

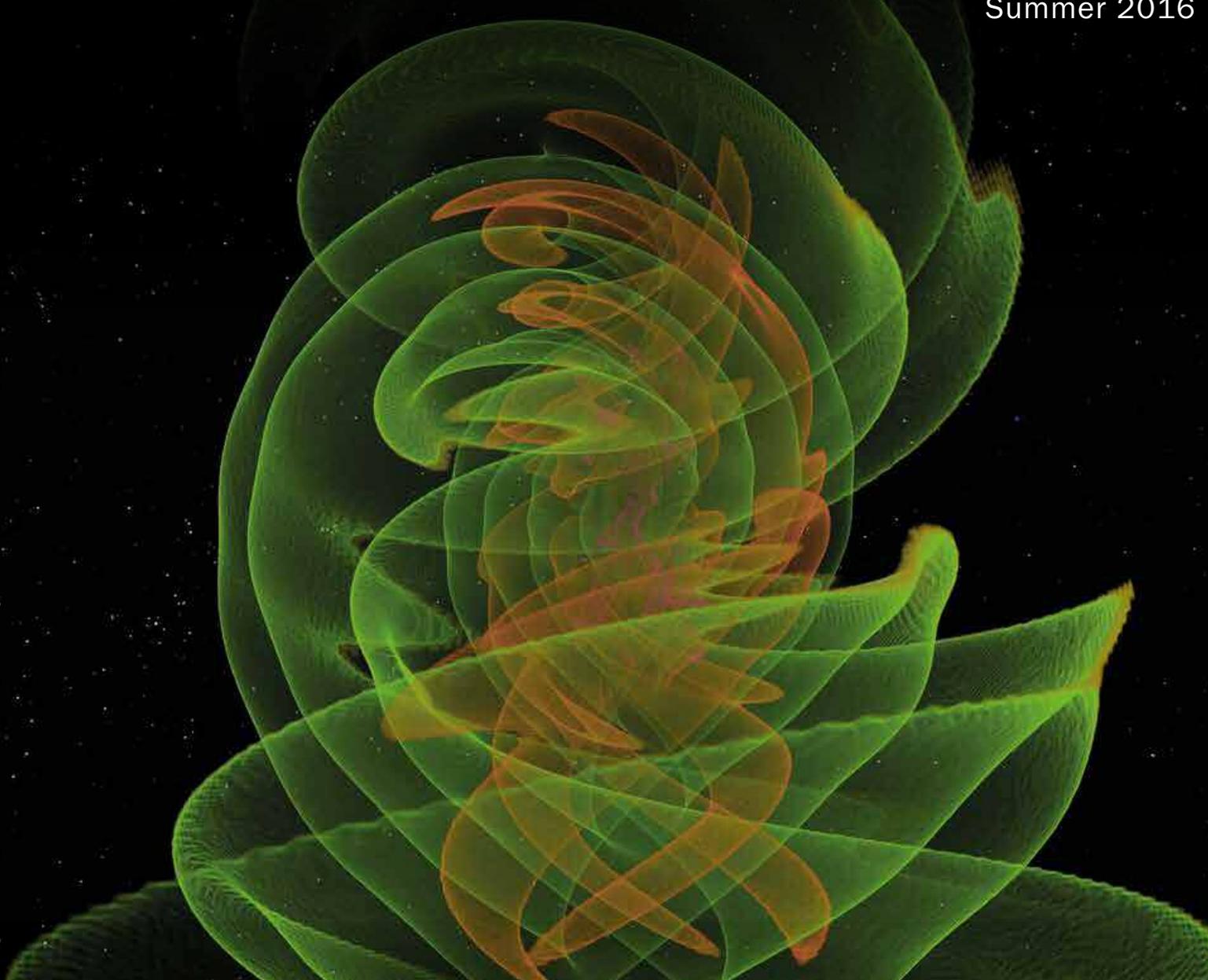
CARDIFF
UNIVERSITY

PRIFYSGOL
CAERDYDD

CHALLENGE**CARDIFF**

THE RESEARCH MAGAZINE FOR CARDIFF UNIVERSITY

Summer 2016



A new wave of astronomy

Lord Martin Rees, Astronomer Royal, discusses Cardiff's role in one of the greatest scientific discoveries of the decade

Social Work

How research into social work practice is helping to improve the lives of children and their families

Dementia

It's not just about the dementia

Improving general hospital care for dementia patients

CONTENTS

ON THE COVER



11 A new wave of astronomy

Lord Martin Rees, Astronomer Royal, interviews Professor B.S. Sathyaprakash about Cardiff's role in discovering the first gravitational wave



14 Tackling injuries head on

International rugby player Jamie Roberts quizzes Dr Peter Theobald about his use of 3D printing to develop novel materials to improve head protection in sport

Editor: Claire Sanders

Contributors: Mike Bishop, Ruth Lovell and Alison Tobin

Photography: Front cover: S Ossokine, A. Buonanno (Max Planck Institute for Gravitational Physics), Simulating eXtreme Spacetime project, W.Benger (Airborne Hydro Mapping GmbH). Picture of Queen's Anniversary Prize Ceremony: British Ceremonial Arts Limited. Additional photography from Photodrome, Mike Hall, Wales News Service, The Royal Society and istock

Design: CR Design

Proofing: Weltch Media

Challenge Cardiff is produced by the Communications and Marketing Department, Cardiff University, 2- 4 Park Grove, Cardiff, CF10 3BN.

Challenge Cardiff is published in English and Welsh. Please email challengecardiff@cardiff.ac.uk to let us know which version you would prefer.

03 A welcome from the Vice-Chancellor

04 Research News

A round-up of our research highlights

08 It's not just about the dementia

Jackie Askey, Dementia campaigner, interviews Dr Katie Featherstone about her ethnographic research into hospital care for people with dementia

17 Improving children's chances

Isabelle Trowler, Chief Social Worker for Children and Families for England, challenges Professor Donald Forrester about how his research into social work practice is helping to improve the lives of children and their families

20 A celebration of innovation

Celebrating our innovation success

22 Cardiff University Brain Imaging Centre

Find out about our new state-of-the-art research-dedicated neuroimaging facility

24 What made me curious?

Coast's Nicholas Crane asks Professor Paul Milbourne about what sparked his passion for human geography

26 Research Institute Focus

Neuroscience and Mental Health Research Institute

We'd like to hear from you

Your feedback is incredibly valuable to us here at Challenge Cardiff. We welcome your comments - please email them to:

challengecardiff@cardiff.ac.uk



WELCOME TO CHALLENGE CARDIFF

Earlier this year, perhaps one of the greatest scientific breakthroughs of this century was announced in Washington.

The detection of the first gravitational wave involved 1000 scientists from 15 countries, and I am very proud that this included our Gravitational Physics Group, based in the School of Physics & Astronomy. The group is led by Professor B.S. Sathyaprakash who in this edition speaks to Astronomer Royal Lord Martin Rees, about Cardiff's contribution to this ground-breaking achievement.

One in four people will experience mental health problems at some point in their life time. This issue of Challenge Cardiff explores the advances our world-leading researchers

are making in the understanding of mental illness and improving the diagnosis, treatment and care for patients, as well as influencing policy and practice. Dementia campaigner Jackie Askey questions Dr Katie Featherstone about her ethnographic research into general hospital care for dementia patients. You can also read about the work of our Neuroscience and Mental Health Research Institute, and how our new-state-of-the-art Cardiff University Brain Research Imaging Centre (part of our £300m Innovation Campus), will improve our understanding of the brain. In the news section we report that our MRC Centre for Neuropsychiatric Genetics and Genomics was awarded the Queen's Anniversary Prize.

The opening of the Cardiff University Brain Research Imaging Centre, by Her Majesty the Queen and His Royal Highness The Duke of Edinburgh, also marks the start of our Summer of Innovation. You can read about this and the other events that will showcase the best of the University's innovation work. To coincide with the opening of the Brain Research Imaging

Centre we will also be launching the Cardiff University Mental Health Blog (blogs.cardiff.ac.uk/mental-health). We hope that this will provide a platform for debate and discussion around the wider medical, social, economic and legal aspects of mental health.

Continuing our What Made Me Curious series, Professor Paul Milbourne, Head of the School of Planning and Geography, talks to broadcaster Nicholas Crane about what sparked his interest in human geography and how his research into urban food planning is helping communities both here in Cardiff and across the globe.

To find out more about the work featured in this issue, please go to our website where you can also view a series of films that accompany the magazine. (www.cardiff.ac.uk/research/news/challenge-cardiff)

Please contact challengecardiff@cardiff.ac.uk if you would like to challenge our academics on an issue that matters to you.

RESEARCH NEWS

Eye tissue grown in lab

Scientists have demonstrated a method for generating several key types of eye tissue from human stem cells in a way that mirrors whole eye development.

