Postgraduate study

The University of Nottingham

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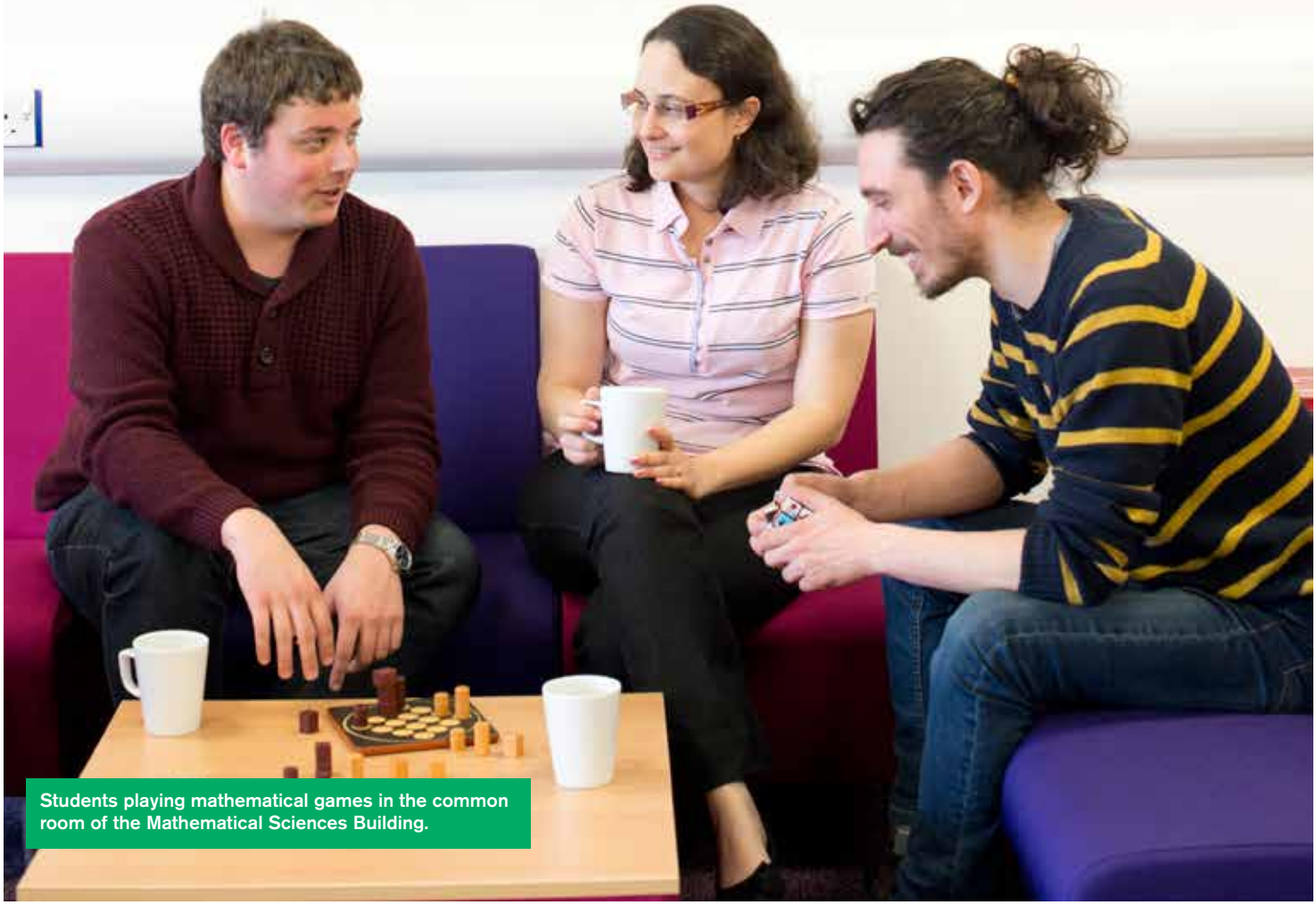
Mathematics@Nottingham

School of Mathematical Sciences Postgraduate Newsletter 2014

Where could postgraduate study take you?



Students playing mathematical games in the common room of the Mathematical Sciences Building.

