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School of Mathematics Newsletter

In this issue:

Athena Swan Bronze Award for gender equality

by DAVE SMITH

The School has been successful in securing an Athena Swan Bronze Award, which will run until November 2022. The award follows an in-depth self-assessment process of gender balance at all levels of the School, from undergraduate recruitment to promotion of senior female academics to professor, followed by the development of a detailed action plan to address gender inequality issues. Key aims include encouraging more of our outstanding female undergraduates to take the 4-year MSci programme, improving gender balance in recruitment to PhD scholarships, ensuring that we are shortlisting and recruiting the best early career academics, and building on recent successes to increase the proportion of women among the senior staff. Securing the award involved significant work by members of the School Equality and Diversity Committee, which includes staff and students, the completion of inclusive culture surveys by many undergraduates, postgraduates and staff, and a very successful Women in Maths lunchtime event which many students and staff enjoyed participating in. We look forward to building on initiatives such as these to improve the School's inclusivity, and to recognise the significant developments that have happened in recent years.

Maths Bio research featured in the Independent

by DAVE SMITH

Infertility is a common problem, and male factors such as sperm motility problems contribute to around half of all cases. Despite this, diagnostic techniques for sperm problems are very basic, involving simple visual assessments of sperm under the microscope and manual counting. The School's research collaboration with Birmingham Women's Fertility Centre recently led to the development of the first software capable of high speed, high precision analysis of the actual propulsive mechanism of human sperm, the movement of the flagellum (tail). This software, named FAST (Flagellar Analysis and Sperm Tracking), was developed by Research Fellows Dr Meurig Gallagher and Dr Gemma Cupples, working with the School's Director of Research Professor Dave Smith and clinical lead Dr Jackson Kirkman-Brown MBE. The release of the software was featured by the Independent. Other applications for the research include analysing sperm of domestic animals for breeding applications, and wild animals for conservation. The software is being assessed by international leader Professor Gerhard van der Horst of the University of the Western Cape, South Africa, for a wide range of species, including goats, monkeys and mice, species with very different (and fascinating!) sperm motility patterns.

Celebrating female role-models in Birmingham

To celebrate 100 years since the first women were given the vote, Birmingham City Council have produced a book celebrating female achievements in the city: *Once upon a time in Birmingham*. Members of the public submitted over 130 nominations

for past and present women. A panel of young female writers from Spark Writers Group were asked to decide on the final 30 women to be included in the book according to who they felt could inspire current and future generations of women. Of these 30, two are associated with the School of Mathematics! Current lecturer, Sara Jabbari was selected as a result of her research into using mathematics to help find alternative treatments for bacterial infections, while Mary Lee Berners-Lee (who studied mathematics at Birmingham in the 1940s) was chosen for her pioneering computer programming work (she also happens to be the grandmother of the web!). The book is written, illustrated and published by women of Birmingham, and showcases a fantastic range of professions and cultures of women from different eras, including examples as diverse as suffragettes, ballet dancers, medics and policewomen. More well-known inclusions are the Nobel Prize for Peace winner Malala Yousafzai and Olympic gold medallist Denise Lewis. For the School to have two connections to the book is an exciting achievement for mathematics. Sara (who still has no idea who nominated her in the first place!) has been busy helping out with promotional events, particularly around International Womens Day, including book-signings, networking events and an exhibition of the illustrations at Birmingham Hippodrome. A copy of the book has been sent to all secondary schools in the city, and you can pick up your own copy from all good (but local!) bookstores.

Once upon a time in Birmingham

Grant success for Tyler Kelly!

The School of Mathematics has had a recent grant success with EPSRC awarding Tyler Kelly a New Investigator Award for his proposal "Mirror Constructions: Develop, Unify, Apply". This grant is valued at around £234k, and will employ a Postdoctoral Research Associate for two years.

This project is predominantly focused on mirror symmetry, a field that aims to link symplectic and algebraic geometry via dualities in string theory. Namely, it predicts that, given a Calabi-Yau manifold X, there exists a so-called mirror Calabi-Yau Y so that the symplectic geometry of X is encoded in Y. This project aims to develop new constructions of mirrors for various Calabi-Yau manifolds X that previously did not have an effective way to compute its mirror, unify this new construction with previously known constructions, and then look at the ramification in related fields. This work relates to work on classifying Fano manifolds, derived categories, and even has connections to computational number theory.

Grant success for Diogo Oliveira e Silva!

Diogo Oliveira e Silva has been recently awarded an EPSRC New Investigator Award, "Sharp Fourier Restriction Theory", as a PI (ca. £300k). The grant will fund a Research Fellow for 2 years.

The Fourier Transform is a powerful tool that lies at the heart of Mathematical Analysis, and has been shaping the history of mathematics since it first appeared almost 200 years ago. Much more recently, it was understood that analysis and geometry can be linked via the Fourier Transform through the notion of curvature. The fertile research ground of Fourier Restriction Theory starts with the observation that curvature causes the Fourier Transform to decay. In turn, this leads to a number of surprising and deep applications. For instance, the Schrödinger equation describes the changes over time of a physical system in which quantum effects, such as wave-particle duality, are significant. Given its dispersive nature (i.e. different frequencies propagate in different directions), certain estimates quantifying the size of the solutions of the Schrödinger equation in terms of the size of the initial datum are a direct manifestation of Fourier Restriction Theory, and play a key role in quantum mechanics.

