Postgraduate study

The University of Nottingham

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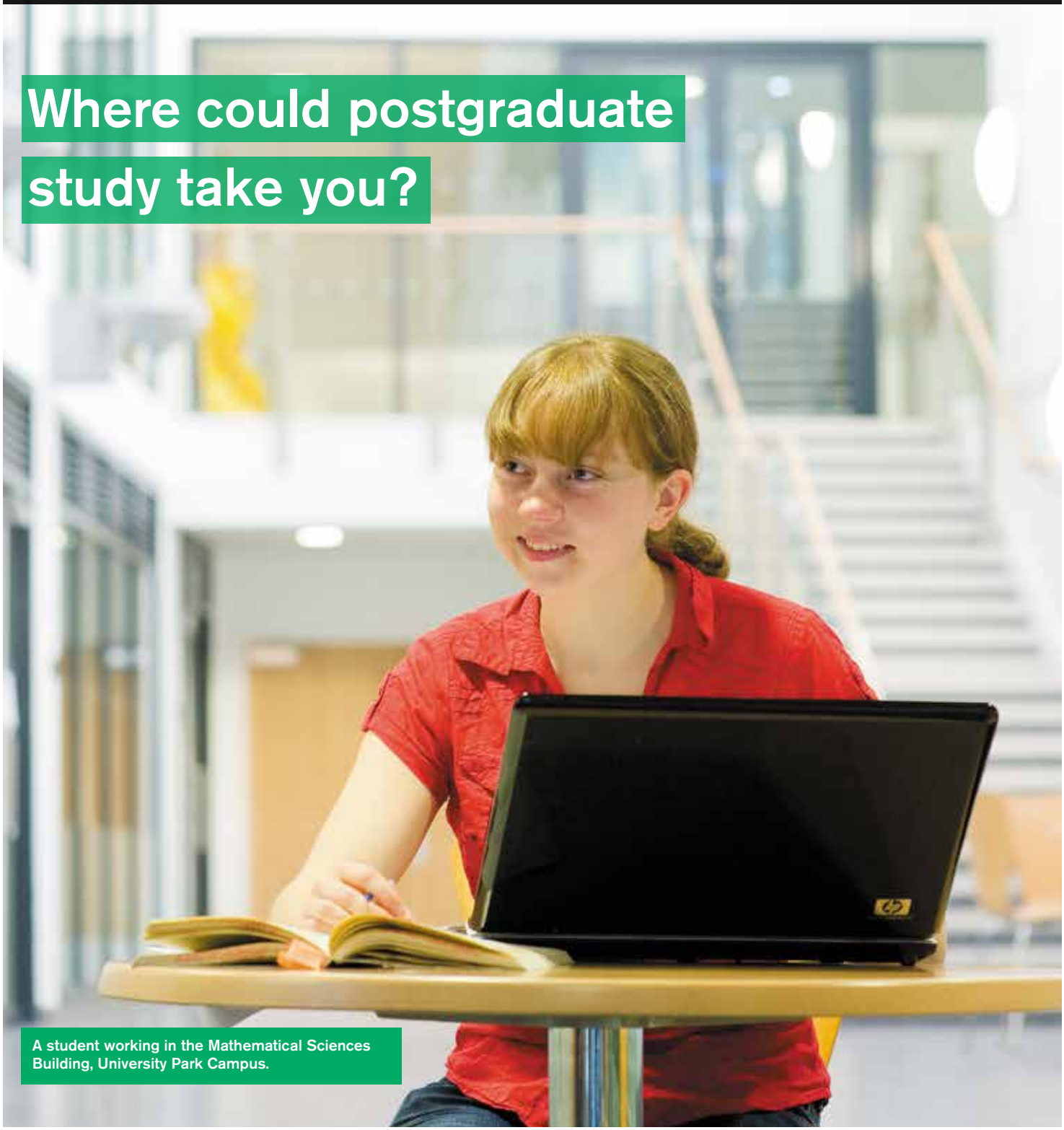
Mathematics@Nottingham

School of Mathematical Sciences Postgraduate Newsletter 2013

Where could postgraduate study take you?



