

SCHOOL OF

Trinity College Dublin Coláiste na Tríonóide, Baile Átha Cliath The University of Dublin

Physics

# 2016/17

## Welcome to the School of Physics Newsletter. We are delighted to bring the School's latest news to our alumni and friends.

This year saw the School secure more than €3.5 million in research funding, with significant success for our research teams at both a national and European level. An example of this is Professor Graham Cross and his Nanomechanics team, whose ground-breaking research on graphene fabrication was published in the prestigious journal *Nature* recently (see cover image). From the Mercury Transit and the City of Physics campaign, to major research breakthroughs in light and magnetism, the School continues to push boundaries and to encourage public engagement with our science. All of these success stories illustrate the School's commitment to being part of a University of global consequence, which was acknowledged by Trinity Provost, Dr Patrick Prendergast across Trinity's recent staff awards. Read more about our winners and some of these events in this issue.

Our students have had a busy year travelling the globe. From China to Russia, and North America to Australia, they have embraced the opportunity to engage with high impact research and teaching. The School wishes to thank our alumni and friends who have made these experiences possible, in particular the Trinity US Alumni Fund which is funding our researchers to spend time at NASA Goddard Space Flight Centre. Read about these trips inside or follow all of our students travels @TCD\_physics.

The School has also relaunched our website, which now features our Books page. From Fitzgerald to Walton, the School's staff have recorded the lives of many famous people who have walked our halls since the beginning of the School's history. Alumni and friends can find out more at www.tcd.ie/physics/books

The School of Physics always likes to hear from our alumni and friends. Please keep in touch by contacting physics@tcd.ie or peter.gallagher@tcd.ie



### Astrophysicists Bring Mercury Transit to Irish Public



Astrophysics researcher Laura Hayes explaining the Mercury Transit to a future student!

On May 9, Trinity's astrophysicists offered the public a unique opportunity to observe the 2016 Mercury transit, when our solar system's smallest planet became visible moving across the Sun. There were hundreds of people that attended Trinity's Front Square to view the event through high-tech telescopes and witnessed footage streamed from NASA's Solar Dynamics Observatory. Visitors also learned about the physics of our Sun, the science of planetary transits, and about new and exciting missions the astrophysics group are currently involved in. Mercury first became visible against the Sun shortly after 12 noon, and it remained so until just after 7:30 pm.

Professor in Physics Peter Gallagher, said, "Mercury is too small to see without magnification, but our telescopes allowed people see it against the vast face of our Sun. There were also plenty of experts on hand from Trinity's Astrophysics Research Group to chat about this exciting event, and to help everyone view the transit safely!" There are only about 13 Mercury transits that are visible from Earth every century. The next ones are in 2019 and 2032, but these will not be visible from Ireland and it will be many more years before the next opportunity arises on our shores. Planetary transits were hugely important throughout science history. They were pivotal in proving Kepler's thenrevolutionary idea that all the planets moved around the Sun in elliptical orbits, and also provided estimates of the distance from the Earth to the Sun. The 2016 Mercury transit comes 100 years after the transit of Venus helped Eddington to verify Einstein's laws of gravity in his General Theory of Relativity.

### Physicists Break New Ground in Light Research

Physicists Kyle Ballantine, Paul Eastham and John Donegan announced the discovery of a new form of light. Until now, it was thought that in all forms of light the angular momentum is a multiple of Planck's constant. The team have demonstrated a new form of light where the angular momentum of each photon takes only half of this value. This difference, though small, is profound and will impact our understanding of the fundamental nature of light.

To make this discovery, the team used an effect discovered in Trinity almost 200 years ago. In the 1830s, mathematician William Rowan Hamilton and physicist Humphrey Lloyd found that, upon passing through certain crystals, a ray of light became a hollow cylinder. The team used this phenomenon to generate beams of light with a screw-like structure. Analysing these beams within the theory of quantum mechanics they predicted that the angular momentum of the photon would be half-integer. To test their prediction they used a specially constructed device to measure the flow of angular momentum in a beam of light. They were able to measure the variations in this flow caused by quantum effects for the first time. The experiments revealed a tiny shift, one-half of Planck's constant, in the angular momentum of each photon. This work confirms speculations which have been made by theoretical physicists since the 1980s.