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Find out about our research groups and what is keeping them busy

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Hello and welcome

First of all, thank you for your interest in studying in the School of Mathematical Sciences at Nottingham. Choosing to study at postgraduate level can be a difficult decision and there are many factors to consider. We've put this newsletter together to give you a greater insight into our school and to help you decide whether The University of Nottingham is the place for you.

The school provides a large and dynamic environment in which to study mathematics with academic staff who are at the cutting edge of their field. What's more, independent reviews of our teaching have singled out our wide choice of modules and the approachability of our staff for particular praise. This means you will be learning from excellent teaching and research staff who work at the forefront of mathematical sciences. We also have a genuine interest in your personal development and will ensure that you receive all the support you need in the transition to postgraduate study.

The School of Mathematical Sciences provides a great foundation on which to develop further goals and aims in your life. You might want to make the most of the opportunities we offer to attend conferences and to present papers, and you can be assured that a postgraduate degree from our school is well regarded and an excellent basis for later employment. If you have any questions, please contact us using the details on page 8. Good luck with your decision making and we hope to welcome you onto campus soon.

Professor Ian Dryden
Head of the School of Mathematical Sciences

News

Support for women in science

The School of Mathematical Sciences actively supports women in mathematics and encourages both female students and staff members to be part of the school.

Our female students have a dedicated tutor specifically to support them who is available to be contacted at any time. There are also regular term-time weekly lunches held for women within the school, which give them a chance to chat, exchange experiences and get to know each other.

Events include discussion forums on topics such as why girls should choose maths and finding a balance between career and family life, and lectures from women from other institutions.

In recognition of promoting women in science, the University is one of only four universities to hold a Silver Athena Scientific Women's Advancement Network (SWAN) Award. This award is for institutions that recognise and celebrate good practice for women working and studying in science, engineering and technology in higher education and research.

The school currently holds a Bronze Athena SWAN Award and has recently submitted an application for the silver award.

Find out more about what our school is doing at **www.nottingham.ac.uk/mathematics/about/women-in-science.aspx**

News

Former research fellow turned film-maker

Andrzej Dragan, a former postdoctoral fellow in the School of Mathematical Sciences and award-winning photographer, has moved into the world of cinema and is about to release his first movie. He collaborated with approximately 40 artists including Waldemar Pokromski, the acclaimed make-up artist behind Schindler's List.

'Heirarchy Lost' tells the story of a scientist who makes an amazing discovery. Andrzej not only conceived the story, developed and wrote the script, but also directed and produced the film. One of our academic staff members, Dr Ivette Fuentes, was also involved in helping him with the story and script. You can find out more about the film on the dedicated Facebook page: **www.facebook.com/HierarchyLost**

Head of school profile

"I have always been fascinated by numbers and I knew I wanted to study mathematics to a high level. I chose to study at The University of Nottingham and it gave me the best possible training for my career. Statistics is my research area and I love the combination of data, mathematics and computation. I have been able to work with collaborators from a huge range of disciplines, as well as with many colleagues in the mathematical sciences.

A pivotal moment in any graduate's life is to choose a career. The job opportunities for mathematicians and statisticians have always been excellent and the demand will grow even stronger as larger and larger datasets are being collected routinely. A PhD in the mathematical sciences provides an excellent springboard to a world of opportunities.

I enjoy exploring new research areas and sharing knowledge with a new generation of students. My particular specialism is in Shape and Object Data Analysis. I have been fortunate to have excellent jobs at the University of Leeds, The University of Chicago, the University of South Carolina and The University of Nottingham. As a researcher I am able to travel internationally to many conferences, workshops and universities for research collaborations and it is great to learn about exciting new ideas and experience new cultures.

I studied for my undergraduate degree in mathematics at Nottingham and I am now back full circle as head of school, in our great new building on our beautiful University Park Campus. I hope you will be interested in joining us!"

Professor Ian Dryden presenting a lecture in the Mathematical Sciences Building.

First-class facilities

The Mathematical Sciences Building.

Our postgraduate students benefit from a range of state-of-the-art facilities and high-quality equipment for their specific use.

The school is located in a dedicated and specifically designed building that was completed in 2011. The building contributes positively to the educational process by carefully integrating academics and students throughout all levels of the building, providing great opportunities for social and academic interaction.

Our masters students have a dedicated computer workroom and research students all have a share of a furnished office. All computers are equipped with specialist software and the nearby George Green Library stocks many specialist mathematical texts. You can also access free Wi-Fi across the campus.