A student working in the Mathematical Sciences Building, University Park Campus.

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

An international perspective
An international student gives their take on studying mathematics at Nottingham

Meet our staff
One of our academics talks about their research and career in academia

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 David Riley
Head of the School of Mathematical Sciences

News

Territorial Army award for maths postgraduate

Mathematical sciences postgraduate student, Joe Giddings, is a reservist with the Territorial Army (TA) at the same time as studying for his PhD, and he recently received the Champion Soldier award.

Joe transferred from full-time study in order to free up time for training for the TA. He generally works the same hours as a full-time PhD student, but every few months takes a couple of weeks off to do a TA reservist training course.

Reservist training involves completing the basic training, which covers first aid, map reading, weapon handling, drill and a lot of physical training, followed by trade training.

Joe said: "I joined the TA in October, I wanted to join the RAF as a fighter pilot but my eyesight wasn't good enough.

"I didn't know what to do after university but at the same time, I didn't want to sit down and do nothing. So I decided to sign up to the TA as well as studying for my PhD. Since making the decision, I have never looked back."

The Champion Soldier award is given to the best recruit at the end of the basic training. Joe is delighted to have been given the honour and we would like to congratulate him on his award.

News

Charity cake baking

A group of postgraduate students within the school have been busy baking for a range of good causes.

The latest charity cake sale put on by the group was to raise money for Comic Relief. Around 20 postgraduate and postdoctorate students and staff were involved in both contributing baked goods to be sold and manning the stall on the day. In total, the group raised an impressive £376.84.

Student profile

"I was an undergraduate at Nottingham and I did an internship here during the summer before my last year, and while doing that I met my 'now' supervisor. It was a combination of really enjoying my time as an undergraduate and meeting my supervisor, and we came up with a project we would like to work on together."

Tom Wicks
PhD Mathematics

Find out more about Tom's experience at
www.nottingham.ac.uk/pgvideos/tomwicks

Scan here with your smartphone for more student profiles.

Tom is working in the common room of 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.

Funding

Start your funding search early

PhD Mathematical Neuroscience student, Kyle Wedgwood, shares his advice on securing funding and talks about his research.

It's important that you explore your funding opportunities well in advance. We recommend that you begin researching at least a year before your proposed start date.

Our web pages are a good place to start looking as they provide information on scholarships and awards that you may be eligible for, please see www.nottingham.ac.uk/mathematics/prospective/research/feesfunding.aspx

Kyle Wedgwood was primarily funded through an Engineering and Physical Sciences Research Council (EPSRC) grant:

"I finished my BSc Mathematics at The University of Nottingham in 2008. I was working in a hospital as a vacation job and it was there I got interested in the possible applications of mathematics to medicine and biology, in particular, the possible applications to neuroscience. After talking to staff in the school, I decided to apply for the MSc Mathematical Medicine and Biology. During this course I met my current supervisor, Professor Stephen Coombes, who later took me on as his PhD student.

The application process was fairly straightforward. As I already knew Professor Coombes, we had a number of informal chats and he was very helpful when I was writing my application and proposal.

My PhD is primarily funded through an EPSRC grant, which pays for my stipend. Other than that, I have received a number of small travel grants, mostly from conferences I have presented at. In addition, I received a travel award from the Graduate School for £600 to help fund a trip to the US. I've also just been awarded an Endowed Postgraduate Award of £150, which isn't technically funding, but it certainly helps pay the bills!

As far as getting funding goes, it's quite a steep learning curve. Start early, but be prepared for rejection, since there is only a limited pot to go around. Whenever you write a grant the most important thing to do is identify what the goals are and why they are important. You can then show how you hope to achieve them and how your skills are aligned to them. The most important thing is to highlight what successes will result from your work. If you don't get the funding, ask for feedback on it – this will help improve any subsequent proposals.