When transplanted to an animal model of corneal blindness, these tissues are shown to repair the front of the eye and restore vision, which scientists say could pave the way for human clinical trials of anterior eye transplantation to restore lost or damaged vision.

A collaborative team comprising researchers from Cardiff and Osaka University in Japan described their findings in *Nature*.

Previous studies demonstrated that particular cell types, such as those that constitute

the retina or cornea, can be created in the laboratory from pluripotent stem cells. However, these studies do not represent the complexity of whole eye development.

These latest experiments report the generation of multiple cell lineages of the eye, including the lens, cornea, and conjunctiva, using human induced pluripotent stem cells.

The scientists have been able to show that the corneal epithelial cells can be cultivated and transplanted onto the eyes of rabbits with experimentally induced blindness to surgically repair the front of the eye.

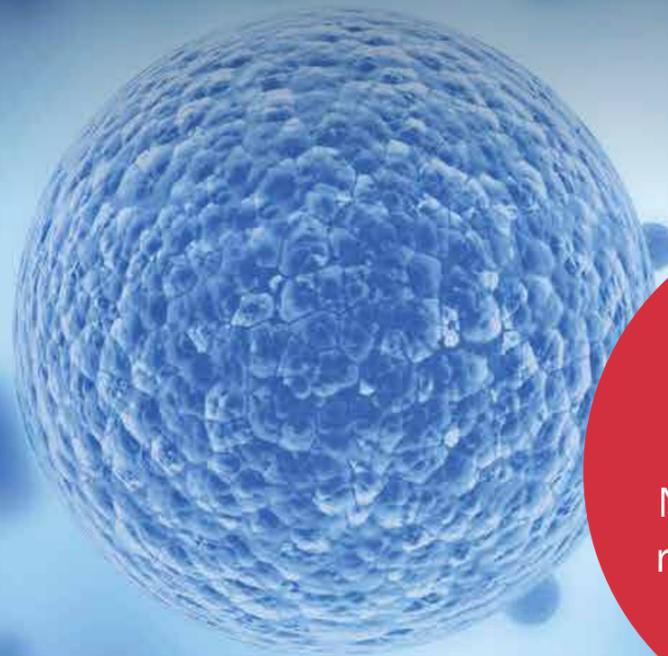
Study co-author, Professor Andrew Quantock from the School of Optometry and Vision Sciences, said: "This research shows that various types of human stem cells are able to take on the characteristics of the cornea, lens and retina.

"Importantly, it demonstrates that one cell type - the corneal epithelium - could be further grown in the lab and then transplanted on to a rabbit's eye where it was functional, achieving recovered vision.

"Our work not only holds potential for developing cells for treatment of other areas of the eye, but could set the stage for future human clinical trials of anterior eye transplantation to restore visual function."

Around 4000 corneal grafts are performed by the NHS annually, which rely on human organ donation.

The research was funded by the Japanese government's Agency for Medical Research and Development.



Around 4,000 corneal grafts are performed by the NHS annually, which rely on human organ donation.

Queen's Anniversary Prize awarded

Cardiff University's world-leading mental health research facility has been awarded the UK's most prestigious academic award - the Queen's Anniversary Prize.

On behalf of the University's MRC Centre for Neuropsychiatric Genetics and Genomics, Professor Sir Michael Owen was presented with the award at a ceremony in Buckingham Palace. The prize is awarded every two years by the Queen in recognition of an academic or vocational institution, and falls within the UK's national honours system.

Professor Owen said: "I am extremely proud of all the staff in the Centre for winning this award.

"It is a reflection of the amazing achievements made possible by an excellent team of scientific, technical and administrative staff which sits at the forefront of mental health research.

"Their efforts have succeeded in casting light into some of the darkest corners

of mental illness and place us in strong position to make further advances that will lead to substantial benefit to patients.

"Over the next five to ten years, the focus of the Centre will be to put our genetic discoveries to work to better understand disease mechanisms, develop improved diagnostic approaches and treatments; and become a leading centre of translational neuroscience.

"Centre scientists are also increasingly applying genetic findings in epidemiological settings in order to study the impact of genes at a population level, improve prediction and diagnosis, and understand how environmental and social factors interact with genetic predisposition to cause mental illness.

"I am very grateful to the MRC for their sustained support for our research over many years, and to Health and Care Research Wales as well as many other funders. I am also immensely grateful to Cardiff University for backing us so strongly and for nominating us for this award."

Among the Centre's landmark discoveries are the identification of a genetic link

between intellectual disability, autism, Attention Deficit Hyperactivity Disorder (ADHD) and schizophrenia; the discovery of the first specific genetic risk factors for schizophrenia, bipolar disorder and ADHD; and the discovery of the first new Alzheimer's disease risk genes for over 17 years.

As well as their fundamental genetic discoveries, the work of Centre researchers has directly influenced policy and practice.

Since 2000, the University has won six Queen's Anniversary Prizes for research ranging from geo-environmental engineering and violence prevention to medical genetics and clinical diagnosis.



THE QUEEN'S
ANNIVERSARY PRIZES
FOR HIGHER AND FURTHER EDUCATION
2015



Water-cleaning chemical made 'on-demand' with new group of catalysts

A quick, cheap and highly efficient method for producing a water-purifying chemical has been developed by researchers at Cardiff University.

The team, from Cardiff Catalysis Institute, Lehigh University and the Department of Energy's Oak Ridge National Laboratory in the USA, have developed a new group of catalysts that can produce hydrogen peroxide (H₂O₂) on-demand in a simple one-step process, opening up the possibility of manufacturing the chemical in some of the poorest, remote and disaster-stricken areas of the world.

Their results have been published in the journal *Science*.

"Using our new catalyst, we've created a method of efficiently producing H₂O₂ on-demand in a quick, one-step process," said co-author of the study Dr Simon Freakley from Cardiff Catalysis Institute.

"Being able to produce H₂O₂ directly opens up a whole host of possibilities, most notably in the field of water purification where it would be indispensable to be able to produce the chemical on-site where safe and clean drinking water is at a premium."

Over four million tonnes of H₂O₂ are produced by industry each year, predominantly through a large, multi-step process, which requires highly concentrated solutions of H₂O₂ to be transported before dilution at the point of use. Current uses of H₂O₂ include paper bleaching, disinfecting and water treatment and in the chemical synthesis industry.

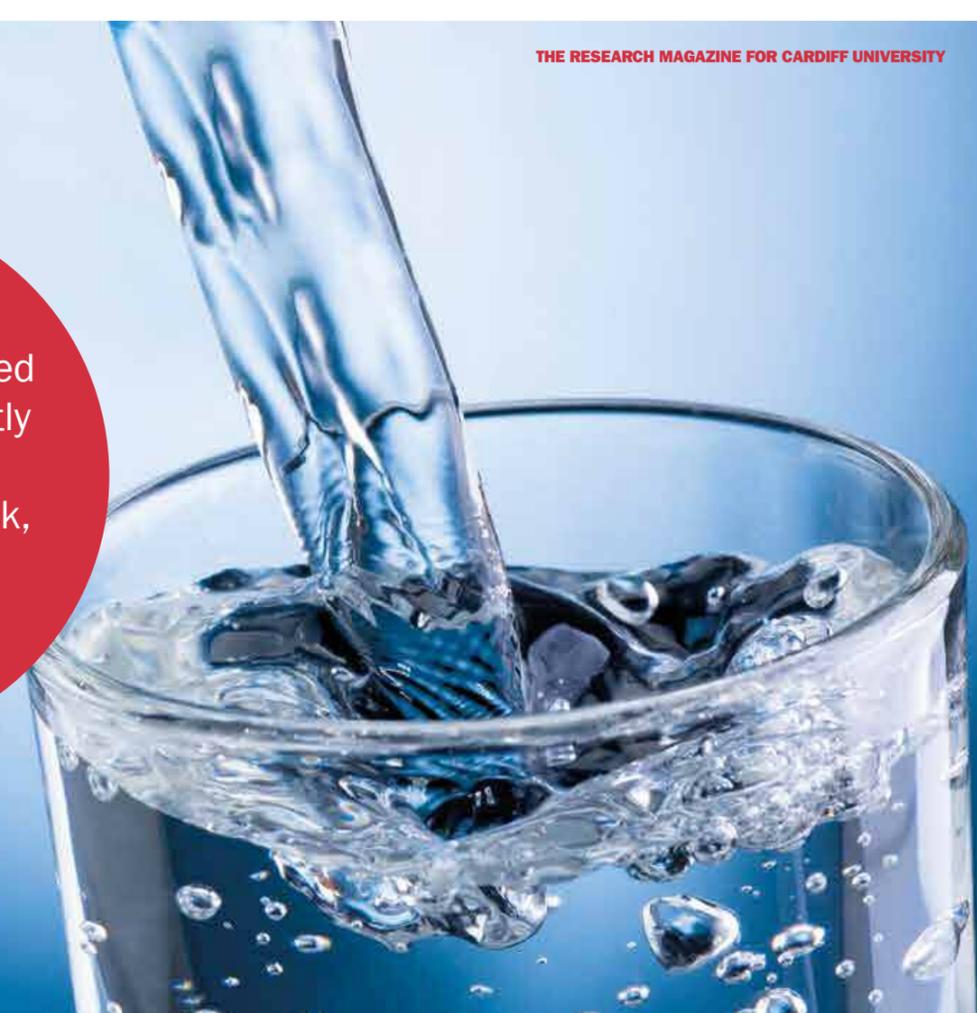
Though centralised systems adequately supply clean water to billions of households around the world, many people still do not have access to these large-scale water supplies and must therefore rely on decentralised systems for a safe source of water.

