Mathematics Research Report

2017
Foreword

Welcome to the 2017 Mathematics Research Report, which covers the Pure, Applied, History, and Mathematics Education groups in the School of Mathematics and Statistics, in the Faculty of Science, Technology, Engineering and Mathematics, at The Open University. The Statistics group publishes its own annual report series, see http://mathematics.open.ac.uk/research/statistics/annual-reports.

Public engagement and outreach activities have always played a core part of our research-related activities, and this year was no exception. Of particular note in 2017 were the activities of our historians of mathematics: June Barrow-Green continues her busy schedule of invited talks, including public lectures in LSE and here in Milton Keynes when the M500 Revision Weekend came to us in May. No less were the activities of her students: Brigitte Stenhouse joined us as a PhD student in October to look at the mathematics of Mary Somerville, and has already spoken about Somerville in Edinburgh at the Royal Bank of Scotland’s launch of its new £10 note (featuring Somerville), as well as appearing on the BBC’s Antiques Road Trip. Tony Royle, meanwhile, published an article entitled “The heartbreaking story of the flying mathematicians of World War I” in The Conversation, which was subsequently picked up by several outlets, including The Times, and the i newspaper, and it was even translated for use in Brazil. If you haven’t yet read it, it is also now available as a podcast from The Conversation website.

This year we are pleased to welcome two new members of staff in Mathematics Education: Sue Forsythe and Cathy Smith. It has been great to see this group getting reinvigorated, and you will see that a number of our seminars have been given by mathematical education specialists this year.

2017 also saw the School of Mathematics and Statistics develop its social media profile. You can now follow us on Twitter @OUMathsStats, and “like” our Facebook page: https://www.facebook.com/OUMathsStats/.

Robert Brignall (Director of Research)
Membership of Mathematics Groups

**Academic Staff**
- Silvia Barbina, Staff Tutor
- June Barrow-Green, Professor
- Robert Brignall, Senior Lecturer
- Katie Chicot, Senior Lecturer and Staff Tutor
- Sally Crighton, Senior Lecturer and Staff Tutor
- Sue Forsythe, Senior Lecturer
- Martina Gibbons, Staff Tutor
- Gerry Golding, Senior Lecturer and Staff Tutor
- Derek Goldrei, Associate Member
- Uwe Grimm, Head of School
- Robert Hasson, Senior Lecturer
- Hilary Holmes, Senior Lecturer and Staff Tutor
- Chris Hughes, Staff Tutor
- Tim Lowe, Senior Lecturer
- Sarah Mattingly, Senior Lecturer and Staff Tutor
- Angie McConnell, Lecturer
- Ben Mestel, Senior Lecturer
- Toby O'Neil, Senior Lecturer
- Sue Pawley, Staff Tutor
- Marc Pradas, Lecturer
- Brendan Quinn, Senior Lecturer and Staff Tutor
- Kathleen Quinn, Senior Lecturer
- Philip Rippon, Professor
- Katrine Rogers, Staff Tutor
- Hayley Ryder, Staff Tutor
- Ian Short, Senior Lecturer
- Jozef Širáň, Professor
- Cathy Smith, Senior Lecturer
- Gwyneth Stallard, Professor
- Claudi Thomas, Senior Lecturer and Staff Tutor
- Andrey Umerski, Senior Lecturer
- Paul Upton, Lecturer
- Bridget Webb, Senior Lecturer
- Charlotte Webb, Lecturer
- Michael Wilkinson, Professor
- Gareth Williams, Senior Lecturer and Staff Tutor

**Emeritus Professor**
- David Brannan
- Jeremy Gray
- Mike Grannell
- Terry Griggs
- John Mason
- Robin Wilson

**Visiting Research Staff**
- Barbara Allen, Visiting Senior Lecturer
- Michael Baake, Visiting Research Professor
- Mick Bromilow, Visiting Research Fellow
- David Crowe, Visiting Research Fellow
- Graeme Erskine, Visiting Research Fellow
- Tony Forbes, Visiting Research Fellow
- Gerard Hayes, Visiting Research Fellow
- Fred Holroyd, Visiting Research Fellow
- Matthew Jacques, Visiting Research Fellow

