The University of Nottingham

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Physics and Astronomy @Nottingham

School of Physics and Astronomy Newsletter 2013

Welcome to your future

Jasmine Rivett working in the nanoscience research laboratory.

The Science Show
University Radio Nottingham's award-winning show

Life after graduation
Find out about the careers support we have to offer

Research opportunities
Exciting summer placements open to our students

Welcome to the School of Physics and Astronomy

This edition of our newsletter emphasises some of the opportunities offered to our undergraduates to participate in the research activities of the School of Physics and Astronomy. This can involve paid summer placements in our laboratories or innovative research work as part of final-year projects, which can make important life-changing and career-building impressions on our students. Our students' creativity can be expressed in other ways too, for example with the inauguration of the 'Science Show' on University Radio Nottingham – in their very first year on the air our students achieved a national award for journalism, for which they deserve warm congratulations. But it's not all physics; our students also develop strong passions for sport, as you will see.

We very much appreciate your interest in our school and we hope to welcome you as a visitor to one of our open days or as a student.

Professor Richard Bowtell
Head of the School of Physics and Astronomy

Exchange

Overseas exchange

Lund in Sweden will become a key European research centre during the next decade with the forthcoming development of important research facilities such as the Max-IV synchrotron radiation facility and the European Spallation Source (ESS) for neutron science.

As part of an initiative to establish Lund University as a key partner, the School of Physics and Astronomy at Nottingham is currently discussing the inauguration of various collaborative programmes including undergraduate student exchange.

This will enhance the opportunities for our students to visit overseas laboratories and gain valuable experience as part of their undergraduate studies.

Artist's impression of the Max-IV synchrotron radiation facility at Lund.

Events

Testing our students' skills

The inaugural 'Egg Race' was held in 2012 to give the opportunity for our first year students to display their ingenuity in designing and building a machine that could transport an egg the maximum distance. The clear winner was the team led by Kristen Thobroe whose design was simple but very innovative and extremely effective.

Above: Team members from left-to-right; Oliver Towlson, Megan Godfrey, Kristen Thobroe, Richard Spencer and Caitlin O'Brien.

The Science Show on University Radio Nottingham

In the studio at URN.

The video of the vortex cannon has gone viral on YouTube.

Podium position for Nottingham physics students in London

Can you really see the Great Wall of China from space? Is glass thicker at the bottom than the top?… and how about the efficacy of homeopathy? These are all 'myth buster' topics tackled live on air on the University Radio Nottingham (URN) award-winning Science Show.

The radio show is the brainchild of Nottingham astrophysicist Emma Bradshaw. She had been working with URN since her days as an undergraduate and out of this experience the idea for the Science Show gradually grew. She developed the concept together with some enthusiastic science students, mostly physicists, and the show finally hit the air last year with its own distinctive brand in communicating science and entertaining students across the University of Nottingham campuses.

In its very first year, the Science Show team was nominated in the 'Best Journalism' category at the 2012 Student Radio Awards in London, and duly gained bronze position, a fantastic achievement. Emma and her team including four physics students, David Farmer, George O'Neill, Carl Mundy and David Brander, received their award at The O2 arena from Radio 1 Newsbeat presenter Chris Smith. The awards ceremony, attended by some 700 people, was hosted by Radio 1's Nick Grimshaw and Capital Breakfast's Dave Berry.

Having now recently completed her PhD research degree at Nottingham, Emma said: "I am incredibly proud that a show I set up due to my love of both science and radio has been nationally recognised, especially in its first year. I've now heard of more radio-based science shows being set up at universities around the country and it's great to know that we have inspired that."