The team, led by Professor Graham Hutchings, has previously developed a state-of-the-art catalyst made from palladium and gold nanoparticles that helped to create H₂O₂ from hydrogen and oxygen.

Now the team has shown that gold can be replaced with five different readily available metals, including tin, zinc and cobalt, to form a much cheaper and more efficient group of catalysts for this specific reaction.

"Using our new catalyst, we've created a method of efficiently producing H₂O₂ on-demand in a quick, one-step process."

Dr Simon Freakley



Cardiff-led £24m project to meet energy challenges of the future

Cardiff University will lead a £24m project aimed at developing more intelligent ways of managing future energy systems.

The FLEXIS project, which also includes Swansea University and the University of South Wales, will set out to meet the diverse, complex and inter-dependent challenges that arise when new sources of energy are integrated into the grid by suppliers.

The challenges include: accommodating power supply from multiple, somewhat random, places; storing energy when it is not needed; coping with extreme flows of energy into the system; accommodating an ailing infrastructure; and making sure all challenges are met in a socially acceptable, affordable way.

As part of the project a demonstration site will be established to act as a test bed for new ideas and to show new technology and energy solutions being developed.

Leading researchers from the UK and Europe will be recruited to Welsh universities as part of the project, helping to strengthen Wales' position as a leader in research and innovation within the energy industry.

Former Finance and Government Business Minister, Jane Hutt AM, said: "This is vital investment for our economy and labour market,

and is a crucial source of funding in driving innovative research and the commercialisation of that research, creating sustainable jobs and growth."

By 2020, over £20m of additional competitive research income is expected to be secured in Wales as a result.



Former Finance and Government Business Minister Jane Hutt AM, Professor Colin Riordan, Vice-Chancellor, Professor Hywel Thomas, Pro Vice-Chancellor for Research, Innovation and Engagement, with the project's Principal Investigators

British media coverage of 'migrant crisis' among the most aggressive in EU

Significant differences in the way media organisations in different EU countries reported the migrant crisis in 2014 and early 2015 have been identified in new research by Cardiff University.

The report, by a team from the School of Journalism, Media and Cultural Studies examined 2000 news stories across five different European countries: Spain, Italy, Germany, Sweden and Britain.

The research identified striking differences in patterns of source access, terminology ('migrant', 'refugee' and 'illegal'), news angles, as well as the explanations and proposed solutions to the crisis.

Domestic politicians, which were found to be the most accessed source category in news accounts, were most prominent in Sweden, followed by Germany, Italy, Britain and Spain. In all countries in the sample, except Germany and Spain, the main opposition to government policy came from the anti-immigrant right.

Media also differed widely in terms of the predominant themes to their coverage.

Humanitarian themes were most common in Italian press coverage (50.6% of articles) and rarest in the right of centre British tabloids (Daily Mail 19.2%, Sun 7.6%, EU average 41.8%).

In contrast, the British right-wing press was found to feature accounts which stressed the threat that refugees and migrants posed to domestic welfare and health systems at a much higher level than the other countries in the sample (Daily Telegraph 15.8%, Daily Mail 41.9%, Sun 26.2%, EU average 8.9%).

British television news reporting, which often focused on the plight of refugees and migrants at Calais or on the Mediterranean, was found to feature some of the most empathetic coverage in the sample. However broadcast reports tended to frame the crisis as a problem of 'illegal migration' or 'illegal immigration' rather than one which partly involved the resettlement of refugees. This meant when discussing potential responses to the crisis, BBC and ITV reports focused on discussing the need to strengthen UK or EU borders.

The research was funded by the United Nations High Commission for Refugees (UNHCR).



It's not just about the dementia



Dr Katie Featherstone

Jackie Askey

At least one in four acute hospital beds is now occupied by someone diagnosed with dementia* and thousands more are coming into hospital with undiagnosed dementia or some form of cognitive impairment.

These people are often admitted to general surgical wards with conditions unrelated to their dementia, and where often the staff are not trained to deal with such patients.

Dr Katie Featherstone, a medical sociologist based in the School of Healthcare Sciences has been awarded £447,000 by the NHS National Institute for Health Research to conduct research into dementia care in hospitals. She is focussing particularly on the behavioural aspects of people with dementia when they are in an hospital.

Jackie Askey is an activist and campaigner working with hospitals to improve the care of patients with dementia and a member of the carers' steering group for the project. Her husband George passed away in January 2015 and she questioned Dr Featherstone about her work and what it will mean for people with dementia and their carers. Jackie's husband had dementia and she looked after him for eight years.

JA: It's a subject that's very near to my heart and I'm very interested in the research that you're doing. My husband went into hospital with a virus and was wrongly diagnosed with end stage dementia. He wasn't eating and they said it was due to end stage dementia. I said 'No, there's something wrong with his taste buds'. He actually had oral thrush and it wasn't picked up for a week and a half, and that was by me.

By only looking at the dementia and not listening to me he died. So your research is absolutely vital, why did you decide to do it?

KF: When someone with dementia is in hospital they often have something else wrong with them, they may have fractured their hip, they may have a chest infection or pneumonia. The behavioural aspects of dementia can really be exacerbated by being in a different and unusual environment and they can go downhill rapidly in that setting.

A lot of people with dementia die in hospital or have very extended lengths of stay.

I'm a medical sociologist. I'm interested in how medicine works, classification of medicine, diagnosis, and family experiences as well. My previous work looked at genetics and genetic conditions. I was looking for a new challenge and had read about growing rates of dementia and that it was rising on the public and policy agenda.

JA: What research has been done on dementia in hospital?

KF: There is lots of research on care of people with dementia in community settings, diagnosis, the genetic basis (which is a big area for Cardiff University) and also in long-term care settings. What really surprised me is that there's very little research into the experience of people with dementia in hospital. We can't assume that research in other areas such as long-term care settings are transferable to hospital settings.

JA: I would agree with you there. What did you do next?

KF: I went to quite a few meetings to decide what research we could do and what struck me was that everyone was asking for an intervention. Although I could see the urgency, there isn't the evidence base yet to inform those sorts of interventions. I think we've both got a vision of what needs to happen but we need to take certain steps before we get there.

What are the challenges being faced by hospital staff, what are the experiences of people in wards, what's the experience of people in hospital with dementia? What's the experience of their carers? Until we understand what's happening now, we can't move on to the next phase of developing interventions and changing things. We need the fundamentals first. That's where I decided to start.

Dr Featherstone has taken an ethnographic approach to her research and Jackie wanted to know what this involved.

Before we start with any other interventions we need to understand what is happening now, how are staff caring for patients, what is the culture in wards? The approach has to match the questions. What are people doing and why? I observe them in their everyday settings. What are the everyday routines and rituals and the mundane work. What does it accomplish?

I go into a ward and stay for a few weeks. I follow shift patterns. I do mornings, afternoons, and nights. I do weekdays, weekends, and bank holidays. I really

get a sense of culture and life in that ward. I write detailed notes in a big notebook. Everyone knows that I'm there and can see what I'm doing.

It gives you everybody's perspective. I can put things into context. What are their everyday practices? Once we know that, we can think about how we can change them.

JA: Something that struck me when I was in with George when he had a virus and dementia, was that the hospital needed me to go in all the time so that I could keep an eye on what George was eating and drinking. Do a lot of patients with dementia have someone with them all the time? At one point if someone had dementia they had to have someone there and they allocated a person to sit with them?

KF: In the hospitals I've been in so far patients only have one-to-one care if they've been violent or are seen as a danger to themselves or to others.

In terms of carers being present, there was an interesting culture of family members being discouraged from being present other than at specific times. Almost a sense of not wanting them to be around. How family and carers are treated or seen by ward staff is something that needs a bit of work. They should be seen as someone who has expertise and who can contribute rather than someone who is going to complain. Which is how I think staff sometimes frame carers.

JA: How do you think your research is going to help?

KF: It's got to have an appropriate impact. That is the challenge. It's a work in progress. We're only part way through. We've already come up with some preliminary findings and ▶

“What really surprised me is that there's very little research into the experience of people with dementia in hospital.”