**Research students**
- Lax Chan, Full-time
- Ioannis Dourekas, Full-time
- Alex Durie, Part-time
- Michael Ewetola, Full-time
- Valentin Fadeev, Part-time
- James Fraser, Full-time
- John Grant, Part-time
- Olivia Jeans, Part-time
- Robert Lewis, Part-time
- Christopher Lynch, Part-time
- Alison Maidment, Full-time
- David Marchant, Part-time
- Tony Royle, Full-time
- Jakub Sliacan, Full-time
- Margaret Stanier, Part-time
- Brigitte Stenhouse, Full-time
- James Tuite, Part-time
- James Waterman, Full-time

**Admin staff**
- Sally Gallagher, Senior Manager
- Sara Griffin, Secretary
- Tracy Johns, School Office Team Leader
Visitors

Robert Brignall
Prof Nik Ruskuc (University of St Andrews), 15 – 19 May
Dr David Bevan (University of Strathclyde), 28 – 30 November

Terry Griggs
Professor Martin Skoviera (Comenius University, Slovakia) 13 – 15 January
Professor Edita Macajova (Comenius University, Slovakia) 13 – 15 January
Professor Ales Drapal (Charles University, Czech Republic) 6 – 9 February

Uwe Grimm
Professor Michael Baake (University of Bielefeld, Germany), 6 – 9 April and 13 – 20 July

Phil Rippon, and Gwyneth Stallard
Vassiliki Evdoridou (IMPAN, Warsaw), 5 – 8 September
David Marti-Pete (RIMS, Kyoto), 16 – 20 October
Dave Sixsmith (Liverpool), 7 – 8 November

Jožef Širáň
Professor Miguel Angel Fiol (Polytechnic University of Barcelona), 4 – 9 June

Charlotte Webb
Dr Alf Coles (University of Bristol), 7 January
Tom Briggs (Bletchley Park), 30 May
Dr Tom Hunt (University of Derby), 10 October
Dr Dave Hewitt (Loughborough University), 24 October

Visits to other institutions

Robert Brignall
University of St Andrews, January, April and June

Terry Griggs
Comenius University, Bratislava, Slovakia, September

Uwe Grimm
University of Tasmania, Hobart, Australia, February/March
University of Bielefeld, Germany, June/July

Ian Short
Newcastle University, December

Jožef Širáň
University of Auckland, New Zealand, February

Cathy Smith
University of Witwatersrand, November
University College London, London Knowledge Lab, December

Margaret Stanier
Southampton University, November

Charlotte Webb
Bristol University, School of Education, January
Loughborough University, Mathematics Education Centre, May
Research degrees awarded

Grahame Erskine, Ph.D., for his thesis *Diameter, girth and other properties of highly symmetric graphs.* Supervisor: Jozef Siran.


Grants awarded

Tim Lowe, Collaborative award for teaching excellence, £15,000, Higher Education Academy

Gwyneth Stallard (PI), Phil Rippon (CI) Classifying wandering domains, £390,936, EPSRC Responsive Mode

James Tuite, LMS Early Career Research Travel Grant, £500

Charlotte Webb, Girls in Maths grant, £500, London Mathematical Society

Editorial roles

June Barrow-Green
- Historia Mathematica (Editorial Board Member)
- Revue d’histoire des Mathématiques (Editorial Board Member)
- Philosophia Scientiae (Editorial Board Member)
- BSHM Bulletin (Editorial Board Member)
- AMS History of Mathematics series (Editorial Board Member)
- Birkhäuser’s Science Networks. Historical Studies series (Editorial Board Member)
- LMS Newsletter (Editorial Board Member)

