The University of Nottingham

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Physics and Astronomy @Nottingham

School of Physics and Astronomy Newsletter 2015

Be inspired to achieve more

Student satisfaction
The results are in – and our students continue to rate us highly.

Physics in research
Undergraduate students making an impact on the world of physics.

PhysSoc
Find out more about the Physics Society, and their recent travels.

Welcome to the School of Physics and Astronomy

We are pleased that you are considering coming to study at the University, and I'm sure you'll want to know more about what it will be like here at Nottingham. You may be particularly interested in catching up with what our students have been doing, whether it is getting their first research papers published, travelling with PhysSoc, or winning top honours at the National Student Radio Awards. Although, we only have room in this newsletter to cover a few highlights, it is worth noting that the school's very high scores in the latest National Student Survey (NSS) place us firmly amongst the favourites in the country according to all our graduating students.

Even as we go to press, we have received more tremendous news with the announcement of the results of the 2014 Research Excellence Framework (REF), in which, every six years, all subjects in all universities are assessed on the quality of the research they undertake. In physics, The University of Nottingham was placed equal third of the 41 institutions offering the subject. This result followed on from being placed equal second in the previous analysis in 2008. In fact, we are the only single institution to stay in the top five over this entire decade – we are the consistently best University for physics in the entire country!

So, if you do decide to come here to study, be assured that not only will you be signing up for an exciting experience as a student, but also that the staff teaching you will be drawing on the best cutting-edge physics available for everything from core physics modules, to the internships and projects that could result in your own first published scientific results.

I very much hope you enjoy reading this newsletter, and finding out more about the exciting physics going on at The University of Nottingham.

Professor Michael Merrifield
Head of the School of Physics and Astronomy

News

Indicators of excellence

Our student satisfaction is up again in the results of the latest National Student Survey. In 2014, 95% of our final-year students expressed 'overall satisfaction' with their physics degree course at Nottingham.

We are also exceptionally proud that in the recent Research Excellence Framework announcement, we were ranked equal third of all physics departments in the UK for our research.

As highlighted by our Head of School, Professor Michael Merrifield, our undergraduate students get to experience this cutting-edge of physics as part of their curriculum through lectures, projects and masterclasses.

School of Physics and Astronomy
95%
overall satisfaction

Physics department rated equal
3rd
for research

Left: Izzie accepting her award at the O2 arena

Below: Izzie with BBC Radio 1's Greg James and Alice Levine

Nottingham physicist wins gold

Fourth-year physics student, Izzie Clarke, recently won the gold award as 'Best Female' at the National Student Radio Awards for her weekly show on University Radio Nottingham (URN).

The National Student Radio Award ceremony was held at the O2 in London, with the winners in each category being selected from a shortlist by presenters and producers at the BBC and Global Radio.

On the night, the ceremony was presented by BBC Radio 1's Nick Grimshaw and Capital FM's Dave Berry and saw students from all over the country gather to celebrate and await the results of their work in student radio for the past year.

Entries for the awards were submitted in July from which six final nominees were announced at the beginning of October. Then, reminiscent of Hollywood's Oscars and the UK BAFTAs, the winners were revealed at the O2 ceremony in November. The four-minute audio entry for Best Female was judged by Radio 1, and won by Nottingham physics undergraduate, Izzie Clarke. The award, which was presented by Greg James and Alice Levine, was well-deserved and appraised Izzie's hard work and dedication.

Izzie said: "It was a complete surprise. I would love the opportunity to go into radio after university, so this is just really exciting".

"In my third year I was Deputy Station Editor and loved being involved with every aspect of the station, but my weekly show gave me the opportunity to get back to doing what I initially fell in love with; playing the music that students (me included) wanted to hear, with a few laughs along the way – often requiring me to do the most outrageous dares on air."

Following her success at the awards show, Izzie has now been awarded a one-off, two-hour radio show on BBC Radio 1. The show is scheduled to be broadcast in April – keep an eye on our Twitter page for more information soon!