Dr Katie Featherstone



“Dementia can really overshadow the person and everything else and that becomes a barrier to care.”

Dr Katie Featherstone

are feeding these into hospitals straightaway. We've had a good response. They recognise they need help, an evidence base and direction. They are incredibly keen to take this on at ward level and at hospital and trust level too. I found that a great thing.

Those general surgical wards need the training and the support so that they can eventually know what good care for someone with dementia looks like. Dementia can really overshadow the person and everything else and that becomes a barrier to care.

JA: It doesn't need millions of pounds just a change in attitude, and training.

KF: It's those small targeted interventions I'm aiming for. By doing them in our early sites and testing and refining them, we can find out what works and why. Also by talking to the population we're doing it for, to the carers' networks and groups.

JA: You've come to our group and we don't hold back.

KF: It's both invigorating and terrifying going to meet the groups of carers.

JA: We will give you a grilling.

KF: I'm doing it for you. It's got to be something you feel is worthwhile.

JA: Anyone who does anything to improve dementia awareness and treatment care

in hospitals, it's going to be more than worthwhile. We all feel the same. Have you got other projects in mind for the future?

KF: I'm already working on the next one, continence and incontinence issues for people with dementia in hospital. I always come to you guys first and say could this be a project. Until you say it's got merit it's not going forward.

JA: They said my husband was incontinent. He wasn't totally continent, but being in hospital they didn't have enough staff to take him to and from toilet or anyone on hand to see him try and get up to go to the toilet. People with dementia can't always remember to ring for the nurse. Which is pretty vital.

KF: It struck me as such a fundamental issue. So much mundane work, taking people to the toilet, catheterisation but people were not talking about it. If someone gets catheterised for far too long that's when they can get infections and die. It's not just a dignity issue but it's also a fundamental issue around survival and mortality.

JA: We have to change the lot of people with dementia.

KF: There's lots to be done it's just chipping away and we can get there.

* Alzheimers Society (2009) *Counting the cost: Caring for PWD on hospital wards*. Alzheimers Society.

Royal College of Psychiatrists. *Who Cares*, Wins January 2005.

Goldberg, S. E., Whittamore, K. H., Harwood, R. H., Bradshaw, L. E., Gladman, J. R., & Jones, R. G. (2012). *The prevalence of mental health problems among older adults admitted as an emergency to a general hospital*. *Age and ageing*, 41(1), 80-86.

Sampson, E. L., Blanchard, M. R., Jones, L., Tookman, A., & King, M. (2009). *Dementia in the acute hospital: prospective cohort study of prevalence and mortality*. *The British Journal of Psychiatry*, 195(1), 61-66.

A new wave of astronomy



▲ Professor B.S. Sathyaprakash

Sir Isaac Newton famously said, “If I have seen further, it is by standing on the shoulder of giants.”

These poignant words were in reference to the collaborative effort that underpins scientific endeavour, so it was therefore fitting that on Monday 14 September 2015 a collaboration of over 1000 scientists from 15 different countries finally added the missing piece of the jigsaw to our current understanding of gravity – a theory that Newton initially proposed.

At 9:51am GMT on that Monday morning, the LIGO (Laser Interferometer Gravitational-wave Observatory) Scientific Collaboration detected a gravitational wave for the very first time.

The implications were profound. Not only did the detection confirm a key prediction

made by Albert Einstein – another pioneer of gravitational physics – exactly 100 years ago, but kick-started a brand new era of astronomy.

Described as tiny ripples in space-time that are emitted as a result of violent cosmic events in the Universe, gravitational waves are the final confirmation of Einstein's spectacular theory of general relativity and will allow scientists to observe stars, galaxies and the Universe's more exotic objects in ways that have never been possible before.

The detection would not have been possible without the key contribution of scientists working at Cardiff University's School of Physics & Astronomy, whose knowledge and expertise enabled scientists to pick out the signal from a cacophony of background noise and decipher where in the Universe, as well as the precise time, the gravitational waves were emitted.

Since the LIGO Scientific Collaboration formed over 15 years ago, Cardiff University's

Professor B.S. Sathyaprakash, who is part of the Gravitational Physics Group (see page 13), has been studying sources of gravitational waves and developing ways to detect them.

The detection made by Professor Sathyaprakash and the rest of the collaboration has been hailed as one of the greatest scientific discoveries of the decade, a statement that has been echoed by Astronomer Royal Lord Martin Rees.

Lord Rees is one of the world's leading astrophysicists as well as a senior figure in UK science, and knows too well the significance of this landmark discovery. He has conducted influential theoretical work on subjects as diverse as black hole formation and extragalactic radio sources, and was one of the first to predict the uneven distribution of matter in the Universe.

Lord Rees (**LR**) speaks to Professor Sathyaprakash (**BS**) about the history of gravitational waves, the efforts to detect them, and the implications for the field of astronomy now that they've finally been found.

LR: For me, Albert Einstein's theory of general relativity, which he put forward in 1915, is one of the most remarkable intellectual achievements in scientific history – a triumph of pure thought and insight.

Einstein's theory told us how space and time are intrinsically linked, and that space tells matter how to move, and matter tells space how to curve. Einstein put forward the idea that the force of gravity was actually the warping of space by objects, like a bowling ball placed in the middle of a trampoline.

One consequence of his theory was that as these objects move, they generate a ripple

that spreads out through space and time – this is what we know as a gravitational wave.

When one of these ripples passes the Earth, the space around us jitters ever so slightly. Space is alternatively stretched and compressed.

Exactly 100 years after Einstein predicted the existence of gravitational waves, the LIGO Scientific Collaboration finally observed this stretching and compressing of space and detected a gravitational wave for the very first time.

BS: After two decades of searching for these elusive signals, this was a very special moment for us. Thanks to the pioneering work performed here at Cardiff University, we were able to determine that this particular gravitational wave originated from two black holes that were circling each other 1.3 billion light years away from Earth, before merging into one giant black hole.

Our speciality here at the University is developing algorithms to search for gravitational wave signals buried in the noisy data that is collected by the detectors. Without the aid of such an algorithm, it would have been impossible to carry out the search in a timely manner. Algorithms formed the basis of the discovery.

Furthermore, we also study the dynamics of two circling black holes, known as a binary system, and the shape of the gravitational waves they emit. These models have helped measure the properties of the black hole binary system that LIGO has observed.

LR: Astronomers have long realised that if we were to detect gravitational waves it would have to involve much stronger gravity than in ordinary stars and planets. The strongest predicted events are those caused by neutron stars, supernovae and two black holes crashing together. As experts in the modelling of binary black holes, it must have been very exciting for your group to get the first signal from such an event?

BS: Indeed, it was very exciting for us. In 2002 we published a paper with some colleagues that predicted that the first sources we would detect would be from binary black holes and there was a very good reason for us to believe so. However, for a number of years now we thought that the first sources we would detect would be two neutron stars merging together. In fact, from the late nineties until a few years ago, binary black holes were thought to be uninteresting for LIGO. It was therefore very surprising to some that the very first sources we detected were colliding black holes.

LR: Up until now, there has never been any firm evidence that gravitational waves exist. The problem is that their detection requires

amazingly sensitive instruments to detect the extremely small jitter in space-time as a wave passes the Earth. The two LIGO detectors, one in Washington State and the other in Louisiana, consist of intense laser beams that are projected in an L-shape along 4km-long pipes and reflected by mirrors at each end. By analysing these beams of light, it is possible to detect gravitational waves by observing very small changes in the distance between the mirrors, which alternately increases and decreases as gravitational waves pass. This expansion and contraction of space is exceedingly small – millions of times smaller than the size of a single atom – which is why the detectors must be extremely sensitive. The experimenters and engineers deserve immense credit for these amazing instruments, as do the theorists such as those at Cardiff University, who calculated what would be observed when two black holes merged.

BS: I am not an experimentalist and what I say is the perspective of someone who marvels at the achievement of his experimental colleagues from a safe distance. The LIGO detectors have to deal with a cacophony of noise both inside and outside of the detector that could quite easily masquerade as a gravitational wave signal. The detectors have to account for ground motion caused by passing cars, earthquakes, and falling trees that can cause the suspended mirrors to swing. At the same time, the fibres from which the mirrors hang begin to vibrate as they heat up, so innovative materials need to be used to counter this. The mirrors themselves also need to be polished to perfection to prevent them from overheating, and the laser beams must be sustained in a high vacuum to stop the light being randomly scattered by air molecules.

It is intriguing to see how all of these advances in basic physics have come together to enable the construction of detectors with unbelievable sensitivity. LIGO has truly shown that technology is only limited by fundamental physics principles and with human ingenuity and sufficient funding we can make the impossible possible.