Robert Brignall
- Australasian Journal of Combinatorics (Managing Editor)
- Discrete Mathematics and Theoretical Computer Science (Guest Editor for Permutation Patterns 2015)

Toby O’Neil
- Editorial Advisor for London Mathematical Society

Ian Short
- Bulletin of the Irish Mathematical Society (Editorial Board Member)

Jozef Širáň
- Journal of Combinatorial Theory Series B (Editorial Board Member)
- Australasian Journal of Combinatorics (Editorial Board Member)

Cathy Smith
- Research in Mathematics Education (Editorial board member)
- Teaching Mathematics and its Applications (Editor)

Gwyneth Stallard
- Proceedings of the Edinburgh Mathematical Society (Subject Editor)

Charlotte Webb
- Science of Education publication for ATM (Editorial team member)
Publications


Publications, continued


**Lewis, Robert R** (2017) Improved Upper Bounds for the Order of Some Classes of Abelian Cayley and Circulant Graphs of Diameter Two, *Journal of Interconnection Networks, 17*(03n04), article no 1741012


Publications, continued


Conferences/meetings organised by members of the School

Open Statistical Physics 2017, Open University, March. Organisers: Michael Wilkinson, Uwe Grimm, Marc Pradas, Paul Upton


Mathematics Education beyond 16: Pathways and Transitions: a conference of the IMA, CETL-MSOR and Teaching Mathematics and its Applications, University of Birmingham, July (Sue Forsythe member of organising committee and lead for joint working group)

The 29th international conference on Formal Power Series and Algebraic Combinatorics FPSAC 2017, Queen Mary University of London, London, UK, July (Uwe Grimm member of organising committee)

Graph Embedding and Maps on Surfaces conference, Podbanske, Slovakia, July/August. Organisers Gareth Jones (Southampton), Roman Nedela (Pilsen), Martin Skoviera (Bratislava) and Jozef Širáň
Invited seminars and talks given

June Barrow-Green  
“Knowledge gained by experience”: Olaus Henrici - engineer, geometer and maker of mathematical models, AMS/MAA Joint Meeting, Atlanta, January

The Mathematical World of William De Morgan, Sublime Symmetry Symposium, London, January

Mathematicians at War, LSE Public Lecture, London School of Economics, March

Charlotte Scott and Philippa Fawcett. 19th Century Women Trailblazers in the Cambridge Mathematical Tripos, Winton Women Trailblazers in Mathematics Conference, Birkbeck/Winton, March

Mathematicians at War, OU M500 Meeting, Milton Keynes, May

Robert Brignall  
Staircases, dominoes and the growth rate of 1324 avoiders, Scottish Combinatorics Meeting, St Andrews, Scotland, April

Terry Griggs  
Representing graphs in Steiner triple systems, Workshop – Graph Theory in Modra, Slovakia, September

Uwe Grimm  
Aperiodic crystals and beyond, University of Tasmania, Hobart, February

Tim Lowe  
STACK: Computer-aided assessment for mathematics, Open University eLearning Community, January

Marc Pradas  
Droplets with dynamic size on smooth surfaces: Snaps, hysteresis, and random walks, King's College London, October

Phil Rippon  
Eremenko points and the structure of the escaping set, Liverpool, May

Tony Royle  
The Perilous Practice of ‘Flying and Applying’, School of Physics and Astronomy Seminar, University of Southampton, October

Spinning, Stalling, Falling Apart, Mathematical Institute, Oxford, November

The Perilous Practice of ‘Flying and Applying’, History of Mathematics Seminar, University of St Andrews, November

Ian Short  
Coxeter’s frieze patterns, the modular group and the Farey graph, University of South Wales, February

Dynamics of isometries of the hyperbolic plane, University of Leeds, March

Coxeter’s friezes, the modular group and the Farey graph, University of Southampton, November

Jozef Širáň  
Regular maps on twisted linear groups, University of Auckland, New Zealand, February

