School of Mathematics Newsletter

In this issue:
- Grant success
- Outreach update
- Student poster competition
- Recent and forthcoming workshops and conferences

EPSRC grant award in representation theory

Simon Goodwin has recently been awarded an EP-SRC standard grant to study 'The representation theory of modular Lie algebras and superalgebras'. The grant will fund a Research Fellow for three years. Below Simon summarises the proposed research programme.

Representation theory of Lie groups and Lie algebras has been a topic at the heart of mathematics for over 100 years with wide-ranging applications in mathematics and physics. This subject has origins in the view of Felix Klein in the 19th century that geometry of spacetime should be governed by its group of symmetries and the subsequent pioneering work of Sophus Lie to develop a theory of symmetries for differential equations.

Lie groups can be viewed as continuous symmetries of geometric objects. For example, a circle has infinitely many symmetries, namely rotations and reflections, which we can vary in a continuous way. Taking a step back we are able to view a Lie group more abstractly, and then representation theory provides the language to understand the different ways that a Lie group can act as symmetries. The Lie algebra of a Lie group is a first order approximation of a Lie group, which is more accessible to study, but retains all the local structure of the group. The abundance of continuous symmetry in mathematics and physics explains the wide ranging applications of this theory.

In the 1950s the 'analytic theory' of Lie groups and Lie algebras was extended so that it can approached more algebraically, and this spurned a large area of mathematics now known as algebraic Lie theory. This is one of the most active areas of mathematics research today, which finds diverse applications across the physical sciences. An important area of algebraic Lie theory is the representation theory of modular Lie algebras. These Lie algebras can be thought of as versions of real or complex Lie algebras where usual arithmetic using real or complex numbers is replaced by modular arithmetic as is used in coding theory and cryptography.

The aim of this project is to exploit exciting recent developments in algebraic Lie theory to give a new perspective of the representation theory of modular Lie algebras. In order to understand representations of Lie algebras, we want to associate numerical data, which governs the structure of the representations. The most important pieces of data are the dimension and characters, and the ambitious goal of this project is to develop methods for determining formulae for these.

Swiss National Science Foundation award

Dr Andrey Kupavskii has been awarded a fellowship from the Swiss National Science Foundation to continue working at Birmingham. Below he describes his project.

Advanced Postdoc.Mobility is a funding programme by the Swiss National Science Foundation, aimed at supporting more 'senior' postgraduate researchers who received a PhD in Switzerland or spent sufficient amount of time doing research in a Swiss research institution. It provides funds for conducting research abroad with the aim of enhancing the independence and the profile of the researchers. My project is entitled 'Designs, intersections, and matchings', and is devoted to combinatorial ques-

tions coming from the field of extremal set theory. The project concerns various problems including the Erdős Matching Conjecture, some structural and extremal questions on intersecting families, as well as the recent developments in the theory of designs. The goal of the project is to resolve some of the problems in the field, but also to learn modern probabilistic techniques from the members of the Combinatorics, Probability and Algorithms group.

Outreach in Mathematics

by ELEANOR MESTEL

The Birmingham Popular Mathematics Lectures are once a month throughout the autumn and spring terms, with a mixture of attendees from local schools, families, and the general public, as well as members of the university. On 18th October, Dr Peter Neumann asked, "Did Galois deserve to be shot?". Professor Paul Flavell also repeated his Inaugural lecture, "Numbers", on 29th November. Both lectures were very well received, and our thanks go out to the enthusiastic speakers. The Popular Maths Lecture series continues once a month on Wednesday evenings in the Watson Building (Lecture Theatre A), starting at 7pm (note earlier timing). The next two lectures will be:

31st January   Dr Martine Barons
"Saving the bees – why do we need maths?"
28th February   Dr Richard Lissaman
"How maths has been used and is being used in video games"
The details of the upcoming lectures are online.

A full list of our mathematics-specific Outreach events can be found here. Please keep me updated about any outreach you're doing which is not organised by me, so I can keep track of the great work which is going on in the School of Mathematics. In March, our largest maths event, the Maths Big Quiz will run for 14-15 year olds attending from approximately 30 local schools. Please let me know if you would like to get involved with the event, or any other one. I am always looking for more help with outreach, and am very happy to talk about your outreach and public engagement ideas, just send me an email (liaison@maths.bham.ac.uk) or see me in Room 218 in the Watson Building.

Multiscale Biology Study Group 2017

by DAVE SMITH

Following last year's success, the School hosted the 2nd Multiscale Biology Study Group from 12th-15th December 2017, with support from the Multiscale Biology Network as well as the Biology and Biotechnology Research Council. Despite very adverse weather conditions, the turn-out was excellent, with attendees from locations as far afield as the USA, Algeria and Portugal, in addition to over 30 participants from across the UK, and from both applied and pure groups within the School.

Participants worked in groups during the week on five different problems relating to plastic surgery, detecting proteins to detect disease, rapid analysis of DNA samples, the dynamics of synthetic structures constructed from artificial viruses, and reconstructing the temperature profile on Earth in prehistoric times. The study group format is always very dynamic, involving brainstorming around blackboards, computer coding, informal conversation over coffee and group meals, and December's event was no exception. To quote Cara Neal, a first year PhD student in the School, 'It was great to work with people from other universities on new problems, and everyone was very enthusiastic and supportive when generating ideas. I particularly enjoyed watching the final presentations at the end of the week, as it was great to see the progress everyone had made after only one week of working on a problem.' Atticus Hall-McNair, also attending his first study group, said that it was 'satisfying to have furthered not only my own understanding but to have helped other researchers at the same time. It was especially rewarding to work alongside people from a variety of academic levels and backgrounds, pooling our varying knowledge towards a short-term common goal.' Euan Smithers attested that it had 'opened my eyes to new exciting research out there'.