LR: The LIGO detectors recently went through a major upgrade, increasing the ultimate sensitivity of the instruments by a factor of 10 which was enough to detect at least one convincing chirp of a gravitational wave almost instantly. Unless the LIGO team had extraordinary luck in detecting this event so soon, we can surely expect more in the near future.

BS: We certainly hope that this wasn't extraordinary luck. In addition to this detection, of which we have little doubt about its reality, we have also detected a less significant event that looks like a binary black hole merger. I personally think that this event is genuine, and not down to any external

noise, and here at Cardiff University we are currently developing data cleaning techniques that may well increase the significance.

It is important to note that so far we've only announced results taken from a month's worth of data collected between September and October last year. We still have another three months' worth of data to analyse and have speculated that there is an 80% chance that this data should contain a binary black hole event similar to the one we have already detected.

LR: Two European detectors, Virgo and GEO600, are joining the search for gravitational waves, and I'm sure this initial detection will stimulate wider efforts to exploit this new kind of astronomy.

BS: In addition to this, the KAGRA detector in Japan will soon join the search, as will the recently announced LIGO-India detector. Together this network of detectors should

greatly increase our chances of observing gravitational waves from many other sources, including exploding stars, spinning neutron stars, magnetars, and one day allow us to observe echoes of the Big Bang itself.

LR: This detection has opened up a new window on the cosmos. This is genuinely a big deal and in my view on the level of the discovery of the Higgs particle, which generated a huge amount of interest from the media and the general public. Many will now be wondering how gravitational waves can be used to advance our understanding of the world around us.

BS: The field of classical astronomy began by exploiting visible light with optical telescopes to observe the stars and planets in the skies above us. Over the last century we have used radio waves, microwaves, x-rays and gamma rays to explore parts of the Universe that are hidden to optical

telescopes. Without these new windows of observation, we wouldn't have learnt about quasars and radio galaxies, neutrons stars, pulsars and black holes.

Gravitational waves will open a brand new window for us to observe the Universe. They will allow us to probe regions of extremely high density and gravity, such as the deep interiors of supernovae, the central engines of gamma ray bursts and the dense cores of neutron stars.

Furthermore, gravitational waves will help us to test Einstein's theory of general relativity with ultimate precision.

But ultimately, gravitational waves are the ideal tools to explore the state of the Universe just a tiny fraction of a second after the Big Bang. This is the closest we can ever hope to learn about the physical conditions at the birth of our Universe. Nothing could be more illuminating.



Members of the Gravitational Physics Group
L to R: Professor B.S. Sathyaprakash, Dr Patrick Sutton,
Dr Stephen Fairhurst and Professor Mark Hannam.

Gravitational Physics Group

For the past decade, the Gravitational Physics Group at the University's School of Physics & Astronomy has laid the foundations for how we go about detecting gravitational waves, developing novel algorithms and software that have now become standard search tools for detecting the elusive signals. The group includes world-leading experts in the collision of black holes who have produced large-scale computer simulations to imitate these violent cosmic events and predict how gravitation coding the gravitational-wave signal detected by LIGO and measuring the properties of the two black holes that collided. Along with Professor Sathyaprakash, the Group consists of Professor Mark Hannam, Professor Bernard Schutz, Dr Stephen Fairhurst and Dr Patrick Sutton.

Tackling injuries head on



Jamie Roberts

American football's league, the National Football League (NFL), is currently embroiled in one of the most controversial periods in its 96-year history.

Considerable questions have been raised about the NFL's ability to control the sheer brutality of the sport, as well as its role in protecting professional players from developing potentially life threatening brain injuries.

Just last year, the NFL was ordered to pay \$756m to over 4,000 ex-players who had sued the organisation on the grounds that it had failed to protect them against concussion and brain injuries.

In 2009, a study showed that NFL players were 19 times more likely to suffer from early onset Alzheimer's disease than the general public. These bleak findings have been compounded by several incidences of NFL players committing suicide in recent years, with their autopsies showing brain damage consistent with routine blows to the head.

In response to this burdening issue, the NFL has implemented several new rules to try and protect players on the pitch and is investing a significant amount of money in research and development to protect against, treat and diagnose brain injuries.

One such initiative is the Head Health Challenge, a \$20m initiative created in conjunction with Under Armour, GE Healthcare and the National Institute of Standards and Technology, that has invited researchers to submit their own ideas on how brain protection can be improved.

Dr Peter Theobald (PhD 2006, PgCert 2010), from the School of Engineering, is part of a collaboration that has successfully secured funding through a strand of the Head Health Challenge to further develop a material that they have designed and built to protect the head in a number of different sports.

Manufactured using the latest 3D printing technology, the novel material has the potential to be rolled out not only in American football, but in a wide-range of other sports, including horse riding, cycling, motor racing and rugby.

High-impact collisions are part of the daily grind for the Welsh rugby international Jamie Roberts (MBBCh 2013). The Harlequins FC star has

acquired a reputation for playing fast, aggressive, direct rugby and has been lauded for putting his body on the line every time he steps onto the pitch.

This all-or-nothing attitude has resulted in a glittering career for Jamie, clocking up over 70 international caps for Wales and touring twice with the British and Irish Lions.

In spite of this, Jamie is acutely aware of the physical strain that sports can impart on the body, principally because he is a qualified doctor, having obtained a medical degree from the University's School of Medicine in 2013.

Below, Jamie (JR) talks to Peter (PT) about the heightened awareness of brain injuries in sports, the role that 3D-printed materials can play in protecting players, and the likelihood of the materials being integrated into various sports equipment.

JR: Head injuries in sports have recently drawn a lot of attention in the media and have become a hot topic for debate. How are you working to address the issue of head injuries?

PT: Our work is looking to develop new materials that will be more effective at absorbing energy during impact in a wide range of scenarios. Specifically, we are aiming to develop materials that can be used to protect the head, so our new materials need to have a range of properties suited for this application, including being light weight.

JR: How closely do you work with people in the medical profession to define the different types of head injuries, and develop ways to prevent them?

PT: Our work designing new materials predominantly focusses on out-performing contemporary products when tested against established, international standards that govern all safety helmets. These standards are routinely reviewed by committees of leading experts from a range of specialities, including medicine, to ensure that they consider the latest scientific evidence. Furthermore, we are constantly

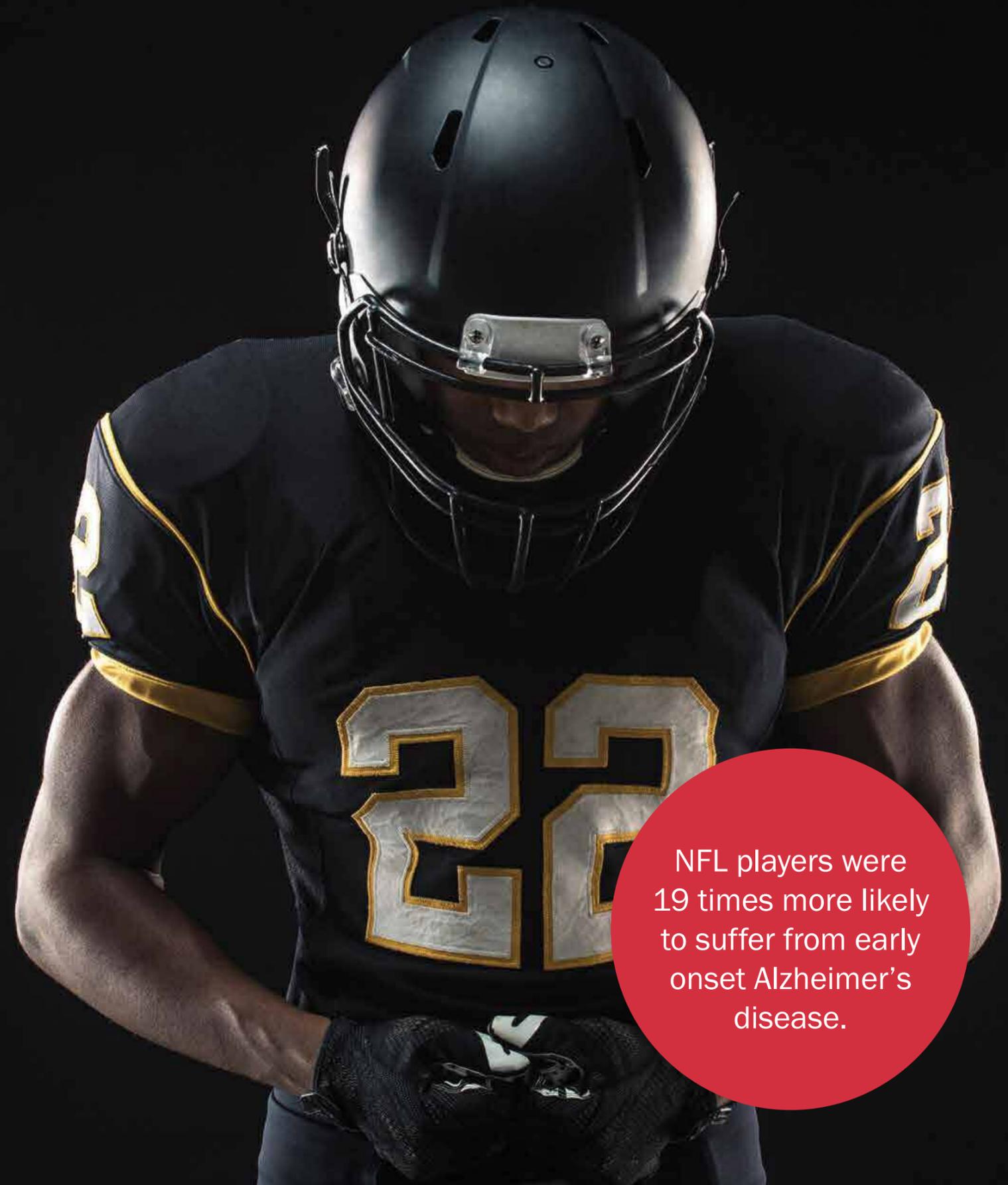
engaging with a wide range of medical-related professionals to ensure that our research is focussed on establishing new materials that are optimised for a particular application.