Cathy Smith  
Articulating pedagogic messages for learning to teach (pre-university) mathematics, University of Witwatersrand, South Africa, November

Gwyneth Stallard  
Complex analysis and complex dynamics: fruitful interactions, LMS General Meeting, June

Commuting functions and wandering domains, University of Southampton, March

Bridget Webb  
Some new homogeneous and set-homogeneous Steiner triple systems, University of South Wales, March
Conference & workshop papers and posters given

**June Barrow-Green**
*From skeleton structures to geometrical surfaces: the mathematical models of Olaus Henrici, Picturing Mathematics, BSHM/Rewley House, Oxford, June*

*“An exquisite machine”: Olaus Henrici’s harmonic analyser, XXV International Congress of History of Science and Technology, Rio de Janeiro, July*

*“An exquisite machine”: Olaus Henrici’s harmonic analyser, Mathematisches Forschungsinstitut Oberwolfach, Germany, December*

**Robert Brignall**
*Characterising inflations of monotone grid classes of permutations, 15th International Conference on Permutation Patterns, Reykjavik, Iceland, June*

*Staircases, dominoes and the growth rate of 1324 avoiders, European Conference on Combinatorics, Graph Theory and Applications (EUROCOMB’17), Vienna, Austria, August*

**Sue Forsythe**
*Developing Effective Learning Circles: An account of how pre-service teachers participated in a shared dialogue of a team teaching experience, ECER, Copenhagen, Denmark, August*

**Terry Griggs**
*Pentagonal Geometries, 26th British Combinatorial Conference, Glasgow, July.*

**Uwe Grimm**
*Mathematics and aesthetics: Order and symmetry in tessellations, Workshop Michael Schreiber, TU Chemnitz, Germany, April*

*Spectral notions of aperiodic order, SIAM Conference on Applications of Dynamical Systems, Snowbird, Utah, USA, May*

*Substitution-based structures with absolutely continuous spectrum, Aperiodic Patterns in Crystals, Numbers and Symbols, Lorentz Center, Leiden, The Netherlands, June*

*Spectral properties of aperiodic structures, Workshop in Ergodic Theory & Dynamical Systems (with a view towards Number Theory), London, September*

*Spectral properties of aperiodic structures, Workshop on Aperiodicity and Hierarchical Structures in Tilings, Lyon, France, September*

**Uwe Grimm**
*Autocorrelation and diffraction via renormalisation. Part I: Concepts and examples in one dimension, Tilings and Recurrence, CIRM Luminy, Marseille, France, December*

**Robert Lewis**
*A family of largest-known degree 15 circulant graphs of arbitrary diameter, The Second Malta Conference in Graph Theory and Combinatorics, Qawra, Malta, June*

**David Marchant**
*The Möbius function of increasing oscillations, 15th International Conference on Permutation Patterns, Reykjavik University, June*

*Permutations, Grids and the Möbius function, Postgraduate day, The Open University, December*

**Ben Mestel**
*Functional difference equations arising from renormalization in quasiperiodic systems, The 23rd International Conference on Difference Equations and Applications - ICDEA 2017, Timisoara, Romania, July*
Conference & workshop papers and posters given, continued

**Toby O'Neil**  
*Measuring anisotropy in planar sets*, Summer Symposium in Real Analysis XLI (Black squirrel symposium), College of Wooster, Ohio, June (featured talk)

**Susan Pawley**  
*Bridging the study gap: Provision of online support between two level one mathematics modules*, Workshop, Esteem Conference, Open University, April

**Marc Pradas**  
*Noise induced phenomena in rugged energy landscapes*, XLVI Winter Meeting on Statistical Physics, Taxco (Mexico), January (invited lecture).

