETINGS** ORDINARY MEETING, 3 APRIL 2017

held at the University of Durham, during the 69th British Mathematical Colloquium (BMC). Over 50 members and visitors were present for all or part of the meeting.

The meeting began at 3.45 pm with The President, Professor Simon Tavaré FRS, FMedSci, in the Chair.

The Programme Secretary, Professor Iain Stewart, presented a report on the Society's activities.

Fifty nine members were elected to membership.

Nine members signed the book and were admitted to the Society.

Professor Tavaré then handed over to Dr Djoko Wirosoetisno who introduced a plenary lecture given by Professor Isabelle Gallagher (Université Paris-Diderot) titled *From particle systems to fluid mechanics*.

The Chair expressed the thanks of the Society to the speaker for giving a fascinating lecture.

The Chair thanked Andrew Lobb and Alexander Stasinski for organising a successful BMC.

# **Reading**



## **MS Prospects in Mathematics Worksholl**

### 7-8 September 2017

Department of Mathematics&Statistics, University of Reading, Whiteknights, PO Box 220, Reading RG6 6AX

#### All Finalists Maths Undergraduates, who are considering applying for a Maths PhD in 2018, are invited to attend the 2017 LMS Prospects in Mathematics Workshop

http://TinyURL.com/PIM-Reading

The meeting will feature a range of speakers from a wide range of mathematical fields across the UK who will discuss their current research and what opportunities are available to you:

Ginestra Bianconi (QMUL) Networks Thomas Forster (Cambridge) Logic and set theory Ben Green (Oxford) Arithmetic combinatorics Jon Keating (Bristol) Random matrix theory Valerio Lucarini (Reading) Dynamical systems Marco Marletta (Cardif) Analysis Beatrice Pelloni (Heriot-Watt) PDEs Sarah Rees (Newcastle) Group theory Jennifer Ryan (UEA) Numerical analysis Samir Siksek (Warwick) Number theory Richard Thomas (Imperial College) Algebraic geometry Amanda Turner (Lancaster) Probability

50 places are available, including overnight accommodation and some funding towards travel costs.

#### Travel costs sponsored by



To apply: Please apply on <a href="https://tinyurl.com/lmsprospects17">https://tinyurl.com/lmsprospects17</a> with evidence of your predicted degree classification. Application deadline is 01/06/2017. (Late application will be considered at the organisers' discretion).

The London Mathematical Society is the UK's learned society for mathematics. Founded in 1865 for the promotion and extension of mathematical knowledge, the Society has a membership of over 2500 drawn from all parts of the UK and overseas. Its principal activities are the organisation of meetings and conferences, publication of journals and books, provision of financial support for mathematical activities, and contribution to public debates on issues related to mathematics, research and education. London Mathematical Society, De Morgan House, 57-58 Russell Square, London WC1B 4H5. Tel +44 (0)20 7637 3686; Fax: +44 (0)20 7323 3655; Fmail: Ime@Ims.ac.uk; Weik: www.lins.ac.uk; Registered chamty no. 25260



### LMS Midlands Regional Meeting and Workshop Modern Geometry and Physics

18 September 2017 Loughborough University

The LMS Midlands Regional Meeting will take place at Loughborough University on Monday 18 September 2017.

The speakers are:

- Giovanni Felder (ETH, Zurich)
- Nigel Hitchin (Oxford)
- Nikita Nekrasov (Simons Center, Stony Brook)

The meeting will be followed by a three-day workshop on *Modern Geometry and Physics*, 19-21 September. The speakers include Barbara Bolognese (Sheffield), Andrea Brini (Imperial), Leonid Chekhov (Moscow), Domenico Fiorenza (Rome), Boris Dubrovin (Trieste), Vladimir Fock (Strasbourg), Lotte Hollands (Heriot-Watt), Marina Logares (Plymouth) and Elisa Postinghel (Loughborough).

Funds may be available to support the attendance of the UK research students.

Enquiries should be addressed to the organisers: H.Ahmadinezhad (H.Ahmadinezhad@lboro.ac.uk) and A.P. Veselov (A.P.Veselov@lboro.ac.uk)





### LMS-IMA Joint Meeting Symmetry and Computation

12 October 2017, 11am – 5pm De Morgan House, Russell Square, London



Speakers (I to r): Evelyne Hubert (INRIA Méditerranée), Kurusch Ebrahimi-Fard (Trondheim), Peter Neumann (Oxford), Gloria Marí Beffa (U Wisconsin-Madison), Darryl Holm (Imperial)

The first joint meeting of the **Institute of Mathematics and its Applications** and the **London Mathematical Society** will take place on October 12, 2017, at De Morgan House, Russell Square, London.