JR: Do you think head injuries have become more prevalent as sports have become more and more competitive, or have we just got better at detecting them?

PT: When a head injury occurs because of an impact, it broadly happens via one of two mechanisms. The first type is caused by a high-energy, single impact that typically results in a relatively quick injury. The second type of injury is caused by the cumulative effect of multiple lower energy impacts, over an extended time period. In sports where there is a risk of a high-energy impact, for example falling at high speed during



Dr Peter Theobald



NFL players were 19 times more likely to suffer from early onset Alzheimer's disease.



Prototype helmet made with C3

a cycling road race, helmets are commonplace; hence, the wearer is protected from a high energy impact, while also being protected from lower energy impacts. Where the impact forces are likely to be less severe than this, for example in rugby union, head protection is not typically mandatory; however, this may mean that players are exposed to injury as a cumulative consequence of multiple, lower energy impacts. It would seem reasonable to assume that this longer-term injury risk is probably increasing where collisions are occurring between increasingly stronger players, and therefore increasing impact energies, with rugby union being a prime example.

In addition to this, the wider understanding of head injuries has changed significantly in recent years, driven in-part by a recently established correlation linking American football participation, which subjects its player to multiple, lower energy impacts, with an increased risk of players developing a degenerative brain disorder called chronic traumatic encephalopathy. This correlation, and the subsequent \$756m dollar litigation case, may have encouraged similar sports to develop a far more proactive stance towards protecting their players. In the UK, football and rugby have both recently adopted enhanced pitch-side assessments and return-to-play protocols.

JR: American football is one sport in which a lot of money has been invested to reduce the incidences of head injuries. How did you come about working with the NFL?

PT: As part of the law suit, the NFL has recently launched a series of innovation programmes seeking new and novel solutions to improve head health in sport. Working with Charles Owen, a UK/US-based helmet manufacturing company, and Cambridge University, we applied

for funding to this programme as we believed that our expertise would enable us to provide a unique contribution to this problem. We were one of five successful applicants, from 125 submissions.

JR: Could you explain a bit about the material you've developed, and what it is designed to do?

PT: Our material, which we've called C3, is a unique combination of an elastomeric material built with a specific structural architecture. An elastomeric material has elastic properties, meaning that it can withstand multiple impacts, which was one of the requirements of the NFL. This material was then manufactured into a unique structural architecture, which we quickly realised showed great promise in being able to absorb a significant amount of energy relative to its weight, whilst also enabling us to subtly modify its structure to achieve enhanced energy absorption in different impact scenarios.

JR: How is the material made? And what is different from traditional manufacturing techniques?

PT: We use additive manufacturing, more commonly known as '3D printing', which is a relatively new technique that allows us to design new structures while only using the precise amount of material required for the desired mechanical function. This layer-by-layer manufacturing also means that we can develop intricate structural architectures that were impossible using traditional fabrication techniques. Hence, we now have the potential to develop a solution that is more effective at absorbing energy, while potentially being lighter than existing products.

JR: Is the material economically feasible?

PT: Using additive manufacturing will be more expensive than the current techniques used to produce the existing impact absorbing component of a helmet. We are confident, though, that this process does have the potential to be commercially viable, probably in the higher-end products initially.

JR: What types of sports equipment could the material be integrated into?

PT: One of the great advantages of our material is the scope for modifying its structural architecture to achieve the most effective energy absorption for predicted impact energies. This allows us to significantly extend the potential applications of the material, for example in to sectors such as protection for motorcyclists and ice hockey players.

JR: Could you see this material being used in rugby, particularly in scrum caps?

PT: We would certainly be confident in our material being effective at absorbing impact energies within rugby; however, the more significant debate is whether mandating the wearing of protective helmets is the correct decision for the sport. Amateur boxing, where blows to the head are clearly commonplace, has recently reversed its decision, meaning that boxers do not now wear head protection. We are confident, though, that there will always be a market for new impact protection materials in events such as cycling, motor racing and equestrian, where there is an inherent risk of a high energy impact. We hope that our efforts mean that participants of sports such as these will ultimately be safer, whether pursuing their hobby or their profession. And of course, if rugby officials decide to proceed with mandating helmets, we'd be happy to work with the sport to design a solution to protect their players, too.



Improving children's chances

Professor Donald Forrester joined the University earlier this year and is an expert in child and family social work. He spoke to Isabelle Trowler, Chief Social Worker for Children and Families for England, about his new role and how his research aims to identify what makes good social work practice and how that can be used to improve outcomes for children and families. ►

“Over the past six or seven years I’ve been interested in the quality of social work practice.”

Professor Donald Forrester



Professor Donald Forrester



Isabelle Trowler

IT: Congratulations on your new appointment as Professor of Child and Family Social Work at Cardiff University and Director of CASCADE. Do you want to tell us about your new role and what CASCADE is?

DF: I took up the role in January this year. CASCADE was set up by Professor Sally Holland who’s now the Children’s Commissioner for Wales. It’s a relatively new centre. It has a specific focus on children involved with or known to children’s social care, giving their voice greater prominence and trying to improve services for them. I think it’s achieved a lot in two years and I’m looking forward to developing it further.

IT: Tell us about your background and how you came to be in this fantastic role?

DF: I qualified as a social worker in 1992. I worked in Southwark until the end of ‘90’s in frontline practice. I was drawn into academic life for lots of reasons. I worked with parents who had substance and alcohol misuse problems. It seemed a high proportion of my caseload involved those issues but there didn’t seem to be much research on this or evidence of how to work with them. So with Judith Harwin, Professor of Social Work at Brunel, we wrote a research bid and got funded.

I’ve been an academic since 2000. I was initially looking at parents who misuse drugs and alcohol. I learnt that what works for people who misuse drugs and alcohol, broadly works for other people. So I became interested more generally in what works in children’s services.

Over the past six or seven years I’ve been interested in the quality of social work practice. How we can relate that to outcomes and what difference that makes for children is a complicated issue. In more recent studies I’ve looked at training, supervision and organisational change. The links between these are what I’ll be studying for the next 15 years. Practice, outcomes and the factors that shape practice.

IT: So you’re looking at the whole practice system. It’s not just about social workers, it’s what they do and the environment they work in. Is that a fair assessment?

DF: Yes it’s a broad canvas.

IT: I wonder what from your practice years you still use in how you think about child and family social work interventions?

DF: I constantly feel my research draws on my practice experience and I’m frequently thinking of children and families I worked with and what did or didn’t work. I’d find it hard to do the research without having done practice.

IT: I think that this issue about how you remember what it’s like to be in practice is really important. In the role I’m in it has a huge influence. I sometimes worry that the gap between practice and people who are creating knowledge, and running systems is huge.

DF: I’m fortunate that my research is very much practice focussed. I did a large Randomised Controlled Trial (RCT) which involved not just training social workers but also providing them with supervision. So they came and talked through their cases. Although I wasn’t their line manager it felt familiar and a valuable reminder of the complexities of the role.

IT: Thinking about your career to date what is your biggest achievement so far?

DF: For me it is not a specific project, though there are several I feel proud of. It is more about an orientation and whether it influences others and is helpful. I think the most important thing to me is the focus on direct practice in research and social work education. The last four or five studies I’ve done - which together involved 600 direct recordings of actual practice - are unusual in having that focus. A lot of my research has surprised me. I don’t think it’s worth doing if you think you know what the result is going to be. A lot of what I was sure would work didn’t.

An area I haven’t looked at yet but would like to research is leadership - is it best understood as the top few people or distributed around? Part of me thinks you need to have some sort of vision of practice for effective leadership.