This project is concerned with the development of robust methods to establish optimal (so-called "sharp") control of the Fourier Transform in the presence of curvature. The aim is to discover the sharp form of certain cornerstone inequalities in Fourier Restriction Theory, and to characterise the ways in which the corresponding functionals can be minimised. In particular, this will lead to a deeper understanding of the solutions of the Schrödinger equation. Multilinear analogues are of interest, for two main reasons. Firstly, they will clarify some subtle measure-theoretical aspects of Fourier Restriction Theory which have remained unaccessible until now. Secondly, multilinear functionals lie at the frontier between linear and fully nonlinear phenomena. The plan is to develop and use appropriate multilinear tools in order to inaugurate a restriction theory for the Nonlinear Fourier Transform, in the version considered in recent influential work of Terence Tao and Christoph Thiele.

Recruitment of Professor John Terry

by DAVE SMITH

The School is delighted that Professor John Terry will be joining us from September. John is a world-leader in the application of dynamical systems methods to biomedical research, with particular emphasis on electrical oscillations, spike wave activity and hypersynchronisation in the brain (associated with epileptic seizures), and the origins of pulsatility in glucocorticoid secretion (which underlies many hormonal disorders such as Addison's disease). This work has led to several patents, and a spin-out company *Neuronostics* which aims to transform the diagnosis of seizure susceptibility assessment. Conversely, his engagement with healthcare research has led back to inspire developments in the mathematical theory of dynamical systems, particularly the bifurcation analysis of neural field models.

John has been particularly successful in securing the investment to support the large-scale activities that are needed to transform healthcare. He has held or co-held over 13 million pounds in research funding, including leadership of the EPSRC Centre for Predictive Modelling in Healthcare, which will move with him to Birmingham. John's appointment is joint with the Institute for Metabolism and Systems Research in the College of Medicine and Dental Sciences, and the School of Computer Science, and is supported by a major University investment. We are looking forward to greatly expanding the School's engagement with healthcare research and computer science as John builds his group over the coming years.

Jinan update

by RACHEL DU CROZ

The University of Jinan–University of Birmingham Joint Institute (JBJI) now has around 300 students studying BSc Applied Mathematics with either Economics, ICS, Mathematics or Statistics at the University of Jinan in Guangzhou, China.

From 22nd July 2019 to the 6th August 2019 the School will be hosting the first JBJI Summer School. This year's event will be led by Professor Chris Parker on the theme of Cryptography and will include a visit to Bletchley Park. We will also be running a number of guest lectures, and social activities as well as providing group English Language sessions led by the BIA. We are delighted that 12 of our UK-based students will be supporting this event.

In addition to the Summer School, the School of Mathematics is looking forward to welcoming 20 students from JBJI in September 2019 for a Study Abroad Year. They will be joining year 3 of the BSc Mathematics course, and will then return to China to complete their degree.

British Young Mathematicians' Colloquium

by ALEX BRUNE

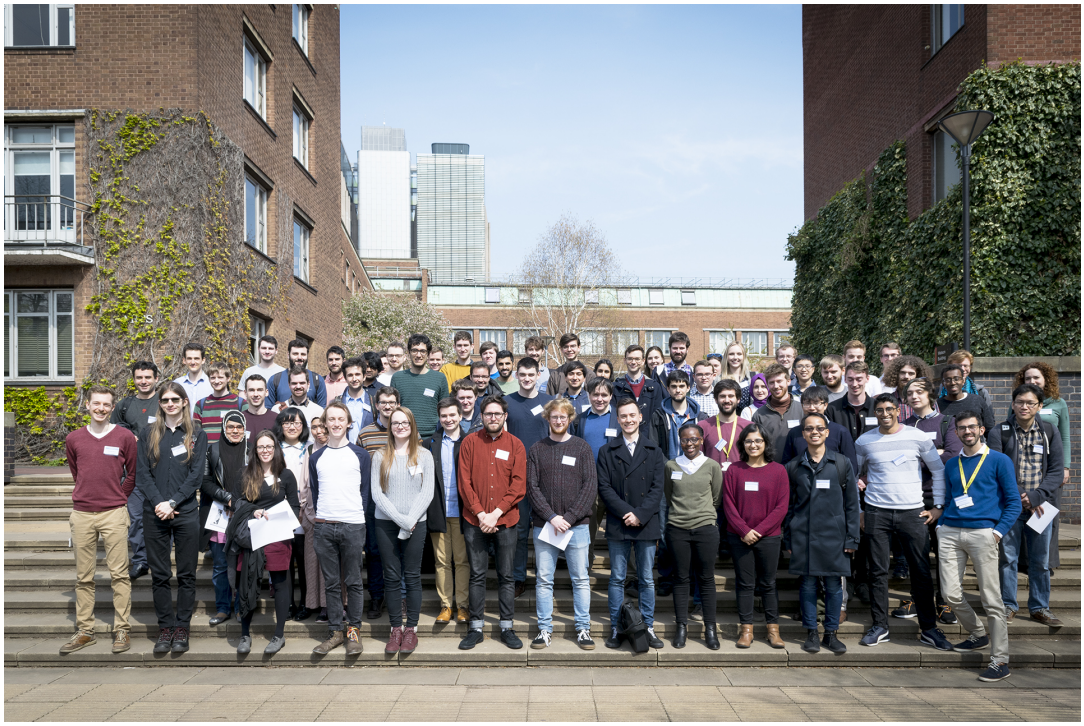
The British Young Mathematicians' Colloquium (BYMC) was held at the University of Birmingham on the 17th April 2019, bringing together postgraduates and early career researchers from several different fields of mathematics. Since its conception in 2015, the BYMC has been held at UoB four times. The number of participants has been growing over the years, and this year, the School of Mathematics welcomed around 70 participants.