Organisers: Elizabeth Mansfield, Arieh Iserles, Evelyne Hubert and Peter Hydon.

The meeting will be followed by a reception. Keep the date!

See more information and register for the meeting at: https://www.lms.ac.uk/civicrm/event/info?reset=1&id=11

Background image: Objects by Matilda Leake

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### Rothesay Life Summer Internship For Maths & Computer Science 2017 Graduates

Rothesay Life has places on its short 2017 Summer Internship for talented mathematics and computer science students which could lead to a permanent role as a quantitative analyst.

#### About Quant Analyst Roles at Rothesay

In our daily work, we work closely with our traders and structuring team, analysing pension fund buyout trades and investment opportunities. We provide a comprehensive set of risk reports and pricing tools for the team, and are an integral part of the risk management of Rothesay Life. In general, we are looking for smart, quantitative, problem-solving-oriented, "get-things-done" candidates who have proven motivation and achievement in applying mathematics and programming in finance.

#### What you will do

Based in The Leadenhall Building in London, our Quant Summer internship will run for 2 weeks from Monday 31<sup>st</sup> July until Friday 11<sup>th</sup> August 2017. The programme is high in intensity and will require you to undertake challenging project work, that will extend your skills, give you direct access to the high calibre multi-disciplined Rothesay team including our risk modelling team and our quantitative analyst team to gain insight into their work and how they support our front office activities.

#### What we are looking for

Shortlisted candidates will:

- Hold or expect to achieve a 1st class degree from a leading university in a relevant highly numerical degree, ideally in mathematics, computer science or related scientific area.
- Have evidence of achieving academic excellence in mathematics and probability applied to the financial services sector.
- Have relevant work experience in financial services using quantitative analysis and programming skills (Python, Java, C, C++ or other major language).
- Be fluent in English so that you can demonstrate excellent verbal and written communication skills for sharing and explaining your work to others.
- Be able to demonstrate commitment and enthusiasm for working in a quantitative team.
- Be available for permanent work within 2 months of your graduation in 2017.

#### What we are offering

- We will pay you £200 per day (£2,000 in total for the internship).
- All travel and accommodation expenses if required will be covered by the Company if you are not London-based.
- By successfully completing this internship, you will have the chance to secure a permanent graduate role with Rothesay Life, starting after your graduation in 2017. Our starting salary package for the permanent role is very competitive. This year, we are looking to offer 2-4 graduate roles.

#### How to apply

You will need a 1 page CV and a 1 page cover letter (PDF format) that states in 300 words or less, why you want to work for Rothesay Life, why we should consider you and why you believe the match between yourself and our Company is a good one.

Applications will be accepted until Friday 30<sup>th</sup> June 2017. Telephone interviews and office interviews will be held in May and June.

Please apply via this link ensuring your documents are in PDF format: http://www.rothesaylife.com/careers/opportunities Meetings

### MATHEMATICAL MODELS IN ECOLOGY AND EVOLUTION

Registration is now open for the Mathematical Models in Ecology and Evolution conference. Taking place at City, University of London from 10 to 12 July 2017, the conference will combine a series of talks, posters and mini symposia discussing the importance of mathematical modelling and the latest developments in the field. Keynote speakers are:

- Nick Chater (University of Warwick)
- Caroline Colijn (Imperial College London)
- Iain Couzin (University of Konstanz)
- Ross Cressman (Wilfrid Laurier University)
- Hanna Kokko (University of Zurich)
- Nuala Sheehan (University of Leicester)
- For conference details and to book your place, visit the website at https://www. city.ac.uk/MMEE2017. This conference is supported by an LMS Conference grant.

### INTERACTIONS OF SYMPLECTIC AND ALGEBRAIC GEOMETRY

A workshop on Interactions of Symplectic and Algebraic Geometry will be held at the University of Warwick from 1 to 4 August 2017. It is intended to gather experts from both algebraic and symplectic geometries to broaden and deepen the interactions of these two subjects. It will provide a forum for discussions on recent developments and outstanding open problems. The speakers contain leading experts and young researchers. Details about the workshop can be found at http://tinyurl.com/lwcmryc.

Funds are available to UK academics for accommodation and travel. If you are interested in attending this event, please register at the above webpage. The meeting is supported by EPSRC and an LMS Conference grant.