My research is focused on techniques for analysing neural dynamics. Principally, we are interested in how rhythms are generated and maintained in and between regions in the brain. Such rhythms are of great importance in both physiological and pathological states in the brain. Mathematical models attempt to highlight the key processes responsible for emergent behaviour through a reduction in the complexity of the system. These present interesting challenges both in the biological and the mathematical arena.

The best resource available to a mathematician is of the human variety, and I'm pleased to say that it is in abundant supply in the School of Mathematical Sciences. My supervisors have been incredibly supportive throughout my time here, both in terms of my research and career development. Working with them, I have had several papers published, and have started collaborative projects with academics at other universities.

My supervisors have encouraged me to take on responsibilities outside of research, which will ultimately help my career progression.

I am due to complete my PhD very soon and have managed to secure further funding through the EPSRC Doctoral Prize. This is funding available to students whose PhDs have been funded, at least in part, by EPSRC. It is designed to allow good students to continue research built on work done during their PhD. The idea is to give students some freedom to explore new ideas, increase their publication rate, undergo new training, present at conferences and to widen the impact of their research through outreach events. EPSRC provide supplementary grants to help fund travel, training and the operational costs of outreach events such as public access lectures."

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 analysis; and statistics and probability. Here we look at two of the groups in more detail.

Industrial and Applied Mathematics

The Industrial and Applied Mathematics research group applies mathematics to solve a wide range of problems in science, technology and engineering. Here are some interesting examples of what the group has been working on:

Pattern formation
Patterns arise widely in nature, from animal coat markings to clouds, from ripples on a beach to rock formations such as the Giant's Causeway. Our research explores the fundamental mechanisms underlying the formation of a diverse range of patterns, through bifurcation theory, asymptotic methods and computation.

Carbon capture and storage
The transport of liquefied carbon dioxide from power stations to subsurface reservoirs requires a detailed understanding of the thermodynamic properties of carbon dioxide in the presence of impurities. We are investigating these properties using statistical mechanics and Monte Carlo simulation.

Rock crushing
The first step in the extraction of minerals from mined rocks is crushing. Rock crushing eats up enormous amounts of energy, and is a poorly understood industrial process. We are working to improve the efficiency of commercial rock crushers through simulation.

Vibration analysis
Vibrations can cause problems in a variety of complex structures such as buildings during earthquakes and engines for road, rail and air transport. We are developing new methods for modelling these vibrations based on techniques originally used to solve problems in quantum mechanics.

Statistics and Probability

The Statistics and Probability research group is active in a range of areas from fundamental theory to data-driven applications in many fields. Here are just a few examples:

The statistics of shapes and images
We are developing new methods to summarise and analyse data on shapes and images, with applications including face recognition software, drug development and medical imaging.

Financial mathematics
Understanding the complex uncertainties of financial markets requires tools from probability theory. Our theoretical advances lead naturally to applications in many areas including hedging, pricing and optimal investment strategies.

Epidemic modelling
We are formulating new modelling methods and data analysis techniques with application areas including the spread of disease through social networks, hospital superbugs, avian influenza, measles and veterinary diseases.

Climate science
Predictions about global climate change are derived from hugely complex models which may take hundreds of hours to produce results. We are developing new ways to make predictions, taking into account inherent uncertainties.

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

The Statistics and Probability research group is looking into new ways of making predictions about climate change.

An international perspective

International student ambassadors are around to help during Welcome Week.

International masters student, Mayte Bonilla Quintana, talks about her experiences of coming to study mathematics at Nottingham and the transition between her home country, Mexico, and Britain.

"I was looking for a masters course that investigated the modelling of biology phenomena. Although a few universities offer courses in mathematical biology, I preferred the structure at Nottingham because it mainly focuses on dynamical systems rather than statistics and computational sciences.