A typical show centres on an interview with a Nottingham science academic. Examples include Professor Ed Copeland discussing The Higgs Boson, Dr Omar Almaini on supermassive black holes and Professor Philip Moriarty revealed his thoughts on whether 'nanobots' could ever take over the world. Such guests are seasoned radio and video professionals, featuring regularly on national radio networks and social media, so it is essential for the radio presenters to adequately prepare for each show. Emma revealed: "I was quite nervous when we started interviewing my lecturers on their research – I was worried that they might start asking me about what I knew! But after a few shows the nerves wear off."

The Science Show doesn't let itself be constrained within the confines of radio communication. A unique feature of the show is the link to YouTube videos produced by the students themselves. One such video on their enigmatic but very simple 'vortex cannon' has gone viral on YouTube with nearly a million viewers – visit **www.youtube.com/user/URNScienceShow**

David Brander reflected on his experience: "Being part of URN really broadened my horizons and let me pursue my dream of taking science to everyone. It taught me valuable skills such as team work and audio visual editing which I hope to apply to jobs in the future."

You can listen to URN on the internet at **www.urn1350.net**

Your career after graduation

For many reading this newsletter, thoughts of future careers may be a long way off. Foremost in your minds will probably be the enjoyment of learning about exciting new areas of physics and how your enthusiasm for your subject will be further developed in a university environment. However, many of you will additionally have at the back of your minds thoughts about the sorts of career your final degree will open doors to.

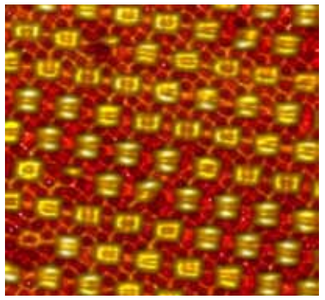
This academic year has seen the school further develop its approach to the undergraduate careers and employability agenda. In a coherent programme custom designed for physicists, the University's Careers and Employability Service delivered initial workshops on interview skills, CV writing and general employment advice, while in November the school coordinated its first, locally-based careers fair.

The fair attracted a range of employers, such as Rolls-Royce and KPMG, who were able to set out potential career pathways for physics graduates within their respective sectors. Various speakers from different employment sectors were also invited to give personal insights into how their qualifications and experiences as science graduates had allowed them to progress in their respective careers.

Throughout the year the school also invites key employers representing different sectors and careers, such as Oxford Instruments and PwC, to give lively presentations to our students. These often include talks given by young graduate trainees in the company who can give the benefit of their perspective and experiences in helping our students decide their future career pathways.

This year saw the school coordinate its first careers fair.

Summer research opportunities



Left: Jasmine working on the scanning tunnelling microscope (STM).

Above: A scanning tunnelling microscope image of an assembly of brominated porphyrin molecules of the type Jasmine studied. Each of the gold-coloured protrusions represents the central core of a porphyrin molecule.

Each year, the School of Physics and Astronomy offers paid summer placements for students to work in our research laboratories and current student, Jasmine Rivett, has made the most of these opportunities.

Fourth-year undergraduate student Jasmine has developed a passion for nanoscience while at Nottingham studying for her MSci Physics degree, and has been able to take advantage of the summer placements on offer to further develop this.

Jasmine said: "It was an excellent opportunity to gain an insight into physics research. It was very exciting to use the skills I learnt in first and second year labs in a real research environment, where you are carrying out experiments that have never been done before."

Nanoscience involves the study of atoms and molecules which are deposited on an ultra-clean and flat silicon surface or 'wafer'. The materials are investigated and imaged at the atomic scale, namely nanometres, or less than one-billionth of a metre. The science is fascinating for its own sake, for example revealing the quantum and wave-like nature of matter, but importantly researchers can also manipulate the arrangement of the atoms and molecules 'from the bottom up' to make new structures that have important technological applications.

Jasmine entered this exciting new world in the summer of 2011, and again in 2012, working in the research groups of Professors Philip Moriarty and Peter Beton and Dr James O'Shea.

She gained valuable laboratory experience working with low temperature cryogenic liquids, preparing new nanoscale samples and imaging the surface molecules using a state-of-the-art scanning tunnelling microscope (STM).