The environment and resources for carrying out research are among the best in the country with many of our researchers using computational methods, and making good use of our high performance computing facility.

The school also has a MAGIC facility, which is a postgraduate training network comprising 18 British mathematics departments. Using video conferencing technology, you can participate in a wide range of interactive courses.

Links with industry

Industrial collaborations

The School of Mathematical Sciences has developed relationships with a range of industry partners that has enabled our students to gain experience working on a variety of industrial projects and to share their knowledge and expertise.

Here are some examples of the companies we have worked with and the types of projects that have benefited from our research.

Rolls-Royce

We have a long-established relationship with Rolls-Royce and we work with colleagues in the Faculty of Engineering and the Rolls-Royce University Technology Centre at The University of Nottingham. Most of our contributions are in the broad area of fluid mechanics, for example in helping to regulate oil temperatures in the gearbox of the Rolls-Royce Trent aircraft engines.

Airbus

We have worked with Airbus through an internship looking at condensation in aircraft fuel tanks and how best to prevent excessive build-up and improve drainage. This is important to avoid fuel contamination.

Unilever

We have collaborated with Unilever on numerous occasions, ranging from a short project building a predictive model of axillary malodour (smelly armpits!) to a sponsored studentship looking at multiphase flows in flexible channels, designed to improve understanding of both drug delivery in the body and how flavour and nutrients from food are released from the small intestine.

Russell Group Limited

Two of our PhD students have worked with Russell Group Limited, a local re-insurance company, looking at portfolio optimisation. The students were able to share their knowledge and expertise in risk analysis to maximise the return on investment to shareholders by analysing the company's portfolio for likely risks and optimising capital investment. The students also went on to apply similar risk analysis and optimisation techniques to a project with Network Rail.

Jaguar Land Rover

Our work on reducing noise and vibration in vehicles caught the attention of Jaguar Land Rover several years ago, and following an initial pilot project where the techniques were trialled in a Range Rover model, the company has become further involved through a European Marie Curie project that will run for four years.

Delta Rail Group Ltd

We have also worked with Delta Rail Limited, a British railway software technology company, to look at ways to improve and optimise their train signalling system. A three-year Knowledge Transfer Partnership (KTP) project is now beginning which will appoint a postgraduate to work at the company premises in Derby, with supervision from academics in the school. The project will develop a predictive model of the rail network to improve flow, working towards enhanced software that will provide the company with a competitive edge.

Public Health England

The epidemic modelling group in the school has worked for many years with the Department of Health (now Public Health England), in particular on modelling and data analysis of antibiotic resistant pathogens such as MRSA. The work has led to a review of the government's current screening policy as it provided insight into the effectiveness of contact precautions in reducing MRSA transmission in hospitals.

Health and Safety Laboratory

Several PhD students from Nottingham have worked with the Health and Safety Laboratory, both in sponsored studentships and in employment after graduating. Various collaborative activities with the organisation have taken place over the last decade and the company has provided sponsored PhD studentships. Projects include a studentship on work-related musculoskeletal disorders (such as low-back pain, joint injuries and RSI) which designed mathematical models to replicate the biological mechanisms and helped in the prediction of what factors help or hinder the recovery process.

Our research expertise

The School of Mathematical Sciences has seven very active research groups in the areas of algebra and analysis; industrial and applied mathematics; mathematical medicine and biology; mathematical physics; number theory; scientific computation; and statistics and probability. Here we look at two groups in more detail.

Mathematical Medicine and Biology

The Centre for Mathematical Medicine and Biology (CMMB) comprises members of The University of Nottingham who use mathematical methods to provide insights into biological and biomedical phenomena. We aim to promote the application of mathematical modelling to medicine and the biomedical sciences. Our research is mostly centred around the following areas:

Epidemic modelling
We look at the mechanisms underlying the spread of infectious diseases such as foot-and-mouth, AIDS, TB and influenza using mathematical modelling. Our work involves the development and analysis of stochastic models as well as statistical inference for infectious disease data.

Systems medicine and biology
We have experts working on a wide range of medical problems, from mathematical neuroscience and modelling a virtual physiological human, to work on respiratory disorders and cancer.