Commenting on their work, Professor Paul Eastham said: "What I think is so exciting is that even this fundamental property of light, that physicists have always thought was fixed, can be changed". Professor John Donegan said, "Our discovery will have real impacts for the study of light waves in areas such as secure optical communications". These results were recently published in the online journal *Science Advances*.



Half-twists: light with half-integer angular momentum (ii) Professor Paul Eastham, Dr Kyle Ballantine and Professor John Donegan who made the exciting break-through earlier this year.

### School Welcomes New Staff to Astrophysics Team



Professor Aline Vidotto and Professor Jose Groh, the new members of our Astrophysics team in the School of Physics.

Professor Aline Vidotto and Professor Jose Groh were welcomed to the School of Physics staff in March 2016 and are the School's new Assistant Professors in Astrophysics.

Aline Vidotto studies the interaction of exoplanets with their host star's wind, and how this interaction can affect planetary habitability. She has developed 3D simulations of winds of Sunlike stars and recently proposed an innovative method to measure exoplanetary magnetic fields, which has attracted considerable attention in the astrophysics community. She previously held independent research fellowships from the Royal Astronomical Society (University of St Andrews) and the Swiss National Science Foundation (Geneva Observatory).

Jose Groh is an expert in the evolution of massive stars, stellar winds, and supernova progenitors and employs both theoretical and observational technique in his research. He currently serves as an elected member of the Organising Committee of the IAU Massive Star Commission. He previously worked as a Senior Research Fellow (Ambizione) at the Geneva Observatory, Switzerland, and at the Max-Planck-Institute for Radioastronomy, Bonn, Germany. He obtained his Ph.D. from the University of São Paulo, Brazil.

### Trinity Becomes One of the First Irish Institutions to Achieve Prestigious Athena SWAN Award



The School's Women in Physics team celebrating the announcement of the School's Athena Swan award.

Trinity College Dublin became one of the first Irish institutions to receive the prestigious Athena SWAN award in July 2015. Athena SWAN is an initiative run by the Equality Challenge Unit (ECU) to address issues in gender inequality and recently celebrated its tenth anniversary. The Athena SWAN programme run by the Equality Challenge Unit and implemented by Trinity aims to advance women's careers in science, technology, engineering, mathematics and medicine (STEMM) employment in higher education and research. This is the first year in which Irish institutions were invited to participate. Both Trinity and the University of Limerick received Bronze Athena SWAN awards for their institutions as a whole, with Trinity also attaining individual Bronze awards for the School of Physics, Chemistry and Natural Sciences.

Welcoming the award, Provost Prendergast said, "Inclusivity, equality and diversity are core values for Trinity College Dublin, and are enshrined in our recent Strategic Plan. We strive to create an inclusive College community in which women and men participate at all levels and where all are recognised fully for their contribution to the University. These are fundamental principles that underpin Trinity's excellence".

The School of Physics would like to acknowledge all the members of the School's Women in Physics Committee for their work on the application. In particular, the School would like to thank Professor Emeritus Eithne McCabe for driving the committee's initiatives.

### School of Physics Staff Shine at Provost's Annual Staff Awards

The School of Physics shone brightly across the board at Trinity's recent staff awards, and was the only School to receive awards in each of three categories. The winners were as follows:

Dr Shane Bergin (Early Career Award): Dr Bergin's research interests stretch from nanoscience to science public engagement, and he has previously been awarded both the European Commission Science Communication Award (2014), and the American Association for Advancement of Science Award (2016). In collaboration with the Schools of Education and Engineering, he has developed a research-led, problem-based cooperative learning teaching innovation which sets students the challenge to design, execute and evaluate their own experimental approach. He is also responsible for two internationally-recognised programmes that sparked a city-wide conversation on physics - *DART of Physics* in 2013 and *City of Physics* in 2015.