In addition, The Science Show on URN won silver in the Best Speech Programming category for their mini-series "A Brief History of You", which was judged by BBC Radio 4 and BBC Radio 4 Extra.

You can tune into URN online at **http://urn1350.net/**

"It's safe to say I'm not afraid to make a fool of myself; once my friend dared me to chat up strangers on air in the student union using the worst lines possible – it was hilarious, but so embarrassing!"

Getting published...

Being the first to discover new knowledge and ideas can be an exciting experience, especially when it leads a young scientist to their first publication in an international scientific journal, or giving a talk to a conference of experts. Sofia and Sarin were best friends during their time studying physics at Nottingham, and by their graduation, they had both made a lasting impact on the world of science. These are their stories...

Sofia Palazzo-Corner

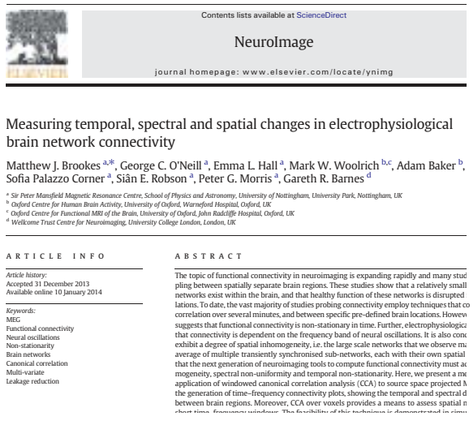
"At the end of the second year on my MSci Physics with Theoretical Physics degree, I had the opportunity to undertake a summer internship in the research laboratory of Dr Matthew Brookes. Here I applied my physics training to study network connectivity of the human brain in the resting state.

This was achieved using the technique of magnetoencephalography (MEG) in which highly sensitive sensors measure the tiny magnetic fields produced by electrical activity in the brain. The magnetic fields typically measure just 0.1 picoTesla, or roughly one billionth of the earth's magnetic field. These were detected using an array of superconducting quantum interference devices, or SQUIDs, that operate at the temperature of liquid helium, -269°C. The result is a complex array of data from which the neurological information on the brain could be extracted.

The work I conducted was clearly novel because two years later I am graduating with my name on a publication '*NeuroImage*', a major scientific journal with a high-impact factor. On this journey I gained first-hand experience of academic research from start to finish; data collection, analysis, conference presentations, all the way to the final paper and its acceptance for publication following peer review.

Dr Matt Brookes and his colleagues in the research group were extremely welcoming and always tried to give me as much responsibility and experience as possible, setting aside time to explain their work.

It has been a unique experience to see this project through from start to finish. Now my undergraduate studies are over, I am extremely grateful to have had the opportunity to participate in both the teaching and research branches of the school."



Contents lists available at ScienceDirect

NeuroImage

journal homepage: www.elsevier.com/locate/ynimg

Measuring temporal, spectral and spatial changes in electrophysiological brain network connectivity

Matthew J. Brookes [a,*], George C. O'Neill [a], Emma L. Hall [a], Mark W. Woolrich [b,c], Adam Baker [b], Sofia Palazzo Corner [a], Siân E. Robson [a], Peter G. Morris [a], Gareth R. Barnes [d]

[a] Sir Peter Mansfield Magnetic Resonance Centre, School of Physics and Astronomy, University of Nottingham, University Park, Nottingham, UK
[b] Oxford Centre for Human Brain Activity, University of Oxford, Warneford Hospital, Oxford, UK
[c] Oxford Centre for Functional MRI of the Brain, University of Oxford, John Radcliffe Hospital, Oxford, UK
[d] Wellcome Trust Centre for Neuroimaging, University College London, London, UK