### ORTHOGONAL POLYNOMIALS, SPECIAL FUNCTIONS AND APPLICATIONS

The 14th International Symposium on *Orthogonal Polynomials, Special Functions and Applications* (OPSFA14) will take place from 3 to 7 July 2017 at the University of Kent, Canterbury. The conference is the first one in the OPSFA series to take place in the UK. The symposium will take place in the Sibson Building at the University of Kent, which is the new home of the School of Mathematics, Statistics & Actuarial Science, opened in March 2017. The following have agreed to give plenary lectures:

- Jonathan Breuer (Hebrew University)
- Sylvie Corteel (CNRS, Paris)
- David Gomez-Ullate (Universidad Complutense de Madrid)
- Evelyne Hubert (INRIA, Sophia Antipolis)
- Arieh Iserles (University of Cambridge)
- Alexander Its (Indiana University-Purdue University, Indianapolis)
- Arno Kuijlaars (KU Leuven)
- Marta Mazzocco (Loughborough University)
- Peter Miller (University of Michigan)
- Margit Roesler (University of Paderborn)
- Nina Snaith (University of Bristol)
- Jacek Szmigielski (University of Saskatchewan, Saskatoon)
- Thomas Trogdon (University of California, Irvine) - Gábor Szegö prize winner 2017

This symposium is an event of the SIAM Activity Group on Orthogonal Polynomials and Special Functions. The activity group promotes research in orthogonal polynomials and special functions; furthers the application of this subject in other parts of mathematics, and in science and industry; and encourages and supports the exchange of information, ideas, and techniques between workers in this field and other mathematicians and scientists. The activity group awards the Gábor Szegö Prize every two years to an early-career researcher for outstanding research contribu-

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tions in the area of orthogonal polynomials and special functions.

The main organisers of OPSFA14 are Peter Clarkson and Ana Loureiro (University of Kent). For more information see https://blogs. kent.ac.uk/opsfa. The symposium is supported by an LMS Conference grant.

### MATHEMATICAL FOUNDATIONS IN BIOINFORMATICS

The students of the Algorithms & Bioinformatics group at King's College London invite research students to submit abstracts to present their work at the second International Student Conference on Mathematical Foundations in Bioinformatics, which will take place on 14 September 2017 at King's College London.

MatBio is a student-conference intending to cover the wide spectrum of mathematical/ computational foundations in Bioinformatics. The conference aims at encouraging excellent research by attracting contribution to string and graph algorithms for handling various problems arising in Bioinformatics. Following the conference, selected abstracts will be invited to submit full papers to a special issue of a journal. Each session of this one-day conference will feature an invited talk followed by oral presentations by students. Breaks will provide the opportunity to network and lunch will be hosted in a local restaurant. Students will be awarded for exceptional presentations.

Deadlines: Abstract submission: 14 July; travel support application: 25 July; registration: 15 August 2017.

Travel support can be provided upon acceptance of a successful application. Apply using the form at bit.ly/MatBio-travel-support. Registration is free. For further information and to register visit the website at Matbio 2017.

The conference is supported by an LMS Postgraduate Research Conference grant (Scheme 8) and the Department of Informatics at King's College London.

### **EPIDEMIC MODELLING**

A two-day meeting on Stochastic Epidemic Models with Structured Populations: Development, Analysis and Inference will be held at the University of Nottingham from 6 to 7 July 2017. The aim is to address model development and analysis and statistical inference in the context of epidemic models with structured populations; with the more mathematical/probabilistic approach of many anticipated participants being complemented by contributions from more applied researchers and those with a background in other fields such as statistical physics. Confirmed speakers include Matt Keeling, Julia Gog, Joshua Ross, Andrew Black, Frank Ball, Phil O'Neill and Theo Kypraios.

More information is available at www. maths.nottingham.ac.uk/personal/pmzdjs/ epidemicMeeting.html. Funds are available to support UK-based research students attending the meeting. The meeting is supported by an LMS Conference grant, the University of Adelaide and the University of Nottingham.

### **GREENWICH MATHS TIME**

The University of Greenwich, Department of Mathematical Sciences is hosting the IMA *Festival of Mathematics and its Applications* on Tuesday 27 and Wednesday 28 June 2017. This Festival presents two days of outstanding mathematics talks, workshops and activities for the general public. Most of the events are suitable for school and college students of year 10 and above. There is an evening talk on Tuesday 27 June by Dr Jennifer Rogers (University of Oxford), titled Yeah, but is it significant?

Further details and booking information can be found on the Festival website at www.gre. ac.uk/mathsfestival. The Festival is grateful for financial support from the Institute of Mathematics and its Applications, the University of Greenwich, the OR Society, the Further Mathematics Support Programme, the London South East Maths Hub, the Kent and Medway Maths Hub and FDM.