The aim of the BYMC is to give early career researchers the opportunity to get an overview of the latest research in the different mathematical disci-

plines as well as present their own work, all in a relaxed and friendly atmosphere. We had 24 contributed short talks from participants, organised in 4 parallel sessions. There were two parallel sessions of 3 semi-plenary talks, given by researchers from areas in pure and applied mathematics, respectively. This year's invited speakers were David Beltran (Basque Center for Applied Mathematics), Scott Harper (University of Bristol) and Katherine Staden (University of Oxford) for the pure mathematics session; Gemma Cupples (University of Birmingham), John Pearson (University of Edinburgh) and Oliver Sutton (University of Nottingham) for the applied mathematics session.

The organisers made a particular effort to make the BYMC accessible to everyone this year, with all lecture rooms, coffee break and meal venues either being on the ground floor or easily accessible by lift. Furthermore, talks were recorded and made available to participants after the colloquium.

The BYMC was as usual organised by a committee of postgraduate students from the School of Mathematics: Gianmarco Brocchi, Alexander Brune (committee chair), Rory Duncan, Cara Neal, Jack Saunders and Karoline van Gemst. They were advised and supported by the Director of the Graduate School, Chris Parker. The colloquium was funded by the MAGIC group and the School of Mathematics.



British Young Mathematicians' Colloquium 2019

LGBT STEMinar in Birmingham

We can now announce that the School of Mathematics, along with the College of Engineering and Physical Sciences, will be hosting the fifth annual LGBT STEMinar on January 10, 2020. This one-day conference aims to bring visibility for LGBTQ+ identified researchers in STEM. Previously, it has been held at the University of Sheffield, University of York and at the Institute of Physics. This year's local organisation lead, Tyler Kelly, is a lecturer in the School of Mathematics and the staff advisor for the University's oSTEM (out in STEM) student society.

The conference is part of the LGBT STEM project (https://lgbtstem.wordpress.com), an initiative designed to improve visibility of LGBT people in the STEM fields with the aim of providing role models for those who are either at a junior stage of their career or only considering the possibility of going into a STEM field. The STEMinar's details can be found at http://www.birmingham.ac.uk/lgbtsteminar2020.

Best Publication Award for PhD student

The School of Mathematics is delighted to con-

gratulate James Whitley who has been awarded the Michael K O'Rourke Best Publication Award for his paper *Vertices for Iwahori–Hecke algebras and the Dipper–Du conjecture* which appeared in the Proceedings of the London Mathematical Society.

James began his PhD studies with the late Anton Evseev and is currently completing his studies with Simon Goodwin. Below is an excerpt from the nominating statement for the award.

Group theory and representation theory, which give the mathematical language of symmetry, have been at the heart of mathematics since the pioneering work of Évariste Galois in the early 19th century. The most fundamental case is the symmetric group, and its representation theory remains amongst the most active research areas in mathematics. A crucial development was the introduction of Iwahori–Hecke algebras, which are deformations of symmetric groups providing important new insight. The representation theory of Iwahori–Hecke algebras has important parallels with group representation theory. The Dipper–Du conjecture was influential in this area and generated a great deal of research interest but remained open for 25 years. It is a remarkable achievement that James Whitley resolved this conjecture, and the proof forms the main result of the nominated paper. This paper is a substantial piece of research involving mastery of a range of techniques from modular representation theory and homological algebra, along with ingenious combinatorial methods with Young tableaux.

News in Brief

- Former School of Mathematics student Jack Garner has been awarded the *Alumnus of the Year* award from the University for 2019! An interview with Jack about this achievement can be found here. Congratulations Jack from the whole of the School!

- Congratulations go to Professor Daniela Kühn who has been invited to speak at the 8th European Congress of Mathematicians, which is to be held in Slovenia in July 2020. More details about the conference can be found here.

James Whitley receiving his award from Professor Tim Softley