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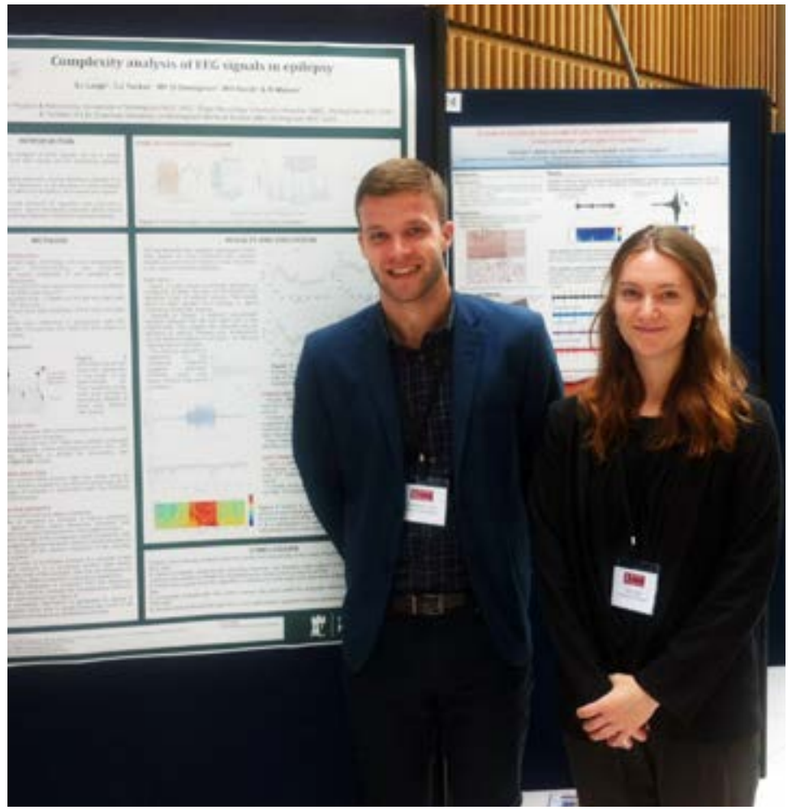
ABSTRACT

The topic of functional connectivity in neuroimaging is expanding rapidly and many stud
pling between spatially separate brain regions. These studies show that a relatively small
networks exist within the brain, and that healthy function of these networks is disrupted
lations. To date, the vast majority of studies probing connectivity employ techniques that co
correlation over several minutes, and between specific pre-defined brain locations. Howeve
suggests that functional connectivity is non-stationary in time. Further, electrophysiologic
that connectivity is dependent on the frequency band of neural oscillations. It is also conc
exhibit a degree of spatial inhomogeneity, i.e. the large scale networks that we observe m
average of multiple transiently synchronised sub-networks, each with their own spatial
that the next generation of neuroimaging tools to compute functional connectivity must a
mogeneity, spectral non-uniformity and temporal non-stationarity. Here, we present a me
application of windowed canonical correlation analysis (CCA) to source space projected M
the generation of time–frequency connectivity plots, showing the temporal and spectral d
between brain regions. Moreover, CCA over voxels provides a means to assess spatial n

Left: Sofia undertook her final-year research project in Rio de Janiero, Brazil – seen here overlooking Copacabana beach with fellow student, Adam Parsons.

Above: Sofia's name in print.



Above: Brain scanning at the Sir Peter Mansfield Magnetic Resonance Centre.

Left: Sarin and her project partner, Christopher Tucker, at the International League Against Epilepsy.

Sarin Leigh

"The research project I carried out in the final year of my MSci Physics with Medical Physics degree was a collaboration with the University's Medical School. Our research involved the development of sophisticated signal processing tools to systematically identify and characterise epileptic seizures that are recorded in electroencephalogram (EEG) data. After conducting a literature review and following meetings with clinicians and researchers, my project partner Christopher Tucker and I wrote a computer program to analyse long EEG data sets. The finished program included five different signal processing methods – all focusing on different features of epileptic seizure.