### TEACHERS' CONFERENCE IN MATHEMATICS 2017

The Department of Mathematics, King's College London, will be hosting the 2017 *Teachers' Conference in Mathematics* on 20 June 2017. Every year the Department of Mathematics organises a conference which aims to inform teachers of developments in mathematics, to widen participation and

strengthen connections between schools and university. The three speakers are:

- Peter Sollich (KCL) Applied Mathematics
- Guiseppte Tinaglia KCL) Pure Mathematics
- Martin Greenhow (Brunel) Maths Education

For further information and to register for the event visit the website at http://tinyurl. com/mem3hqn.

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### **ICE-FLUID INTERACTION**

2 – 6 October 2017

in association with the Isaac Newton Institute programme *Mathematics of Sea Ice Phenomena* (21 August – 20 December 2017)

Ice-fluid interaction will, first and foremost, serve as a focal point for international collaboration between polar scientists and practitioners. It will target the polar research community especially mathematicians, physicists, engineers and experimentalists, to provide an opportunity to share knowledge about the science of the polar zones that relate primarily, in this case, to the countless interactions that occur between sea-ice and the underlying ocean. It is intended that other floating ice types, e.g. lake ice and river ice, and glacial ice will also form part of the discussions, where fluid interactions and exchanges are present. The central aim is to identify key science questions that must be addressed by theoretical and experimental programmes in order to advance our understanding of ice processes.

The topics of the workshop are divided into the following sessions: mathematical models of the effects of physical and geophysical phenomena on the behaviour of sea ice, including those that express how ocean waves and swell propagate in ice fields and can alter its morphology; theories of linear and nonlinear hydroelastic waves, especially applied to floating ice; topics that relate to sea ice heterogeneity, e.g. electromagnetic, acoustic and ocean wave scattering; modelling the dynamics of fields of sea ice; ice growth and ablation, including phase transitions and sea ice as a mushy layer; the formation of sea ice morphology and melt ponds; sea ice constitutive equations and the relationship between internal ice forces and the deformation of ice covers; granular flow and discrete element models of sea ice; and other ice types, including glacial ice and river ice.

Further information available from the website www.newton.ac.uk/event/sipw02 Closing date for receipt of applications 2 July 2017

### **FPSAC 2017**

Formal Power Series and Algebraic Combinatorics

### July 9 - 13, 2017

#### Queen Mary University of London

The 29th International Conference on Formal Power Series and Algebraic Combinatorics (FPSAC) will be hosted by Queen Mary University of London.

Topics include all aspects of combinatorics and their relation to other parts of mathematics, physics, computer science, chemistry and biology. The conference will include invited lectures, contributed presentations, and poster sessions.

The official languages of the conference are English and French.

Invited Speakers:

- Drew Armstrong (University of Miami, USA)
- Soojin Cho (Ajou University, Seoul, South Korea)
- Luc Lapointe (Instituto Matematica y Fisica, Talca, Chile)
- Greta Panova (University of Pennsylvania, USA)
- Dan Romik (UC Davis, USA)
- Colva Roney-Dougal (University of St. Andrews, UK)
- Gordon Slade (University of British Columbia, Canada)
- David Speyer (University of Michigan, USA)
- Kristina Vušković (University of Leeds, UK)

The conference will start with a welcome reception on the evening of July 8. Each morning and afternoon session will start with an invited talk, followed by three contributed talks. There will be two poster sessions on Sunday and Monday afternoon. A conference dinner will be held on Wednesday evening.

Organised in partnership with the Clay Mathematics Institute, The National Science Foundation, and Queen Mary University of London.







For further information and to register: https://sites.google.com/site/fpsac2017/home





### Introduction to Geometry, Dynamics, and Moduli in Low Dimensions

### LMS-CMI Research School

Warwick 11 – 15 September 2017

Organisers: J. Aramayona (Madrid), S. Schleimer (Warwick), J. Smillie (Warwick)

#### Course outline

The Research School will offer a broad introduction to low-dimensional geometry, topology, and dynamics. Experts in the field will each deliver a mini-course devoted to a particular sub-area. The mini-courses will be accompanied by problem sessions, supervised by tutors. The School is the opening event of the EPSRC-Warwick Symposium "Geometry, dynamics, and moduli in low dimensions" to be held at Warwick during the academic year 2017-18. Participants of the School are also invited to apply to the other workshops of the symposium.

#### Lecture Courses

Yael Algom-Kfir (Haifa) Free groups as fundamental groups of graphs Tara Brendle (Glasgow) Description of Teichmüller space in terms of hyperbolic geometry Nathan Dunfield (UIUC) Methods for computation of geometric structures and invariants Erwann Lanneau (Grenoble) Teichmüller dynamics

Julien Marché (Paris VI) Geometric structures viewed in terms of representations

These lecture courses will be supplemented by tutorial sessions.