IT: I went to Holland a couple of weeks ago to visit Buurtzorg. It was set up by a nurse who found himself in the same situation many social workers find themselves in, huge bureaucracy, not much practice, being told what to do by other people, very little

use of professional autonomy or use of professional judgement. So he set up this organisation which has 8,000 practitioners working in community nursing and child and family community work. No managers or supervisors, just 16 coaches. They have intravision (small group reflection and challenge). They work in small units of 10-12 people and are self-managing. So why do you think a supervisory relationship is so important?

DF: That’s a really interesting model and in some ways I think we need to experiment more with different ways of doing supervision.

We’ve just completed research where we directly observed 24 supervision sessions and what struck me is how similar they were to one another and reminded me of how I was supervised and how I supervise.

We did a workshop with the managers and what they were delivering was very different from the reflective, thoughtful supervision they aspired to be delivering. We need to understand why that is. It’s partly about a perception of what management oversight is, the way wider pressures shape children’s services and what OFSTED need.

We offered some other ways of using hypotheses to these managers and several of them said it did take longer per case, but once they were using a more reflective approach, one of them said by coincidence they closed every case.

IT: Also deciding what we want to achieve for families. That then leads to how we measure our effectiveness and impact.

DF: Social work has a dual role, we have a role to help people and improve outcomes. There is a secondary thing about having minimal state involvement with families unless they want it. That is a different set of things to measure against. It’s about being respectful, humane and proportionate in our involvement, and that’s not something we can measure against outcomes. Nonetheless, to me it’s something that is very important and that we haven’t looked at enough. It’s more complicated to evaluate. This is also complicated by the fact that the primary client is the child but we want good outcomes for families and parents.

IT: Most of your career has been in England although you have done some work in Wales previously with the Welsh Government.

DF: I did some work with Welsh Government, and some funded by Alcohol Research UK. This initially looked at a service called ‘Option Two’ which Americans might call intensive family preservation service. It worked with families where there was a likelihood that children might come into care and where there were drug and alcohol issues. It provided whole family interventions and both of my evaluations were to see whether that succeeded in stopping children coming into care.

People thought the quality of service was very good and it did stop a proportion of children coming into care. It contributed to the Welsh Government setting up intensive family support teams bringing together multi-agency teams to work more intensively with families.

IT: Using motivational interviewing?

DF: Yes, it is a core feature in my studies. My first study found that social workers couldn’t work with the denial and minimisation they were experiencing. So I went to the world of substance misuse to try to get answers. Both methodologically and for effective ways of working with people. Motivational interviewing is a style of counselling and communication. It pays a lot of attention to understanding that resistance is understandable. In child protection you need to be able to understand this to do the work. It teaches you how to overcome that and develop more effective healthy relationships. So most of my studies have looked at that.

IT: What’s your current hypothesis on what does change practice and really impacts on families?

DF: The quality of practice and intensity of service they receive are crucial. Whether they have significant problems is also crucial. Key elements of good practice are empathetic collaborative relationships that marry a sense of purposefulness, and the ability to use authority well.

IT: What’s going to be your main aim in this new role? What do you want to achieve in the next five years for children and families?

DF: I want to build the centre so academics can thrive and do good work that makes a difference within the Centre. For instance, we are developing expertise in child sexual exploitation. We already have a track record of involving children and young people and giving them a voice.

One of the great things about Cardiff is that it has a PhD programme and other things that will allow you to bring academics through.

I’m particularly interested in how you create changes in practice and exploring different approaches to that. I think we can describe the key elements of really good practice, and people recognise that reflective unit meetings and the difference that collaborative but purposeful workers can make to a family’s life. Yet creating organisations that can deliver that is so complex and difficult. So I’m looking at training, and an area I’m researching at the moment is supervision. It is crucial to get this right.

The way we educate, the way we research is to focus back to practice. Social work is an invisible trade as it happens in people’s houses. That has been problematic. We need to make it less invisible as that’s the only way we’re going to constantly increase the standards.

A celebration of innovation

For 18 months, the University has been building an innovation system which will unlock the power of research.

Combining new facilities and staff with an increased focus on 'work ready' courses and skills for graduates, Cardiff Innovation System brings together campus investment, new partnerships and cultural change to drive prosperity.

The aim is to make Cardiff an innovation capital for Wales by harnessing research to create prosperity, better connecting businesses with academics, and translating innovations into new products and technologies, services, and start-ups.

Devised by Vice-Chancellor, Professor Colin Riordan, this pioneering approach permeates all aspects of University life – from teaching and research through to student work placements and industry-focussed degrees.

The University is recruiting leading international researchers, building a £300m innovation campus to drive growth, and putting student entrepreneurship at the heart of education.

Major capital investment on the University's Innovation Campus, includes Cardiff Business School's £13m Postgraduate Teaching Centre; a £44m Cardiff University Brain Research Imaging Centre; a Translational Research Facility for Catalysis and Compound Semiconductors (£77m), and the development of Innovation Central - a £49m collaborative space.

In 2014-2015, new partnerships helped Cardiff exceed its objectives: the Welsh Wound Innovation Centre created the world's first national wound healing centre of excellence. A National Software Academy has helped to address the shortage of skilled software engineering students, and 'Y lab' has brought the University and Nesta together to develop solutions to major public services challenges in Wales.

The launch of Compound Semiconductor Centre Ltd – a joint venture between IQE Plc and the University to develop Compound Semiconductor technologies – helped attract a £50m UK Innovation

Catapult in Advanced Compound Semiconductor Applications. CIS also helped secure a partnership role for Cardiff in a £50m catapult for UK Precision Medicine. We have also launched Creative Cardiff – supporting the city's creative industries and economy.

This year, a Clinical Innovation Partnership has been forged with Cardiff and Vale University Health Board to turn clinical research into cutting edge products and services.

To celebrate our innovation success, Summer of Innovation aims to strengthen our innovative partnerships and showcase our work to the wider world.

Positioning Cardiff at the forefront of innovation, growth and enterprise in Wales, Summer of Innovation will provide a platform for academics, business, government and other external stakeholders to exchange ideas on innovation and think about ways of solving current issues.

The celebration starts in early June with the opening of the state-of-the-art Cardiff University Brain Research Imaging Centre, and includes our Innovation and Impact Awards in mid-June. We will showcase our innovative work around graduation in mid-July, and feed into events including the National Eisteddfod in late July and early August.

The intention is to close the programme with a high-profile public lecture which will launch a series of Innovation Public Lecture Briefings for 2016/17.



Events

We are currently working on a full programme of events which will be listed on our website. www.cardiff.ac.uk/summer-of-innovation

Confirmed events are detailed below:

Staff fair and workshops – Tuesday 6 June

Celebrating innovation and providing an opportunity for staff to engage with elements of the Innovation System from the new Innovation Buildings to our collaborative partnerships.

Opening of Cardiff University Brain Research Imaging Centre – Tuesday 7 June

Inaugurating the new state-of-the-art building which is set to become one of Europe's top facilities for brain imaging. (see page 22 for more details).

Digital 2016 – Tuesday 6 - Wednesday 7 June

We will be involved with this annual festival of digital inspiration and innovation which takes place at the Celtic Manor Resort in Newport.

Cardiff University Innovation and Impact Awards – Wednesday 22 June

Our Innovation and Impact Awards celebrate our successful collaborations and links with business. Winners are carefully selected based on the innovation, impact and added value arising from the collaboration, and can be large businesses or small companies, social enterprises or government organisations, charities or public bodies.

Venturefest – Wednesday 28 September

Bringing together entrepreneurs, investors and innovative companies to inspire business growth.

Contact us

To find out more about the Summer of Innovation, please email innovationsystem@cardiff.ac.uk

Cardiff University

Brain Research Imaging Centre

The Cardiff University Brain Research Imaging Centre (CUBRIC) is a state-of-the-art research-dedicated neuroimaging facility housing a combination of equipment and expertise that is truly unique within Europe.

It houses Europe's most powerful MRI scanner, the Siemens 3 Tesla Connectom, a specially adapted MRI scanner of which there is only one other in the world at Harvard University in the USA.

It will enable researchers to study tissue microstructure in incredibly fine detail. The scanner's power is such that it has been described as the Hubble space telescope of neuroscience.

Scientists at the Centre will seek to provide unprecedented insights into the causes of neurological and psychiatric conditions such as dementia, schizophrenia and multiple sclerosis, as well as understanding the workings of the normal, healthy brain.

The new facility has been part-funded by the Engineering and Physical Sciences Research Council (EPSRC), the European Regional Development Fund through the Welsh Government, the Medical Research Council (MRC), the Wellcome Trust, the Welsh Government and the Wolfson Foundation.

Together, these investments are supporting innovation in world-class brain imaging research, including the creation of highly-skilled research jobs in Wales. More than £27m of the cost has been provided by funders.