Professor Mauro Ferreira (Global Engagement Award): Professor Ferreira was acknowledged for his exceptional contribution to global education and research, cultural understanding and global experiences that directly benefits the Trinity community, raising the University's profile and supporting the development of students into global citizens. Professor Ferreira has been a key link between the University and partners in Brazil, and was particularly noted for his contribution to the success of the *Science Without Borders* programme. Professor Ferreira's research interests are in the electronic properties of low-dimensional systems.

Joseph McCauley (Professional Staff Award for Outstanding Colleague): School's Senior Experimental Officer, was recently awarded this inaugural Provost's Professional Staff Award which acknowledges his dedication to the School and to Trinity's sub-aqua club. Joe was instrumental in the development of the Rosse Observatory and the LOFAR radio telescope project in Birr, Co Offaly. As part of ECLIPSE 2015 team, Joe took to the skies on an Irish Air Corps Maritime Patrol Aircraft to capture high-resolution imagery of the eclipse.



The School of Physics recent award winners enjoying some well deserved sunshine (L-R) Joseph McAuley, Dr Shane Bergin and Professor Mauro Ferreira .

### A Reflection on Light

A *Reflection on Light* is a new film by artist Grace Weir that travels across different locations and histories surrounding the hanging of a painting titled *Let there be Light* by Irish painter Mainie Jellett (1897-1944), the granddaughter of former Trinity Provost John Hewitt Jellett (1881-1888). The collaborative project began during Grace Weir's Artist-In-Residence in the School and was filmed in Mainie's former house on Fitzwilliam Square, the New Galleries at IMMA and a number of spaces in Trinity.

The film premiered at the small Irish Museum of Modern Art (IMMA) as part of Grace Weir's solo exhibition *3 Different Nights, Recurring*, which was exhibited at IMMA from November 7 2015 to March 28, 2016. The exhibition was followed by a showcase of *A Reflection on Light* on April 15 2016, which included an expanded installation and curated exhibition in the School of Physics.

The painting which inspired the project currently hangs in the School of Physics' Fitzgerald Library and is available for viewing by contacting physics@tcd.ie



Artist Mainie Jellett's *Let there be Light* painting which is currently on display in the School's Fitzgerald Library

### Trinity Walton Club Showcase 2016

Seventy-one secondary school students (aged 13-14) showcased their STEM projects at a special exhibition and ceremony on Saturday, May 28, at Trinity. The event marked the end of the first 30 weeks of their Trinity Walton Club 100-week STEM education journey. The event was attended by the Provost Prendergast, and by Marian Woods, daughter of E.T.S. Walton, both of whom spoke at the event.

The students or 'Alphas' – named after the alpha particles E.T.S. Walton observed in his Nobel Prize-winning experiments – showcased some of their physics, maths and technology & engineering projects. Among this year's projects were (i) a room describer that allows blind people to gain information on the layout of a space upon scanning a discrete tag, (ii) the comparison of series that approximate  $\pi$  and (iii) a project that asks "Is it more efficient to walk or run"?

Established in September 2014, Trinity Walton Club offers secondary school students, who have an interest in STEM, the unique opportunity to come to Trinity at the weekend, work alongside Ph.D. students



**Physics** 

from the Schools of Physics, Mathematics and Engineering and to further develop their knowledge and skills while engaging with Trinity academics and invited guests. Further to the club programme, Trinity Walton Club offers additional opportunities for junior cycle students during the summer months to partake in a 10-day STEM camp at Trinity. For more information or to get involved, please visit www.tcd.ie/waltonclub

### Junior Sophister Students Experience Physics in Kazan



Our seven Junior Sophister students sightseeing during their trip to Kazan.

In September 2015, seven Junior Sophister students tentatively set off on the first Trinitysupported undergraduate experimental physics course in Kazan Federal University (KFU), Russia. The optics and nuclear physics focused curriculum took place in KFU's state-of-theart laboratories which, coupled with a warm Russian welcome and a stunning landscape, made this the opportunity of a lifetime for the students. KFU has a long tradition of prestigious scientists, including seven Nobel Prize winning physicists, the most recent of whom is V.L. Ginzburg who won the Nobel Prize in 2003 for his "pioneering contributions to the theory of superconductors and superfluids".