For further information, please visit: www2.warwick.ac.uk/fac/sci/maths/research/events/2017-18/ symposium/igdm/

Apply online (https://tinyurl.com/gwgv8lr) by 16 June 2017. Research students, post-docs and those working in industry are invited to apply. A reference is also required: https://tinyurl.com/ jcmgffk

\*All applicants will be contacted within three weeks after the deadline; information about individual applications will not be available before then.\*

#### <u>Fees</u>

Research students: £150. There will be no charge for accommodation and subsistence costs.

Early career researchers: £250. There will be no charge for accommodation and subsistence costs. Other participants (e.g. those working in industry): £250

Research students who have not completed their PhDs by the start of the Research School and who would otherwise be unable to attend can apply for financial aid.

Fees are not payable until a place at the Research School is offered but will be due by 11 August 2017.





### Algebraic Topology of Manifolds LMS-CMI Research School

Oxford

### 11 - 15 September 2017

Organiser: Ulrike Tillmann (Oxford)

Manifolds are at the centre of much of geometry and topology, and through the influence of axiomatic topological quantum field theory they have become an important organising force in category and representation theory.

Classically, in the 1960s, algebraic topology was at the heart of their classification theory in form of characteristic classes and numbers, cobordism theory, surgery theory, and later Waldhausen's K-theory of manifolds. We are now experiencing a renaissance of the field as well as a paradigm shift where manifolds not only are the objects of study but become the tools. The school aims at inspiring the next generation with this exciting success story of interwoven

ideas bouncing between different fields, and giving the participants the tools to contribute to this lively research area.

### Lecture Courses

Dan Freed (Austin, USA) Topological Quantum Field Theory Oscar Randall-Williams (Cambridge, UK)

Characteristic classes & moduli spaces of manifolds

Greg Arone (Virginia, USA)

The Goodwillie–Weiss embedding calculus

Nathalie Wahl (Copenhagen, Denmark)

Homological stability

These lecture courses will be supplemented by tutorial sessions. In addition there will be guest lectures.

For further information, please visit: https://people.maths.ox.ac.uk/tillmann/ATM-SCHOOL.html

**Apply online** (www.surveymonkey.co.uk/r/RS33-ATManifoldsApplicationForm) by **16 June 2017**. Research students, post-docs and those working in industry are invited to apply. \*All applicants will be contacted within three weeks after the deadline; information about individual applications will not be available before then\*

#### **Fees**

Research students: **£150**. There will be no charge for subsistence costs. Early career researchers: **£250**. There will be no charge for subsistence costs. Other participants: **£250** plus subsistence costs.

Research students who will not have completed their PhDs by the start of the Research School and who would otherwise be unable to attend can apply for financial aid to cover their travel costs. Fees are not payable until a place at the Research School is offered but will be due by 21 July 2017.

#### THE BEAUTY OF NUMBERS IN NATURE

by Ian Stewart, Ivy Press, 2017, paperback, pp 224, £14.99, ISBN 978-1782404712.



lan Stewart packs a huge amount into this book. Symmetry, tiling, packing, pattern formation in biology, animal gait, fractals, chaos and gravity are all covered in a bright and chatty 'popular mathematics' format, profusely

illustrated in full colour.

The book begins with a question: 'What shape is a snowflake?' This forms a (slightly contrived) springboard to discuss a wide range of mathematics and its applications, with the issue of snowflakes recurring a few times throughout the text before the question being finally addressed fully in the last few pages of the book.

The issue of snowflakes brings me to the something which is not at all clearly pointed out anywhere in the volume: This is not a new book. Rather, it is a republication of Ian Stewart's 2001 book What Shape is a Snowflake? From a casual comparison between the 2001 volume and this book, a few of the facts have been updated, some extra material has been placed in the Further Reading section and various images changed, but there are no significant changes to the text. At one level that is fair enough - it is book that has been out of print, and if anything the new title suits the content better - however, I would have preferred the matter to have been clearly stated by the publisher. I assume that this reprinting is also responsible for the small number of typographical and image errors which are present.

That gripe aside, this is a good popular mathematics book. Despite its division into three major parts and 16 chapters, it is in fact a book which can be opened almost at random. Most sub-sections of the book are fitted onto a double-page spread and Stewart has the wellhoned skill of taking a single idea and explaining it in a short, self-contained way. This, along with the glossy format and large number of illustrations, makes it ideal for the sort of school pupil who, while interested in mathematics and science, is underwhelmed by the prospect of reading a whole book on the matter. If she simply opens this book anywhere and starts reading, then pretty soon she will come across a juicy tidbit to encourage her to delve further.