I applied online and the site explained the process very well, I was also given contact details so if I had any queries with my application, I could have them answered as soon as possible. After I received my conditional offer, the University gave me a variety of useful information about accommodation, the International Office, International Welcome Week, the city and more.

I was also given a lot of advice about scholarships and I found out about a scholarship partnership between The University of Nottingham and the Mexican government, so I applied and received funding to cover my tuition fees and an estimated living cost.

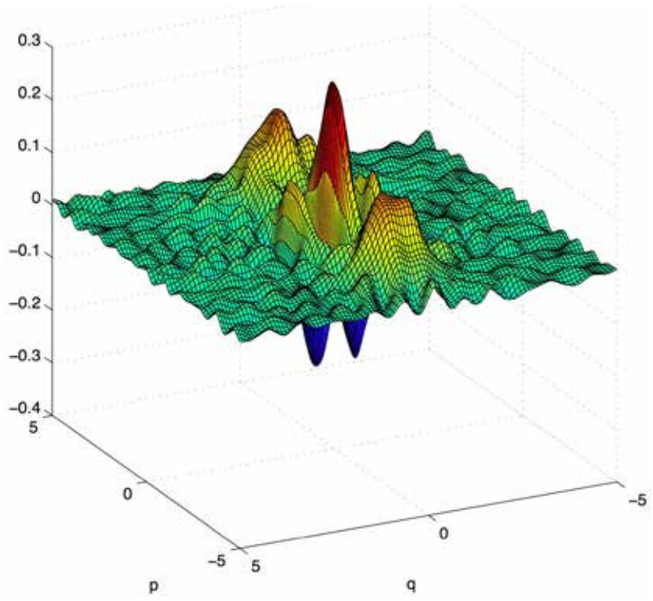
The International Office organised events for us both at home and in the UK to help us to meet people. There was a dinner party with present and former students, representatives from the University took part in a 'Study UK' fair back in Mexico, and once we were in Britain we were invited to events including a coffee morning.

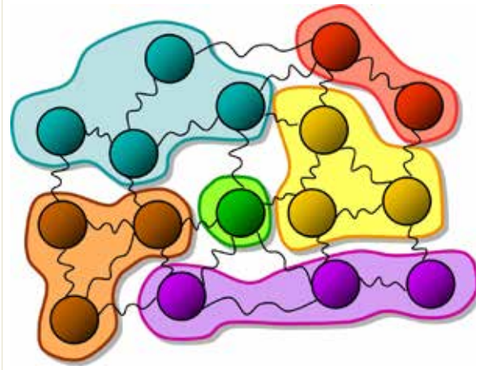
When I arrived in Britain, I took part in International Welcome Week. This involved talks on aspects such as British culture, University facilities and visa procedures. The talks were very informative and helped me to understand better the University and the culture here.

I found there was a smooth transition from my home country, Mexico, to Britain, although getting used to the weather and the short days was hard!

My advice to other international students coming to Nottingham would be to make sure you hang out with people on your course, it will make it easier for you to settle in."

Mayte Bonilla Quintana
MSc Mathematical Medicine and Biology





Above: Pictorial representation of entanglement among multiple quantum particles (Phys. Rev. A Kaleidoscope Image Oct 2008, © G Adesso).
Left: Wigner function of the Schrödinger cat quantum state reconstructed with the statistical technique of homodyne tomography (© M Guta).

Taking maths further: quantum technology

We have an active team of researchers studying a wide range of topics in quantum information science.

We are currently entering a new technological era, where the fundamental properties of quantum systems are exploited in applications such as super-fast computation, high-precision metrology and secure cryptography. Quantum information science is a young and eclectic field joining quantum physics with information and computation, probability and statistics, and control theory.

Quantum mechanics was arguably the most successful scientific theory of the 20th century. As miniaturisation is moving to smaller and smaller scales, it becomes clear that the ultimate carriers of information are quantum systems such as atoms and photons, the building blocks of nature.