**Phil Rippon**  
*The structure of the escaping set of a transcendental entire function*, Workshop on complex dynamics, Kyoto, December

**Katrine Rogers**  
*Optimising super-oscillations for optical imaging*, The Physics and Technology of Superoscillations, Institute of Physics, London, October

*Super-oscillations for sub-wavelength focussing*, Innovations in Wave Modelling, Nottingham, July

**Tony Royle**  
*The Perilous Practice of ‘Flying and Applying’,* AMS/MAA Joint Mathematics Meeting, Atlanta, January

*The Perilous Practice of ‘Flying and Applying’,* BSHM Research in Progress, Queen’s College, Oxford, February

*The Perilous Practice of ‘Flying and Applying’,* SIAM-IMA Chapter Conference, University of Manchester, May


*Spinning, Stalling, Falling Apart*, Novembertagung, Brussels, November

*The Impact of the Women of the Technical Section of the Admiralty Air Department on the Structural Integrity of Aircraft during World War One*, History of Women in Engineering in the UK Conference, IET Savoy Place, London, November.

**Jozef Širáň**  
*Regular and bi-rotary maps of negative prime Euler characteristic*, British Combinatorial Conference, Glasgow, July

**Cathy Smith**  
*The transmission of mathematics mastery as a new pedagogic culture* (with Candia Morgan). British Educational Research Association, September


*Teachers’ knowledge about assessing and teaching for semi-structured questions development and challenges* (with Jennie Golding). Mathematics Education beyond 16: Pathways and Transitions: a conference of the IMA, CETL-MSOR and Teaching Mathematics and its Applications, July

**Gwyneth Stallard**  
*Wandering domains and commuting transcendental entire functions*, Workshop on Complex Dynamics, RIMS, Kyoto, December

**Brigitte Stenhouse**  
*The Mathematics of Mary Somerville*, Novembertagung 2017, Brussels, November
Conference & workshop papers and posters given, continued

James Tuite

Searching for digraphs with small excess, The Second Malta Conference in Graph Theory and Combinatorics, Qawra, Malta, June

Diregularity of extremal networks, 26th British Combinatorial Conference, Glasgow, July

Bridget Webb

Countably infinite homogeneous STS, 26th British Combinatorial Conference, Glasgow, July

Charlotte Webb

The role of mastery, problem solving and conjecturing as part of a learning mathematics journey. Association of Teachers of Mathematics Conference. Stratford upon Avon, April

Using a theoretical framework in classroom based research. BERA special interest group: Practitioner research. London, June

Mathematics seminars hosted by the School

In 2017, 32.3% of our seminar speakers were women.

10 January, Alan Beardon (University of Cambridge) Tessellations in geometry, analysis and number theory

17 January, Anna Pratoussevitch (University of Liverpool) Discreteness of Ultra-Parallel Complex Hyperbolic Triangle Groups

24 January, Jeffrey Giansiracusa (Swansea University) A survey of topology and data

31 January, Katherine Staden (University of Warwick) The number of triangles in a graph with a given number of vertices and edges

7 February, Alf Coles (University of Bristol) Mastering mathematical concepts

21 February, June Barrow-Green (The Open University) “Knowledge gained by experience”: Olaus Henrici – engineer, geometer, and maker of mathematical models

28 February, John Mason (The Open University and the University of Oxford) From Worked Examples via Key idea, Core Awarenesses and Variation to the Issue of Student Attention

14 March, Ben Mestel (The Open University) Quasiperiodic renormalisation for general rotation number

28 March, Raul Hindov (Lund University) Factoring integers with Ford circles and Dirichlet’s approximation with Short circles

4 April, Chris MacMinn (University of Oxford) The swelling and drying of a spherical gel

25 April, Stephen Coombes (University of Nottingham) Next generation neural field modelling

2 May, Sandro Azaele (University of Leeds) A spatial stochastic model for explaining macro-ecological patterns in species-rich ecosystems

16 May, Alice Thompson (University of Manchester) Feedback control of falling liquid films

30 May, Thomas Briggs (Bletchley Park) A brief history of Bletchley Park
Mathematics seminars hosted by the School, continued