Thus, while describing packing problems on page 80, Stewart comments in passing on arranging circles in a square box. For 25 and 36 circles the answer is, as one might expect, a 5x5 and 6x6 square array. But, he states, 'there are better ways to pack 49 circles into a square than the 7x7 array'. My immediate response to reading that statement was to wonder if I could find 49 pennies around the house to experiment with.

Stewart also scatters interesting facts liberally across the book. So, for example (page 50), if you have inhaled something and it gets stuck in your lung, the odds are it will be your right lung – as it is slightly larger, as is its primary bronchus. Further, 1 in 8,500 people has situs inversus, where the internal organs are in mirror image positions to the norm, but perhaps surprisingly such a person is no more likely to be left-handed. On page 121 Stewart notes that mathematicians have shown how to construct drums of different shapes which produce exactly the same sound. Or did you know (page 137) that when moving at high speeds centipedes may have times when only 3 out of its 40 or so legs are touching the around?

All-in-all this is a very good book. It is clearly written, visually appealing, and given the full colour format, competitively priced. Secondary schools should have a copy in their libraries and members of the LMS should be buying copies for their teenage children, or in the event that they don't have teenage children, somebody else's. I would gallantly

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offer to subsidise the cost of such purchases myself, but as noted above, I'm struggling to find 49p to enable me perform some important investigations in circle packing. Mark McCartney University of Ulster

#### TURING'S VISION: THE BIRTH OF COMPUTER SCIENCE

by Chris Bernhardt, MIT, 2017, paperback, pp 208, £14.95, ISBN 978-0262533515.

If you are looking for a biographical story book about Turing, this is not the book for you. If, however, you want a brief canter (or perhaps that should be Cantor) through Turing's 1936 paper "On Computable Numbers" and an excellent descrip-

tive narrative of the associated mathematics which underpins it, then you need to read this book.

It is wonderful to start a book with the casual mention of the murder of Hippasus associated with proving a theorem – it makes you think! We are led rapidly from those early foundations of mathematics in the fifth century BC through Boole to Hilbert who outlined the program of work that bears his name and the "decision procedure" which motivated Turing's work.

I must confess that I am more of a computer geek than mathematician and, when I studied, I would have welcomed the opportunity to digest pure mathematics with pages of equations and a few expressive words. By illustrating the chronicle of Turing's work with words alongside the relevant equations the book strikes just the right balance whilst remaining rigorous. No holds are barred in tackling the building blocks needed to get to Turing's paper. We are guided through the halting problem, lambda calculus and the pigeonhole principle with enough detail to understand their significance. The chapter on Turing Machines is where we start realising the genius of what he achieved in Cambridge in the mid 1930s. Looking back, you really have to pinch yourself to comprehend that what was being conceived predated the computers of today. He provided a beautiful and powerful abstraction.

When describing the theory and practice behind different types of "computer", it is no surprise to see Charles Babbage and Ada Lovelace feature in the narrative of the book with the first mechanical calculator. I was then delighted to see that brought right up to date with the references to more recent proofs concerning cellular automata.

Russell's Barber and Cantor's diagonal argument are treated with respect and reverence in the service of getting us over the line to how Turing proved finally that Hilbert's view of the Entscheidungsproblem was not correct. Though do be prepared for a little mind, or Hilbert Hotel, expansion if "how big are infinities" is not your specialised topic!

In the final chapter, the story is brought up to date without any mathematics. It covers not only Turing's work through the war years but also the apology and subsequent pardon in 2013. Today in the UK we also now have the Alan Turing Institute as a fitting legacy to what our hero of the book started.

As the author concludes "The paper now stands as the foundation of theoretical computer science". I will conclude by saying that Chris Bernhardt's book now stands as a solid foundation to understand Turing's seminal 1936 paper.

> Simon Cox Computational Studies, Electronics and Computer Science University of Southampton



#### WEAPONS OF MATH DESTRUCTION

by Cathy O'Neil, Allen Lane, 2016, pp 272, £12.99, ISBN 978-0241296813.

Author Cathy O'Neil's tale about the dark side of Big Data makes a compelling case for the looming dangers of modern largescale mathematical models and machine learning algorithms, which are increasingly pervasive in many aspects of our lives. She coins the term 'Weapons of Math Destruction' (WMDs) for the ability of such models

and algorithms to do real damage to individuals and society when misused. Although flawed data modelling and analysis is not new, and many data scientists are aware of the dangers of using predictive algorithms without a solid statistical basis, O'Neil highlights the spread and scale of modern tools and theretheir fore potential to do harm to an unprecedented level. The majority of the book is dedicated to examples of, and stories around, WMDs in areas such as hiring, financial credit

scoring, insurance, online advertising, or crime prediction. Her well-documented and informed account is filled with real stories of people who has suffered the consequences of blindly trusting flawed models in real-life decision making.