Additionally she was able to gain experience of a wide range of nanoscience techniques and facilities including atomic force microscopy (AFM), as well as write a new computer program to analyse the image data.

Jasmine added: "It was brilliant to be able to actually use the equipment that we learn about in lectures and I ended up with some really nice AFM images."

Jasmine's work made an impact. Professor Peter Beton said: "The images of organic dye molecule and fullerenes, or buckyballs, that Jasmine obtained using scanning tunnelling microscopy have opened up several new directions of research for our group related to phase changes and molecular-based computing algorithms.

The expertise she has gained provides a great background for her fourth-year project on graphene, for which she will link up with Chinese researchers at Fudan University in Shanghai."

Jasmine added: "I haven't worked with graphene before, but since its discovery a few years ago, it has become a very important material in nanoscience research so I am really looking forward to using it to make new devices.

I would really like to do research in nanoscience and I have applied for PhDs at Nottingham, Bristol and Cambridge. It's a very active field at the moment and I am particularly interested in green energy and medical applications of nanoscience."

"Students are very lucky that the research within the school is excellent; it means that as well as having enthusiastic lecturers, these summer placements are possible."

Jennifer Gaskell


Jennifer running in Els Ports National Park, Spain.

Ultra-distance running; a marathon and a bit more…

"There's nothing more satisfying than running all through the night and watching the sun come up, knowing you've covered a vast distance over the mountains while others slept!"

Nottingham physics student Jennifer Gaskell exudes enthusiasm for her chosen sport. It's not on the Olympic agenda but you might realise from her quote that her sport is really a bit special: ultra-distance marathon running. The conventional 26 miles and 385 yards is really just a warm-up; quadruple that distance, add in a few mountains plus some map-reading and navigation and you begin to gain an impression of the challenges Jenn sets herself.

Jennifer started ultra-distance running during her days as a mathematical physics undergraduate at Nottingham after first joining the University mountaineering club. She is now undertaking postgraduate research, studying for a PhD in Theoretical Physics. Her running achievements include the 131-mile 'Ring O Fire' race around the whole coastal perimeter of Anglesey and the 100km Chamonix-Courmayeur-Champex mountain race which completes a semi circumnavigation of Europe's highest mountain, Mont Blanc. She also regularly completes in the two-day OMM (original mountain marathon) orienteering competition which is held each year in a different UK mountain location.

Jennifer says: "Nottingham is a great location with the extensive green areas of our University Park Campus and the adjacent Wollaton Park available for lunchtime and evening training. Then for more challenging hills, the Peak District is within easy travelling distance."

Looking to the future, next summer it's the Ultra Trail du Mont Blanc and the Lakeland 100 but before that Jenn has the Spine Race in her sights – 268 miles non-stop along the entire Pennine Way in the depths of winter; she modestly claims she "might not finish, because no girl ever has!".

You can meet Jenn at our open days and follow her blog at: **jennsultraadventures.blogspot.co.uk**

"Young ultra-runner undertakes as many adventures as possible. Loves being set challenges and attempting the near-impossible… sometimes succeeds!"

Out of the blue

Research at university should involve blue sky ideas. Indeed the concept of combining evolutionary genetic algorithms with machines that can manipulate individual atoms is something, possibly, of science fiction.

But this is precisely what Julian Stirling was involved with during a summer project as a second-year undergraduate physics student, developing an instrument that could, in essence, automatically evolve predefined nanoscale structure.

Julian said: "The success of the work strengthened my interest in scanning probe microscopy and I went on to build a scanning tunnelling microscope during my third year undergraduate project, for which I won the Bill Moore Prize."

The idea was further developed during the first part of his PhD here at Nottingham with his work on automated scanning probe software. This won him first prize in the postgraduate poster competition sponsored by Tessella, a leading scientific software company. The software and the research findings have since been presented to leading scanning probe manufactures.