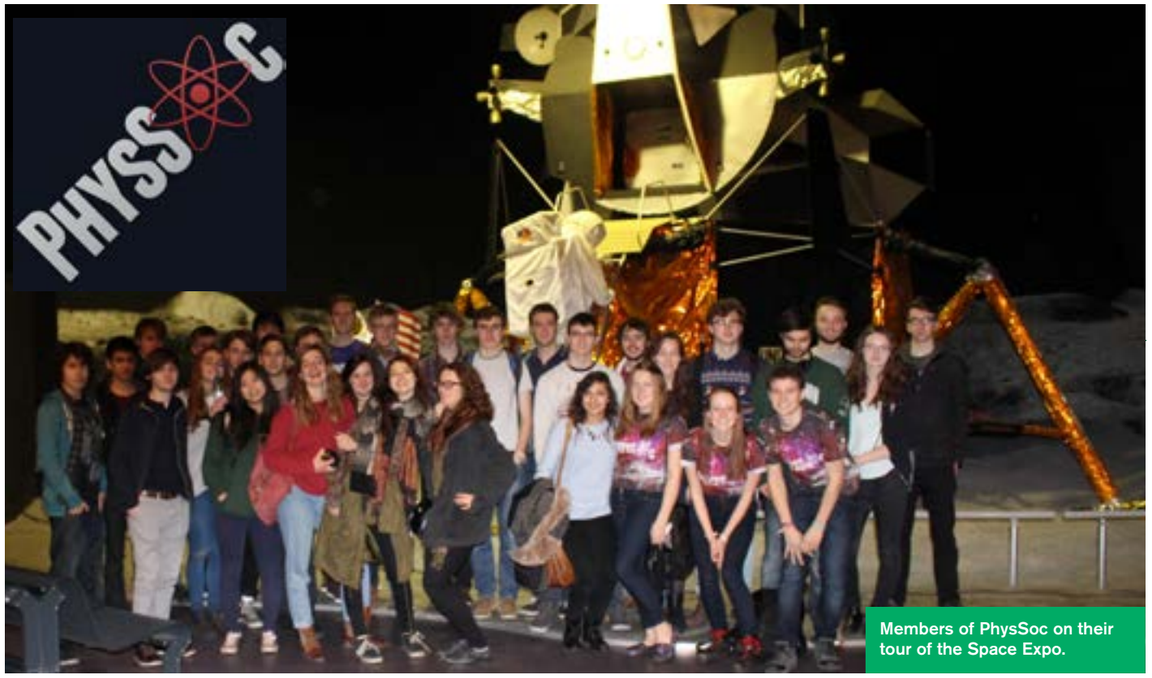
Encouraged by our supervisor, Christopher and I presented a poster of our work at the British Chapter of The International League Against Epilepsy conference. Something novel about our work must have been noticed because I was immediately asked to deliver a short talk about my section of the project on 'Rank Vector Entropy (RVE) analysis in epilepsy research'. I was delighted to be awarded a prize in recognition of the immediate impact RVE analysis could have in epilepsy research, and for delivering a very clear and succinct presentation.

Soon after, I was asked to visit a research laboratory at Newcastle University where we implemented the RVE analysis in studies of epileptiform activity in brain slice preparations. The experience inspired me to consider an academic career more seriously. I have since applied for a PhD at Newcastle involving collaboration with a university in the USA. Looking back, the final year of my degree course at Nottingham provided me with a wealth of opportunities. The support and supervision from the leading academics who taught me helped me to build advanced analytical skills and to thoroughly understand the theory behind complex ideas. Also, the training we received improved my public speaking skills significantly and increased my confidence, playing a huge role in my success at the conference."

Upon completing her project, Sarin has since been selected to represent the University in an event featuring undergraduate projects at the Houses of Parliament.

"It was amazing to attend this conference and be able to talk about my work with leading academics. The support I received from academic staff was exceptional and makes me look back at my University experience very fondly."