O'Neil illustrates common characteristics of WMDs, such as a lack of transparency or accountability (to the point that "Many companies [...] hide the results of their models or even their existence"), their self-reinforcing nature, or the use of inexact or unreliable proxies. Sometimes they are based on simplistic models which "sacrifice accuracy and insight for efficiency", and, like humans, have a potential

WEAPONS OF MATH DESTRUCTION

for embedded discrimination and unfairness. The chapter on university rankings is particularly insightful, and I wished a copy would find its way to Minister of State for Universities, Science, Research and Innovation, Jo Johnson's desk.

The author is in a unique position to tell this cautionary tale. With a Harvard PhD

> and a postdoc at MIT in algebraic geometry, she left a position at Barnard College in 2007 to work in a hedge fund and had a "first row seat" to the 2008 financial crisis. After leaving finance in 2011. started working she as a data scientist and writes the MathBabe bloa which. among other things, spreads the word about WMDs.

Beyond the lack of a solid scientific basis (to the point of comparing the situation to 19th century phrenology "that relied on pseudoscientific nonsense to

make authoritative pronouncements, and for decades went untested"), the author's main concerns are the moral and ethical issues in an era of ever more powerful predictive models, with examples in predatory advertising, or targeting and influencing voters through social media. She reminds us that "models are moral" as they are "opinions embedded in mathematics".

There is hope in this book too. First, that we may be experiencing a transitional period and will find ways to control these newly found predictive 'weapons'. The author does not trust the free market to adjust itself but instead sees the need of government regulation and legislation.

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From her account it transpires that more stringent requirements are needed not only to the collection but to use of data, including complex mathematical models, and legislation should be introduced to ensure transparency and prevent misuse, such as unfair discrimination. For example, independent auditors could be required to certify models and algorithms in important decision-making situations, from mortgage applications to job evaluations. Secondly, the author points out that many WMDs can be adapted to help society by simply changing their objectives, "mathematical models can sift through data to locate people who are likely to face great challenges [...] It's up to society whether to use that intelligence to reject and punish them or to reach out to them with the resources they need".

Although a very timely read, I must admit I found the exposition slightly repetitive and somehow lacking the coherent structure

#### and narrative expected in a book rather than in, say, a blog entry. That made my job as a reviewer a bit more difficult than expected, both in managing to finish the book, and to make sense of my notes. I am also not a big fan of the overall controversial and, at points, apocalyptic tone, and somewhat disappointed that most examples and stories were US-centric.

Overall, in an era of ever more powerful predictive tools, O'Neil's account is a very lucid and timely cautionary tale, which successfully raises awareness about the dark side of Big Data, and puts the spot on mathematicians working on data science and the ethical issues they face, and also on policymakers and the need of regulation. If we 'tame' WMDs, they will be remembered as "relics of early days". If not, O'Neil reckons, "our livelihoods increasingly depend on our ability to make our case to machines".

> Ruben Sanchez-Garcia University of Southampton



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### MULTI-SCALE MODELLING OF ICE CHARACTERISTICS AND BEHAVIOUR

11 – 15 September 2017

in association with the Isaac Newton Institute programme *Mathematics of Sea Ice Phenomena* (21 August – 20 December 2017)

Realistic models of Earth's climate system are essential to making projections about what we may experience as our climate changes. Polar sea ice forms a critical system component which must be accurately accounted for in global climate models. It forms the thin boundary layer coupling the polar oceans and atmosphere, and has seen rather dramatic changes over the past two or three decades. A fascinating and important feature of sea ice is that it displays rich structure and behaviour on scales ranging over 10 orders of magnitude: length scales from microns to hundreds of kilometres, and time scales from milliseconds to decades. This broad range of scales for sea ice structure and properties is relevant to biological, chemical, industrial, weather, as well as climate–related processes. It also leads to sea ice structure at certain scales being similar to other materials such as porous human bone and polycrystalline metals, which can be used to bring new techniques to studying sea ice, and vice versa.

Complex behaviour of sea ice over such a large range of scales presents, however, a fundamental challenge to modelling these systems. For example, many key processes whose relevant length scales may be centimetres or meters to kilometres, impact climate, and must be incorporated into large–scale numerical climate models with grid sizes often on the order of tens of kilometres. Mathematical methods which rigorously account for these smaller scale processes, and enable computation and analysis of their effective behaviour on larger scales relevant for coarse–grained climate models will be a focus of the workshop, and linkage of scales one of its central themes. Moreover, some sea ice properties exhibit scale invariance or predictable scale dependence, while others appear to be wholly emergent, a consequence of interacting processes within and applied to the ice cover. This workshop will address sea ice processes across a wide range of length and time scales, with an emphasis on understanding emergent and scale–invariant phenomena.