Julian added: "It was great to see how, over a short space of time, the initial concept had developed from a summer project to the start of a real solution to a long standing problem within the scanning probe community."

The blue sky research also continues, just recently the project was awarded the 2012 Silver HUMIES prize for the application of genetic algorithms. Not bad for a project that, in its conception, was almost science fiction!


Julian Stirling has presented his novel software developments to scanning probe manufacturers.

PhD student shortlisted for national communicator award

What influences and motivates young school children to think about a career in science? Many established professors and lecturers in the School of Physics and Astronomy can probably point to an influential teacher, book, TV programme or event that started them out on their scientific ventures.


Our audience gets the opportunity to learn about astronomy in an interactive environment from a real astronomer.

To make life-changing opportunities like this available to a wide group of young people, early career Nottingham astrophysicists are bringing astronomy into the community.

With the aid of their mobile planetarium they have presented The Inflativerse show to around 2,500 young people in their first year. They travel to schools delivering shows on the night sky, navigation by the stars, the constellations and planets visible that month, the myths behind the constellations, how the night sky changes over the year, and so on.

Postgraduate astronomer Evelyn Johnston said: "Our ultimate aim is to encourage them to look up into the sky on the next clear night to see if they can identify a constellation or planet we've taught them about, and from here begin to develop a deeper understanding and better appreciation for astronomy and physics."

The team also made an impact in January 2012 at a local BBC Stargazing LIVE event in nearby Wollaton Park.

Evelyn, who is studying at Nottingham for her PhD, was nominated for a national award for her contributions to The Inflativerse. As a shortlisted nominee for the 'Institute of Physics Very Early Career Physics Communicator Award', she attended a function in London where she presented an account of her Inflativerse work in front of TV physicist and author Professor Jim Al-Khalili. Nottingham was represented well at the awards with Julian Stirling (see 'Out of the blue' above) also presenting an account of his own outreach activities.

Professor Ed Copeland and Phill Jupitus.

Stargazing LIVE

If you watched the BBC programme Stargazing LIVE during January 2013, you will have seen our very own Professor Ed Copeland explaining possible scenarios for the ultimate fate of our universe with Brian Cox, Dara O'Briain and Phill Jupitus. Based on the observation we are currently dominated by dark energy, they included the unpleasant possibility that everything will fly apart, and possibly even tear apart over many billions of years – but the reality is we don't know.

Ed Copeland is Professor of Physics at Nottingham with special research interests in how the physics of the very early universe may be tested by observations of both the largest scales (astronomy) and the smallest scales (particle physics) in the universe. The overlap of these areas is known as 'particle cosmology'. Our undergraduate students benefit from his expertise when he teaches the Modern Cosmology specialised option module.

Visit www.sixtysymbols.com where you can find Ed and other members of the school presenting short entertaining videos on physics and astronomy.

Olympic silver for David Florence

David Florence took silver in the canoe slalom double event.

You may recall the thrilling competition in the men's double canoe slalom on the white water course at the London 2012 Olympics. It was one of the great moments in last year's memorable games and represented a second successive Olympic medal for our graduate in mathematical physics, David Florence. Warmest congratulations to David on his fantastic achievement.

Atom Chips as Quantum Sensors

The Condensed Matter and Ultra-cold Atom research groups in the School of Physics and Astronomy are collaborating on the creation and investigation of a new quantum state of matter. The Bose-Einstein condensate is a cloud of ultra-cold atoms confined in a vacuum above the surface of an atom chip using optical, magnetic, electric, microwave and radio-frequency potentials. The atom chip creates a magnetic trap for the atoms using precisely fabricated gold wires. The experiments focus on understanding and manipulating the behaviour of the quantum gas in close proximity to the chip surface.

Right: The wires are fabricated from pure gold using optimised semiconductor fabrication techniques developed by Dr Jessica Maclean.

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