However, this information does not obey the rules of usual 0 and 1 bits, but is encoded in the state of quantum systems, the simplest one being a two-dimensional system called a qubit. At the heart of many quantum information applications is the notion of entanglement between systems, which is a correlation of a purely quantum nature. Exploiting entanglement, we can build encrypting devices for secure communication; we can implement mind-baffling experiments such as quantum teleportation; and we can solve computational problems exponentially faster than the most advanced current supercomputer.

- We explore the mathematical theory of entanglement and its role for quantum communication and information processing, how to engineer quantum correlations experimentally and how to protect information transfer from data loss and malicious eavesdropping.
- We develop efficient statistical methods for the detection of entanglement between different parts of a system composed of several sub-systems, and the experimental reconstruction of quantum states from measurement data. We develop mathematics for key enabling components of quantum engineering such as quantum control, which deals with controlling the states and dynamics of quantum systems.
- We explore the relationship between quantum technologies and relativity aiming to understand the effects of gravity and motion on quantum information and quantum metrology. These questions are timely since cutting-edge quantum experiments are reaching relativistic regimes. Such as advanced plans to use satellites to distribute entanglement for quantum cryptography and teleportation (eg the Space-QUEST project).
- The research group within the School of Mathematical Sciences organised a European workshop on Signatures of Quantumness in Complex Systems where the fundamental role of quantum effects in complex and even living systems was unveiled. The group is also involved in the organisation of an international workshop on relativistic quantum information at Nottingham in June 2013, and a programme in quantum control at the Newton Institute in Cambridge which will take place in 2014.
- The Engineering and Physical Sciences Research Council (EPSRC) has selected the topic Developing Quantum Physics for New Quantum Technologies as a Physics Grand Challenge, and quantum information science is signposted as a growth area.

Meet our staff

Dr Susanne Pumpluen's career in academia has taken her all over the world, giving her exciting opportunities to live and work in several different countries and to experience different cultures along the way.

Dr Susanne Pumpluen

"I think it was clear for me from very early on that I would like to have a career in academia. Although I was equally interested in languages, I decided that studying mathematics would give me a broader choice of careers.

After doing my undergraduate studies at the University of Munster I did my PhD at FernUniversität Hagen (both Germany), and spent time living in America as a college instructor at New Mexico State University (NMSU) in Las Cruces. Since my original plan was to try to obtain a permanent post in Germany, I was then required to do my 'habilitation' which is basically like writing a second PhD thesis plus several publications. This, along with a talk I made at a research institute, helped me secure my next position at at the University of Regensburg.

I was the third woman since the foundation of the university who did this higher qualification in mathematics and I later obtained an award for my thesis.

One of the best things for me in trying to make it in academia was the opportunity to travel and live and work in different countries (and actually get paid for it!). For instance, it gave me the chance to spend some months at the University of Ottawa, to be a visiting assistant professor in Las Cruces and to teach at the University of Trento in Italy. I have friends all over the world now as a result and got to know different cultures.

I also believe that the flexibility of being in academia really helps in having a family. My twins are twelve years old and although the first years were really hard (well, I guess every mother of twins will agree on that), I think I am able to organise my work flexibly enough to be there for them.

My research interests lie in the areas of algebra, number theory and algebraic geometry. I recently also started to look at possible applications of my research on algebras to coding theory, in particular to space-time block codes. Space-time block coding is used for reliable high rate transmission over wireless digital channels with multiple antennas at both the transmitter and receiver ends.

As wireless communication is becoming more widespread (it is used for example in laptops, iPads, mobile phones and portable TV's), there is a great demand to find ways to transmit information like data, speech or images at a high rate, taking into account limited bandwidth and transmission power, and trying to loose as little data as possible during the transmission.

I have been at The University of Nottingham since 2004, as Associate Professor since 2008. The academic year 2005/6 I spent at the University of Trento on a German DFG research grant. I am really glad that Nottingham chose me, it is a great University to work at."

Dr Susanne Pumpluen
Associate Professor

For further information please contact the Mathematical Sciences Admissions Team:

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