Further information available from the website www.newton.ac.uk/event/sipw01

Closing date for receipt of applications 11 June 2017

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### **CALENDAR OF EVENTS**

This calendar lists Society meetings and other mathematical events. Further information may be obtained from the appropriate LMS Newsletter whose number is given in brackets. A fuller list is given on the Society's website (www.lms.ac.uk/ content/calendar). Please send updates and corrections to calendar@lms.ac.uk.

#### **JUNE 2017**

1 LMS Northern Regional Meeting, York (469) 1 Combinatorial Techniques in Analysis and Probability, Lancaster (469) 1 Compressive Sensing Workshop, Bath (469) 2 Profinite Groups, Lincoln (468) 2–3 Integrable Models, Conformal Field Theory and Related Topics, Leeds (469) 5 London Crypto Day, Royal Holloway (469) 5 Escher and Coxeter: A Mathematical Conversation, Gresham College London (468) 7-9 Bond-Node Structures, Lancaster (469) 8-9 Scottish Partial Differential Equation Colloquium, St Andrews (469) 13–15 Interacting Systems and Stochastic PDEs, Sheffield (468) 15–16 Early Career Topology Researchers in Conference, Sheffield (469) 16 Invariant Theory: Recent Progress and Applications, Middlesex University (469) 19-23 Group Actions and Cohomology In Non-Positive Curvature, INI Cambridge (465) 19–23 New Trends in Representation Theory LMS– CMI Research School, Leicester (467) 19–23 Summer School and Workshop: The Sen Conjecture and Beyond, University College London 20 Teachers' Conference in Mathematics, King's College London (470) 21-23 Recent Advances in the Numerical Analysis of PDEs. Bath (469) 26 Levy Processes and Anomalous Diffusion, Manchester (469) 26–30 Quantum Topology and Categorified Representation Theory, INI Cambridge (465) 26–30 Orthogonal Polynomials and Special Functions LMS Research School, Kent (467) 26-30 Géométrie Algébrique en Liberté, Bath (469) 26-30 Microlocal Analysis and Applications LMS-CMI Research School, Cardiff (468) 27-28 Festival of Mathematics and its Applications, Greenwich (470) 27–30 Postgraduate Group Theory Conference, Cambridge (469)

28 LMS Popular Lectures, Institute for Education, London (470)

29 New Mathematical Methods in Computational Imaging. Heriot-Watt University (469) 30 LMS Graduate Student Meeting, London (470) 30 LMS Society Meeting, London (470)

### **JULY 2017**

3-5 Gravity and Black Holes, Cambridge (468) 3–7 Orthogonal Polynomials, Special Functions and Applications, University of Kent (470) 3–7 Scalable Statistical Inference, INI Cambridge (466) 3-7 BSDEs, SPDEs and their Applications Workshop, Edinburgh 3–7 British Combinatorial Conference, Strathclyde (464) 6–7 Stochastic Epidemic Models with Structured Populations, University of Nottingham (470) 9–13 Formal Power Series and Combinatorics Conference, QMUL (470) 10–11 Boundary Integral Methods, Nottingham Trent University (468) 10–12 Mathematical Models in Ecology and Evolution Conference, City, University of London (470) 10-14 Computer-aided Mathematical Proof, INI Cambridge (466) 10–19 Foundations of Computational Mathematics Conference, Barcelona (461) 17-21 Conference on Applications of Computer Algebra, Jerusalem 31–5 Aug International Mathematics Competition, Blagoevgrad, Bulgaria (466)

### **AUGUST 2017**

1–4 Interactions of Symplectic and Algebraic Geometry, Warwick (470)
1–4 Young Researchers in Mathematics Conference, University of Kent (469)
6–12 Groups St Andrews Conference, Birmingham (469)
7–10 Nonlinear Water Waves, INI Cambridge (468)

### SEPTEMBER 2017

 Christopher Hooley and the Artin Conjecture:
 Years On, Bristol (468)
 4–8 September European Study Groups with Industry, Warwick (468)
 4–8 Variational Methods, New Optimisation Techniques and New Fast Numerical Algorithm, INI Cambridge (468)
 7–8 LMS Prospects in Mathematics Workshop, Reading (470)
 10–15 Mathematics Education for the Future Decade, Balatonfüred, Hungary (460)
 11–15 Algebraic Topology of Manifolds LMS-CMI Research School, Oxford (470)

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