Digital plant: from molecule to organism
Combining experimental biology, mathematical modelling and statistics to understand how microscopic components interact to give rise to complex plant structures and address key questions in plant biology. This work is a crucial component of research into global food security – finding ways to improve crop growth to feed our growing population.

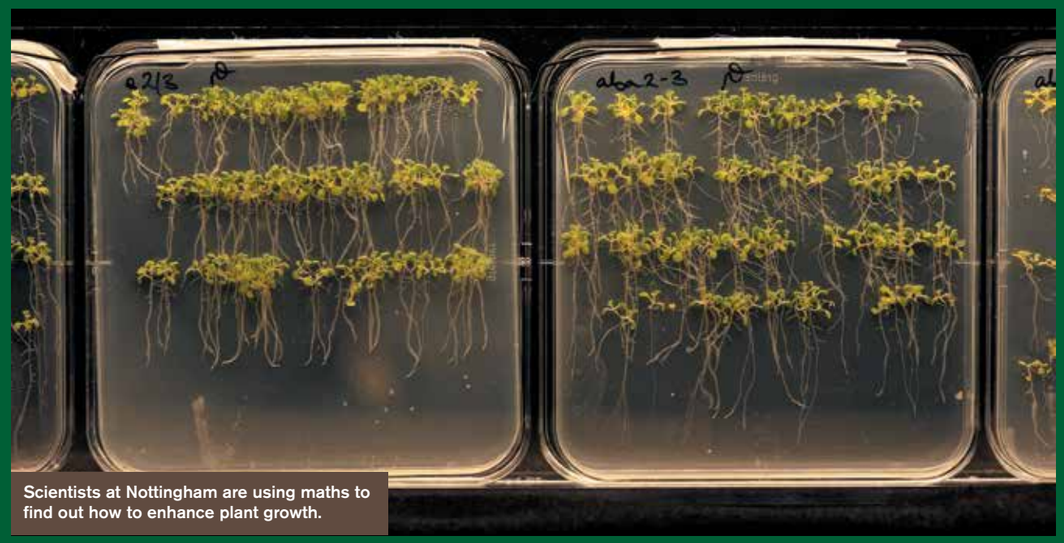
Our research focuses on:
- Cell-scale: using mathematical modelling and statistics to understand plant growth processes such as fertility, fruit ripening and root branching
- Tissue-scale: incorporating these models into multi-cellular templates to create digital organs. Emergent properties spontaneously arise and generate order within these structures, for example, how root growth is determined by the mechanical properties of the individual cells.
- Organism scale: creating virtual root or shoot networks to predict how changes in environmental conditions (such as water, nutrient or light availability) affect growth

Number Theory and Geometry

Number theory is one of the oldest parts of mathematics. In its study of fundamental properties of numbers it uses every other part of mathematics and stimulates a variety of new developments in other areas. Number theory remains the most applicable part of pure mathematics through, for example, coding and cryptography and computer science.

Our research areas include:
- analytic number theory
- arithmetic, algebraic and anabelian geometry
- computational number theory
- geometric and categorical theories and correspondences
- higher class field theories, higher adelic analysis and geometry, higher automorphic forms
- local number theory, Iwasawa theory
- number theory, representation theory and quantum field theory
- zeta and L functions

You can find out more about each of our research groups at **www.nottingham.ac.uk/mathematics/research/researchgroups.aspx**



Scientists at Nottingham are using maths to find out how to enhance plant growth.

Advancing the next technological revolution

The Relativistic Quantum Technologies team at Nottingham is carrying out research into relativistic quantum properties that can be used to improve current quantum methods for things such as communications, sensors, clocks and computing, as well as in the design of new tools and methods.

We live in the information age and are entering an era where technologies are undergoing a revolution by making use of so-called 'quantum effects'. Quantum simply means very small things, in other words on the scale of atoms. Quantum technologies, which include such things as communications, cryptography, computing and metrology, have become popular because they enable us to achieve tasks that are not using traditional (classical) methods. One example is quantum cryptographic protocols, which are now used commercially. These are methods that are used particularly in communication devices where secure transmission of data is required. The advantage of using these over classical methods is that attempted eavesdropping on communications can be detected.