13 June, Priya Subramanian (University of Leeds) *Formation and Spatial Localization of Phase Field Quasicrystals*

20 June, Holly Krieger (University of Cambridge) *Complex dynamics and the arithmetic of elliptic curves*

13 July, Argyris Christodoulou (The Open University) *Stability of the Denjoy–Wolff theorem*

13 July, Yannis Dourekas (The Open University) *Cantor bouquets in spiders’ webs*

13 July, James Waterman (The Open University) *Iteration in tracts*

13 July, Jay Fraser (The Open University) *Determining possible Petrie dual walk lengths for a given set of regular maps*

5 September, Neil Manibo (University of Bielefeld) *Lyapunov Exponents and Absence of Absolutely Continuous Diffraction*

7 September, Vasiliki Evdoridou (University of Warsaw) *Inner functions and accesses to infinity from Fatou components*

12 September, Cathy Smith (The Open University) *Towards distinctive pedagogic messages for pre-university mathematics*

26 September, Katrine Rogers (The Open University) *Optimising super-oscillatory functions for sub-wavelength focussing in optical imaging*

3 October, Michael Wilkinson (The Open University) *Understanding rainfall: the role of turbulence and large deviation theory*

10 October, Thomas Hunt (University of Derby) *Mathematics anxiety: Causes, consequences, and strategies to reduce it*

17 October, David Martí Pete (University of Kyoto) *Fingers in the parameter space of the complex standard family*

24 October, Dave Hewitt (Loughborough University) *Designing software to address some common difficulties students experience: the case of Grid Algebra*

31 October, Bridget Webb (The Open University) *Some new homogeneous and set-homogeneous Steiner triple systems*

7 November, Dave Sixsmith (University of Liverpool) *On domains with connected pre-image*

14 November, Lucy Rycroft-Smith (Cambridge Mathematics) *What is Cambridge Mathematics and what are Espressos?*

21 November, Simon Albrecht (University of Liverpool) *Conjugacy classes of disjoint-type functions*

28 November, David Bevan (University of Strathclyde) *Permuted packings and prolific permutations*

14 December, Dominic Vella (University of Oxford) *Elastic instabilities: From Pizza to the Venus flytrap*
Other Activities

**June Barrow-Green**
- Visiting Professor at London School of Economics
- Chair of the Executive Committee of the International Commission on the History of Mathematics; member of the ICHM May Medal Committee
- Member of LMS Council, Prizes Committee, and Standing Orders Review Group; LMS Librarian
- Member of BSHM Council, Chair of BSHM Neumann Prize Committee

**Katie Chicot**
- LMS Holgate Lecturer
- UKMT council
- Maths section committee BSA
- Member of BSHM Neumann Prize Committee

**Sue Forsythe**
- Member of strategic committee of the East Midlands South Mathematics Hub

**Uwe Grimm**
- Member of International Program Committee for the XXIV Congress and General Assembly of the International Union of Crystallography, Hyderabad, India, August
- Reporter at Spectral Structures and Topological Methods in Mathematical Quasicrystals, Mathematisches Forschungsinstitut Oberwolfach, Germany, October

**Chris Hughes**
- Board member of National Network of Mathematics in Wales
- Royal Institution Mathematics Masterclass speaker

**Susan Pawley**
- Royal Institute Masterclass Organiser, Bletchley Park series

**Phil Rippon**
- Chair of BMC Scientific Committee

**Cathy Smith**
- Member of Enigma Maths Hub Strategic Board

**Gwyneth Stallard**
- Member of LMS Council, Research Grants Committee, Early Career Committee, Personnel Committee, Good Practice Scheme Steering Group
- Member of Judging Panel for L’Oréal Women in Science Fellowships

**Brigitte Stenhouse**
- Interviewed about Mary Somerville on *Antiques Road Trip*, BBC1, October

**Bridget Webb**
- Elected member of the BCC and archivist (until July)

**Charlotte Webb**
- Member of the Outer Circle of the Association of Teachers of Mathematics