PhysSoc launch mission to the European Space Agency



Members of PhysSoc on their tour of the Space Expo.

PhysSoc President, Kris Thobroe, reports on the latest overseas visit by our students to ESA's Space Expo, Amsterdam.

"At the end of another great term of events and activities, the Physics Society (PhysSoc) crossed over to the continent for a weekend in Amsterdam and a visit to the ESA's Space Expo in Noordwijk. Our members enjoyed free time to explore the beautiful city of Amsterdam, decorated with lights and markets ready for the Christmas celebrations before an organised tour of the Space Expo.

ESTEC is the largest of the European Space Agencies' sites and is described as 'the incubator of the European space effort'. Housing an impressive collection of satellites, technology and information the students were able to wander around and marvel at the past ESA missions and ask about the cutting-edge research that's underway, with new exhibits including models and information on famous spacecrafts, Rosetta and Philae. The trip was a great success and we'll be sure to return again next year with another group of excited students!"

Recognising the great activities organised by PhysSoc, they were recently awarded 'Best Departmental Society' by the Students' Union. If you want to find out more about PhySoc and their future adventures, take a look at their Facebook page: **www.facebook.com/NottinghamPhysSoc.**

"A truly amazing trip, a once in a lifetime experience".

Blue-skies research in graphene

The subject of the 2010 Nobel Prize in Physics, wonder material graphene is already featuring regularly in our undergraduate teaching.

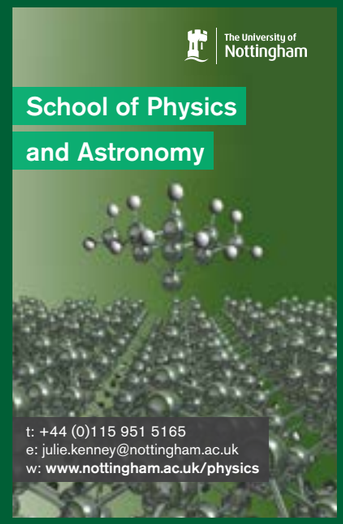
Just one-atom thick but possessing exceptional strength, graphene has outstanding properties that promise to revolutionise electronic devices. In 2013, undergraduate physics students Katherine Wright and Oliver Scott undertook their research project on graphene, and their work has just featured as a paper in the international journal *Nano Letters*. Now, in an exciting new development, the School of Physics and Astronomy has installed a unique facility for growing high-purity, large area graphene using the technique of 'Molecular Beam Epitaxy' (MBE).

It is anticipated this new equipment, which is the first of its kind in the world, will unlock the potential for graphene in the field of electronics and opto-electronics, replacing the technologies on which today's devices are based, resulting in faster more powerful computers. To achieve this, graphene must be grown at exceptionally high temperature and Nottingham's new MBE machine, funded by the UK Engineering and Physics Sciences Research Council, will operate at 1850°C .

The innovation gives Nottingham a world lead; not only will the novel and fascinating physics of graphene feature in undergraduate lectures, but in the near future we expect undergraduate research projects will investigate the unique samples produced with this MBE equipment. This is just another example of how excellence in research feeds through to the undergraduate experience.

Molecular Beam Epitaxy, School of Physics and Astronomy.