Danny Bennett, current Theoretical Physics degree student said, "The experience of working abroad in an academic setting

was very helpful, especially now that we are applying for summer internships and final-year projects abroad. Not only have we further developed our experimental skills, we also work better in groups and have a better understanding of experimental set-up and result analysis. It was also great to work with students in different courses; they have different skills and look at problems from an alternative perspective which is great for multidisciplinary research! Travelling across the world to study physics was initially a scary thought, but we all had a fantastic time, and now I would definitely consider doing part (or all) of my postgraduate degree abroad. I would like to thank the School of Physics for giving me this amazing opportunity and KFU for being so welcoming and accommodating to all of us!" This trip was funded by the School's Barklie travel fund, which was set up by Alice Barklie. The School of Physics hopes to extend it's partnership with Kazan Federal University in 2016/17 through recent funding success with the Erasmus+ Mobility Programme.

### Stefano Sanvito Elected to the Royal Irish Academy of Science

On Friday, May 27 Professor Stefano Sanvito was one of two Trinity academics newly elected to the Royal Irish Academy. Professor Sanvito was honoured for his world-class contribution to science with work adding significantly to the promising field of molecular spintronics. He is the author of 150 publications including pioneering works on molecular spin-valves and on the ferromagnetism of diluted magnetic semiconductors. Professor Sanvito is a Fellow of Trinity and Deputy Director of CRANN and is currently Professor of Condensed Matter Theory in the School of Physics.

Election to membership of the Royal Irish Academy which has occurred annually since 1785 is the highest academic honour in Ireland. Those elected are entitled to use the designation MRIA after their name. There are now 497 member of the Academy, in disciplines from the sciences, humanities and social sciences.



New Royal Irish Academy (RIA) members Professor Michael Marsh and Professor Stefano Sanvito with RIA President Professor Mary E Daly.

### Trinity Physicists Capture Magnetism from Empty Space



Theoretical physicists have long believed that empty space is seething with zero-point energy, the quantum residue of electromagnetic radiation. Nobody has ever managed to find a way to tap this limitless store of energy, and the signs that it even exists are slender.

A team from the School of Physics have discovered a new and unexpected manifestation of this elusive energy. In a study of cerium dioxide nanoparticles used in catalytic converters that control toxic exhaust emissions from cars – Professor Michael Coey, Dr Karl Ackland and Dr Munuswamy Venkatesan came across a strange magnetic effect. Quite unlike the behaviour of normal magnets like iron, the effect did not vary at all with temperature. Stranger still, the magnetism only appeared when the particles were

clumped together. Separating them into smaller clumps by diluting with nonmagnetic nanoparticles destroyed the magnetism.

In a paper published in *Nature Physics*, the team, which also included Professor Siddhartha Sen, a quantum field theorist in School of Mathematics, came up with an astonishing explanation. Electrons in the clumps of tiny particles were responding to the vacuum electromagnetic field. Sen and Coey recently predicted that such behaviour might be possible in systems with an enormous surface area (a milligram speck of the cerium dioxide nanoparticles has as much surface area as an entire sheet of newspaper). Furthermore, they predicted that when the particles were separated out into regions smaller than the wavelength of the light associated with them, the effect would disappear. This is exactly what was observed. For more information please visit doi:10.1038/nphys3676

# Alumni Interview

### One-to-One with Justin Lawler



Justin Lawler, B.A., Ph.D. (1994)

#### What was your childhood ambition?

I'm sure I wanted to be an astronaut at some stage. By secondary school I had thought about engineering but had always been interested in understanding how things worked. I must have asked a lot of "but why" questions as a child and physics gave me the opportunity to pursue that. I was also very fortunate to have parents who encouraged me to follow whatever I found interesting.

### What made you decide to study physics in Trinity?

Trinity had the reputation as the best place to study physics in Ireland. I had visited a physics department at another university and it felt like a museum. It was an easy choice.

### What appeals to you most about your current role?

To put it simply it's self-determination. There is an aspect of a "physics mind-set" that views the world as sub-optimal which sometimes doesn't work well with the real world. I was never comfortable working in large organisations, I always found them frustrating places. Being part of the senior management, running and owning a business, means you are ultimately responsible for the successes and failures. I am fortunate to still use some of the physics I learnt but I also get to apply those analytical skills to knowledge that I have acquired in management and business. Starting and running a business is not the sort of position that will suit everyone but I wouldn't have it any other way.