The last two decades have seen accelerated development in quantum technologies, including advances in the experimental control of individual quantum systems (arrangements of atoms) for which Serge Haroche and David Wineland were awarded the 2012 Nobel Prize in Physics. Being able to control the behaviour and arrangement of atoms is vital for the development of quantum technologies. Many other important experiments have also been successfully carried out, notably in cryptography and teleportation, for example in the 2010 World Cup in South Africa, a quantum cryptographic protocol was installed to transmit information between Durban's stadium and the operation centre, and in 2012 a teleportation protocol was successfully performed across 144km between two Canary Islands. Teleportation in this sense means a way to transmit information using quantum effects.

Motivated by these successes, major space agencies in Europe and Canada have invested resources for the implementation of space-based quantum technologies. There are advanced plans to use satellites for quantum cryptography and teleportation and to install quantum clocks in space. However, at these large scales relativistic effects become observable, that is to say that gravitational issues have to be taken into account. The Global Positioning System (GPS), a system of satellites used for time dissemination and navigation, requires relativistic corrections to determine time and positions accurately.

Current quantum technology development has focused on perfecting the small-scale issues but has largely ignored the large-scale issues. Recent work carried out by the Relativistic Quantum Technologies (RQT) team led by Ivette Fuentes at Nottingham shows that relativity produces observable effects on quantum teleportation and quantum cryptography. Moreover gravity and motion can decrease the efficiency of currently proposed quantum methods. Theoretical work is now being undertaken at Nottingham to fully demonstrate the importance of these effects. A comprehensive understanding of relativistic effects on quantum properties will enable us to not only make the necessary corrections to technologies that are affected by them but to also use the relativistic effects as a design tool.

Ivette Fuentes leads the Relativistic Quantum Technologies team looking at quantum methods.

Student profile

"I love the campus, it [the University] has got a great reputation, it's got a new maths building, it's a great place to be, with the medical school right across the road... I've applied to do a PhD here, hopefully it's going be in the same topic as my dissertation, which will be modelling brain tumours and will be alongside the Medical School as well."

Denise Vlachou
MSc Mathematical Medicine and Biology

Find out more about Denise's experience at
www.nottingham.ac.uk/pgvideos/denisevlachou

Scan here with your smartphone for more student profiles.

Denise is working in one of the seminar rooms in the Mathematical Sciences Building.

Student profile

Gambling on a masters

Iker Perez Lopez came to Nottingham from Spain to do his masters after developing an interest in maths through working in the gambling industry. Here he talks about being an international student at Nottingham.

"I did my undergraduate degree back home in Bilbao, Spain, and then I started working in the gambling industry for around six months. We used to use maths to work out which teams were more likely to win the matches in order to place the odds for people to gamble. I enjoyed it a lot so that's why I chose to look for a place to study for a masters.

My initial plan was to get the qualification and then return home and keep on working in the gambling industry, but now I'm here I have changed my mind because I have found it very rewarding. I have experienced what it's like to stay and work here and to be taught by lecturers who really, really enjoy what they are doing.

I had never lived abroad before coming to Nottingham and I thought it would be quite difficult but now I'm here it's actually quite the opposite. From the very beginning there were plenty of socials and the Postgraduate Students' Association (PGSA) is always arranging ways for you to meet people from the UK, as well as other international students. So from the very beginning, although it didn't quite feel like home, it felt like I was somewhere where I was in the same situation as many other people.

There are plenty of sports facilities here which I appreciate as I like sport a lot, and there are libraries and other facilities on all the campuses. The new Mathematical Sciences Building is also really good. There are so many people here enjoying studying here, the level is really high and the research is top rated. So far everything I have done here I have found really gratifying and rewarding. I think it's a really, really nice place and my advice to anyone is, if you get the opportunity to come here, you should."

"From the very beginning there were plenty of socials and the Postgraduate Students' Association (PGSA) is always arranging ways for you to meet people."

Iker Perez Lopez in the atrium of the Mathematical Sciences Building.

For further information please contact the Mathematical Sciences Admissions Team:

School of Mathematical Sciences,
The University of Nottingham, University Park Campus,
Nottingham NG7 2RD

t: +44 (0)115 951 3847
e: maths-pg-admissions@nottingham.ac.uk
w: **www.nottingham.ac.uk/mathematics**

Postgraduate course information is available at **www.nottingham.ac.uk/pgstudy**

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e: alternativeformats@nottingham.ac.uk

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