Physical constants card



Physical constants

Electron rest mass	$m_e = 9.1094 \times 10^{-31}$ kg
Proton rest mass	$m_p = 1.6726 \times 10^{-27}$ kg
Atomic mass unit	$u = 1.6605 \times 10^{-27}$ kg
Elementary charge	$e = 1.6022 \times 10^{-19}$ C
Speed of light	$c = 2.9979 \times 10^{8}$ m s^{-1}
Permeability constant	$\mu_0 = 4\pi \times 10^{-7}$ N A^{-2}
Permittivity constant	$\epsilon_0 = 8.8542 \times 10^{-12}$ F m^{-1}
Planck constant	$h = 6.6261 \times 10^{-34}$ J s
	$\hbar = h/(2\pi) = 1.0546 \times 10^{-34}$ J s
Boltzmann constant	$k = 1.3806 \times 10^{-23}$ J K^{-1}
Stefan–Boltzmann constant	$\sigma = 5.6704 \times 10^{-8}$ W m^{-2} K^{-4}
Avogadro constant	$N_A = 6.0221 \times 10^{23}$ mol^{-1}
Molar gas constant	$R = 8.3145$ J mol^{-1} K^{-1}
Gravitational constant	$G = 6.674 \times 10^{-11}$ N m^2 kg^{-2}
Solar mass	$M_\odot = 1.989 \times 10^{30}$ kg
Solar luminosity	$L_\odot = 3.839 \times 10^{26}$ W
Solar radius	$R_\odot = 6.963 \times 10^{8}$ m
Year	yr $= 3.156 \times 10^{7}$ s
Astronomical unit	au $= 1.4960 \times 10^{11}$ m
Parsec	pc $= 3.0857 \times 10^{16}$ m
Hubble constant	$H_0 = 68$ km s^{-1} Mpc^{-1}

Our credit card-sized constants card is great for reference, as and when needed.

The third edition of our physical constants card is now being distributed – small enough to be handy at all times, we know you'll find it really useful when solving physics and astronomy problems.

An atomic switch: The image on the card depicts the results of a calculation that models the interactions between the atoms on a crystal face of silicon with an atomically sharp tip of an atomic force microscope (AFM). The surface atoms bond together in pairs to form rows of dimers, which in turn adopt a `buckled' configuration where one end of the dimer protrudes further out from the crystal surface than the other.

By using an AFM, the dimers can be `poked', allowing us to "toggle" the dimers back and forth – similar to the motion of a seesaw – representing a purely mechanically activated atomic switch.

In addition, have you seen our Ruler of the Universe? It's proving to be really popular throughout The University and beyond.

We'll be handing these rulers out at our upcoming open days – a big hit with our visitors and a really useful visual aid, but be sure not to take them into exams!

You can also email julie.kenney@nottingham.ac.uk to request either of these resources.

Staff Oscars

Whether it's summer open days, UCAS visit days, or dealing with the huge volume of UCAS correspondence, you will always find our UCAS secretary, Julie Kenney, is there to cheerfully keep things running smoothly.

Therefore, the school was very proud last year when Julie was awarded the University Staff Oscar in the category Best Member of Support Staff – School/Department. Staff Oscars are awarded by the Students' Union based on nominations made by students, confirming the high esteem with which Julie is held by students and staff alike.

Julie's Oscar adds to the Chancellor's Award that she's already received from the University. Congratulations, Julie!

Julie Kenney with her Oscar.

Professor Moriarty

Sixty Symbols and YouTube celebrity, Professor Philip Moriarty, is now the Undergraduate Admissions Tutor for the School of Physics.

You can meet him in person at our summer open days and UCAS visit days. If you come to study at Nottingham then you'll find him lecturing 'Frontiers in Physics' to first year students.

Sixty Symbols sheds a light on the mysterious world of physics and astronomy through a series of entertaining videos. Want to know more? Visit **www.sixtysymbols.com**.

Professor Philip Moriarty.

Visiting us

If you haven't been able to visit us yet, there are still opportunities to come and see us.

It's a great way for you to explore Nottingham, see the campus, our facilities and meet our staff and students.

For dates of upcoming open days, visit the website – **www.nottingham.ac.uk/ugstudy/visitingus/opendays**

For further information please contact:

School of Physics and Astronomy,
The University of Nottingham, University Park Campus,
Nottingham, NG7 2RD

t: +44 (0)115 951 5165
e: julie.kenney@nottingham.ac.uk
w: **www.nottingham.ac.uk/physics**

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t: +44 (0)115 951 4591
e: alternativeformats@nottingham.ac.uk

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