### What are your strongest memories of Trinity?

I'm tempted to say that my overwhelming undergraduate memory is of lecturers with brown corduroy jackets! I studied theoretical physics before switching to the experimental physics degree. I spent time in the Maths Society (then in No 39 New Square), its central location was handy as lectures could be at either end of College and it had access to it's own computing resources. I spent most of my final year in the physics department working on my final year project. I really enjoyed the experience and it encouraged me to go on to a do a Ph.D.

### Have you any advice for students or fellow alumni?

A good physics degree is an educational foundation to build on, it is up to you to make something of it. Whichever career you choose, the analytical ability you acquire and the drive to understand will serve you throughout. In industry, scientists have to prove their value over engineers as industry values the perception of practicality and applicability. It is up to you to acquire the skills to further your career but also do it because you enjoy it.

### History of the School of Physics by Dr Eric Finch

The sixth instalment in the Fitzgerald series is a historical guide to the development of physics in Trinity. It focuses primarily on the three centuries from 1683 to 1984. The study of physics was formalised in 1724 when Richard Helsham became the first Erasmus Smith's Professor of Natural and Experimental Philosophy, as the position is still called. Some of the other distinguished physicists appearing in the book are Molyneux, Bartholomew and Humphrey Lloyd, Hamilton, Stoney, Fitzgerald, Joly, the Nobel Laureate E.T.S. Walton and Bradley. A detailed analysis is included of the difficult times for physics in Trinity after 1900 and the remarkable revival that began in the 1960s. The book can be purchased from September 2016 at www.tcd.ie/Physics/books

#### Eric Finch Three Centuries of Physics in Trinity College Dublin



The sixth of the Fitzgerald series by Dr Eric Finch.

# Recent Funding Success in the School of Physics

## Alumni Thank You

Researchers in the School have had several recent successes in obtaining funding.

Congratulations to Professor Jonathan Coleman, who has been awarded a European Research Council's (ERC) Advanced Grant. The prestigious ERC Advanced Grants are only made to Europe's most distinguished researchers. The awards recognise scientists who are working on cutting-edge research and who truly push the frontiers of knowledge. Professor Coleman's grant of €2.2 million will fund research on novel methods to use liquid exfoliation to develop printed electronics using 2D materials.

As part of Science Foundation Ireland (SFI)'s latest round of research infrastructure funding, Professor Peter Gallagher was awarded €1.4 million towards building a Low Frequency Array (LOFAR) telescope in Birr castle, joining Ireland up with the LOFAR telescope network across Europe and improving our understanding of the universe. Initial support for the project was generously provided by Trinity alumni and friends.

Congratulations also to Professor Martin Hegner, who was one of only 25 researchers nationally to have received an SFI Investigator Award in 2015. This funding will be used to continue his development of the project Nanomechanical detection of noncoding RNA for diagnosis in biological fluids, cutting-edge tools for the detection of diseases such as breast cancer. The School of Physics wishes to thank all of our physics alumni who have engaged with us on projects this year. In particular, we wish to acknowledge our GradLink mentors who joined us in November 2015 and made the GradLink programme in its second year a phenomenal success. GradLink is a programme that connects alumni with students seeking career and development advice. For photos and information on next year's Gradlink programme see www.tcd.ie/physics/alumni/gradlink. We look forward to working with you in the future!

### Get Involved

Trinity has a long tradition of outreach and community engagement. To find out about the numerous ways you can get involved with Trinity both at home and abroad, please visit www.tcd.ie/alumni/volunteer

### Upcoming Alumni Events

Christmas Commons 7 and 14 December 2016

Christmas Homecoming 21 December 2016

Other Upcoming Events: www.tcd.ie/alumni/news-events/events

### **Class Notes**

Do you have any news or updates that you'd like to share with your fellow alumni? Submit your news with an image, subject of study and year of graduation to alumni@tcd.ie For more information please visit www.tcd.ie/alumni/news-events/publications

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