The event was appreciated by the problem presenters too. Dr Rob Neely (School of Chemistry) commented that 'the study group gave us a unique opportunity to share our work with some fantastic mathematicians. We've taken away some great new ideas that we couldn't have developed in isolation. We certainly aim to continue the collaboration in the future'. Dr Tom Dunkley-Jones (Birmingham Fellow from School of Geography, Earth and Environmen-

tal Sciences gave the feedback 'My thinking about the problem advanced by months, if not years, in 3 days'. We are very grateful to the Multiscale Biology Network and BBSRC for funding the event, and to all problem presenters and participants for making it an enjoyable and productive week.

Participants of the Multiscale Biology Study Group

Maths Poster Competition

by ALBERTO ESPUNY DIAZ

Our postgraduate students are organising a Maths Poster Competition, to be held on the 31st of January.

The main goal of this activity is to provide an opportunity for students to practice giving a poster presentation. This is a basic ability needed in academia, as posters are one of the main formats in which research is presented. The poster session is also a good chance for networking inside the School, and there will be tea, coffee and biscuits for everyone. All members of staff are invited to come support the students.

The first edition of this competition (which will become an annual event, hopefully) will be held on Wednesday 31st from 16:00 to 18:00. This is going to be a joint event for both PhD and MRes students as well as MSci students: each group has their own prize, but the rules are the same and the posters will be displayed jointly. Posters will be evaluated by a jury made up of members of staff from our School.

If you would like to take part in the competition, or only want to come to the poster session to support your colleagues or students and see what is going on, you can register following this link. All information about the contest will be updated here.

The competition is funded by the Postgraduate Development Fund and the School of Mathematics.

META workshop

by NATALIA PETROVSKAYA

The joint research group 'The Mathematical Ecology: Theory and Applications (META)' runs a series of workshops related to various topics in mathematical ecology. Another META workshop, 'Mathematics Behind Complex Ecological Patterns' was held in our School on 13th December 2017. The key theme was complexity in spatio-temporal ecological patterns - a general and challenging problem

that requires adequate mathematical methods to describe it and handle it. The workshop included four mini-sessions on evolutionary ecology, pattern formation, pattern detection, and dispersal where invited talks were mixed with PhD talks in each session. The invited talks were given by Daniel Bearup (Kent), Tilo Burghardt (Bristol), Jaqueline Da Silva (Federal University of Jequitinhonha and Mucuri Valey & Leicester), Meurig Gallagher (Birmingham), Andrew Morozov (Leicester), Ivo Siekmann (Liverpool John Moores) and Paolo Tilles (Federal University of Santa Maria & Leicester). The PhD talks were delivered by John Ellis (Birmingham), Simran Sandhu (Leicester), Wenxin Zhang (Birmingham), and Anna Zincenko (Leicester). The speakers discussed mechanisms of ecological pattern formation, various mathematical models of ecological dispersal, detection and recognition of spatial patterns arising in ecological and biological systems, and control of spatial spread of invasive species.

Young Mathematicians Colloquium

by ALBERTO ESPUNY DIAZ

Once again, the University of Birmingham is going to hold the Young Mathematicians Colloquium, continuing with a tradition that started three years ago. This colloquium aims to bring together PhD students and young researchers in every area of mathematics from all across the UK so that they can share their more recent discoveries and their impressions about academic life.

The colloquium will be a one-day event taking place on the 18th of April. There will be two parallel sessions, one for pure mathematics and one for applied mathematics, which will be further subdivided for contributed talks. In total there will be three invited speakers in each session. The invited speakers are Kenneth Falconer (University of St Andrews), Valentina Grazian (University of Aberdeen) and Annika Heckel (University of Oxford) for the pure mathematics session; for the applied session, it is a pleasure to have Daniel Jones (INRIA and École Polytechnique), Fabian Spill (University of Birmingham) and James Sprittles (University of Warwick).

The colloquium will also feature sessions for contributed talks. One of the goals of the meeting is to give an opportunity for students to present the research they are undergoing to students from other universities. This also applies to students from Birmingham, who are most welcome to submit an abstract for a presentation. The deadline for the submission of abstracts is the 31st of March.

We hope to attract a broad audience. There will be multiple coffee breaks, lunch and a conference dinner to provide an opportunity to engage with others. Furthermore, the emphasis of the colloquium is on young mathematicians. Many of our invited speakers are themselves at post-doctorate level. The hope is that they can provide advice and answer questions about academic progression for aspiring PhD students and undergraduates.

The colloquium is organised by a group of our own PhD students: Alexander Brune, Padraig Condon, Alberto Espuny Diaz and Joel Mitchell. The organisation has received funding from the University of Birmingham (via the Postgraduate Development Fund) and the MAGIC group. All information about the colloquium, as well as the links for registration, can be found on the colloqium's webpage.

We hope this colloquium will be a success in bringing together students from all universities and establishing future collaborations with them. We encourage all our students to attend, and members of staff are also invited to attend the lectures throughout the day.

News in Brief

- The University of Birmingham is joining a prestigious national institute set up to advance the world-changing potential of data science. Birmingham is set to become part of The Alan Turing Institute, which is named in honour of the British pioneer whose work in theoretical and applied mathematics, engineering and computing laid the foundations for the emerging field of data science. Several research groups in the School – including Combinatorics, Probability and Algorithms; Mathematical Biology; Optimisation; and Analysis – will be involved. More details can be found in the following link.

- Congratulations go to Paul Roberts who got married to Lizzie on the 25th November, honeymooning in Rome!