<http://sites.cardiff.ac.uk/cubric>

What made me curious?

Writer, broadcaster and geographer, Nicholas Crane spoke to Professor Paul Milbourne about what sparked his passion for human geography.

NC: Where did you grow up?

PM: I grew up in Whitefield, a small industrial town about five miles north of Manchester. This was a place of social contrasts, containing three large council estates and one of the most affluent suburbs in North West England. It was also a place of considerable change; council estates swallowing up swathes of green space and bringing with them several thousand people, and a motorway driving six lanes of tarmac through farmland barely 400 yards from our house. Even with such change, nature remained an important part of life: rugged hills providing an important visual backdrop, footpaths still taking us through open farmland, and the largest municipal park in Europe only a 15 minute walk away.

NC: How did your interest in geography develop?

PM: Most probably from these early experiences of place and landscape. I also had a wonderful geography teacher at school, who was able to bring the subject alive. Moving away to study human geography at Aberystwyth University developed my geographical imagination in other ways. The academic content of the course broadened and deepened my understanding of the subject, enabling me to make connections between academic themes and personal experience: urban and social geography emphasised the interconnectedness of social and spatial inequalities and injustices in the urban environment, while a module on landscape and nature opened my eyes to how 'natural' spaces are socially and politically constructed to reflect the interests of particular (powerful) groups.

Moving away from Manchester also made me realise how regions and places matter to our sense of identity. Living in a small Welsh-speaking town in rural Wales broadened my understanding of the ways in which landscape, culture and language shape people's sense of place and identity.

NC: What is your research about?

PM: It's largely positioned within social and

environmental geography, exploring the interplay between social and spatial processes of inequality and injustice. My work has examined the geographies of welfare, particularly poverty, homelessness and welfare reform, in relation to urban and rural places in the UK and US, especially on how social problems become 'spatialised', that is, associated with and concentrated in some places but not others.

More recently, I have focused on social and environmental forms of injustice across a range of themes and settings, including community growing projects in disadvantaged urban neighbourhoods involving 20 cities in the UK, North America and Australia. This research has shown how community groups have been able to transform neglected spaces in their neighbourhoods – in physical, environmental, socio-cultural and political terms – through collective forms of gardening. These projects have not only created new senses of place but also new forms of sociality, conviviality and empowerment among residents. While the scope of this research is global, it is very much concerned with what can be achieved locally. A local component to this work has involved community growing projects in Cardiff as part of the University's Grangetown Community Gateway engagement project. Closer to the office, I have helped to establish a communal garden on the roof of our University building.

My research seeks to extend the community growing agenda in a couple of ways. First, it engages with austerity politics to think critically about the management of public green spaces in the city. With public sector cuts forcing local authorities to evaluate spending priorities and community growing groups seeking out additional land, it is possible that more public green spaces could be transformed into growing spaces, providing locally sourced fruit and vegetables in the heart of the city. The bigger agenda for me is to bring agriculture back into the city – moving from aesthetical to productive plantings and creating more of what we might call 'edible spaces' in our cities. Second, working with colleagues in the School's Sustainable Urban and Regional Food Research Centre, I am



▲ **Nicholas Crane**
Presenter of BBC Two: Coast

making connections between food poverty, food justice and healthy eating within the city. We are asking critical questions about how we could develop more holistic approaches to urban food planning, produce more equitable foodscapes in the city, and address the twin problems of hunger and obesity.

NC: So tell me why you think human geography is important?

PM: It shapes our lives in a variety of ways – through everyday interactions with place and environment, movements through physical and virtual space, and the influence of global economic, socio-cultural and environmental processes on our lives. Geography is concerned with how we make sense of our place in a changing world. It examines the ways in which the physical and human environments are mutually dependent – how we continue to shape our natural worlds, and how nature impacts on our everyday lives. Geography also has an important part to play in addressing what we might refer to as the 'grand challenges' of our time, providing socio-natural understandings of climate change and the future security of natural resources, such as water, food and energy.

In other ways, geography is concerned with spatial differences and processes: the uneven distribution of people, jobs, wealth, poverty, services and natural resources across space. It seeks to make sense of these differences and processes at a variety of spatial scales – from the global to the local.

NC: Looking beyond the academic, do you think human geography has broader relevance?

PM: Geography is particularly relevant to some of the big political, economic, social and environmental issues facing us today. The migration of large numbers of people from war zone countries to Europe is raising important questions about national borders and cultural integration within European cities. Political devolution within the UK has introduced important policy differences between the four home countries, particularly in terms of welfare, health and education. Political debates about

the future of energy, natural resources and the environment connect with geography's concerns with the interconnectedness of the social and natural worlds.

NC: And do you think geography has more popular appeal?

PM: I have noticed increasing media coverage of geographical themes over the last few years. While geography may not be used as a descriptor in a way that the term history is used to label articles and programmes in the past, I think it's clear that the media has become much more interested in the interactions between people, place and environment. In terms of TV, your excellent series, Coast, which has been running for more than a decade, presents a fascinating account of socio-natural relations at the interface between land and sea. I also read recently that the BBC programme, Countryfile attracted a larger viewing audience than the finale of War and Peace, with 9.5m viewers tuning in.

NC: Could you say something about the changing student demand for human geography?

PM: Geography is becoming a more popular academic subject. In August last year an editorial in The Guardian referred to geography as the 'must-have-A-level'. With 13% more students taking the subject at A-level in 2015 compared with the previous year – the largest increase of any of the major subjects – the editorial claimed that geography had shed its traditional image as a 'Cinderella subject' to become 'the subject of our times'. The article referred to the relevance of geography in understanding the key challenges facing the world today, helping students make sense of the interconnectedness of the physical and social worlds.

NC: And what about human geography in Cardiff University?

PM: The growth in our geography student numbers has been particularly impressive. Since the launch of our new Human Geography undergraduate degree course in 2013, we have seen the number of students taking geography increasing from 90 to 255. A key reason for this growth is the high quality of our research. The School is currently 44th in the QS World Rankings of Geography. I'm pleased that the QS measure of citations per paper positions us third out of the top 50 universities for geography, ahead of both Oxford and Cambridge. The School employs the largest number of human geography staff of any UK university with a research footprint that extends to four continents and covers the full range of human geography.

Another reason for the popularity of geography at Cardiff is the way we teach the subject, encouraging critical thinking and development of analytical skills, and the application of these to real world situations.

NC: I understand it's the 50th Anniversary of the School of Geography and Planning in 2016. Could you tell me how you are celebrating this milestone?

PM: It's an important year for the School, with a series of high profile events to bring together researchers from the School, other universities, and the worlds of policy and practice to discuss research themes. The first was on homelessness, co-organised with Shelter, also celebrating its 50th year in 2016. Future events cover the changing city-region, food justice, post-industrial landscapes and spaces of desire. The School is also hosting the 2016 UK-Ireland Planning Research Conference in September.

Further details of these events can be found on our website (www.cardiff.ac.uk/cplan).



Professor Paul Milbourne

Neuroscience and Mental Health Research Institute

Mental illness is one of the greatest remaining health challenges facing our society. Mental health disorders, which span dementia, epilepsy and the psychiatric conditions, affect one in six people in the UK population at a cost of over £100bn per year to the economy.

Cardiff University's researchers are global leaders in unravelling the genetic basis of mental disorders, and this accumulating genetic knowledge has initiated a new era of mental health research. The challenge now is to use neuroscience to translate genetic discoveries into major improvements in the diagnosis and treatment of mental illnesses.

The Neuroscience and Mental Health Research Institute, established in 2010, brings together research expertise in psychiatry, neuroscience and psychology from across the College of Biomedical and Life Sciences, to apply recent advances to understanding the biological basis of mental illness. It has already achieved major successes in funding and recruitment, establishing strong foundations from which to now build a world-leading mental health institute recognised for its research, innovation and impact.

The Research Institute's research is principally undertaken through the following four themes:

Neurodevelopment

The Research Institute is interested in how genetic and environmental factors acting on brain development alter risk for mental illness, and study this process in a variety of ways, including using cellular assays, model systems and clinical, cognitive and imaging studies. These are applied to patient and developmental groups, including carriers of rarer high penetrance genetic risk factors.

Neuroplasticity

The Research Institute is interested in both the basic molecular and the physiological processes underlying learning, prediction and plasticity in the brain, and in their relevance to the understanding and treatment of neuropsychiatric disorders. It addresses these issues using studies which span from cellular approaches to human brain imaging studies in patients.

Neuroexcitation

The Research Institute studies epilepsy and related conditions using a wide spectrum of techniques. These include human stem and iPSC cells, systems neuroscience, clinical psychology

and functional imaging studies, on patients from the National Epilepsy Surgery programme.

Neurodegeneration

Scientists from the Research Institute are involved in research from cellular to clinical studies uncovering the basis of these disorders and looking for new routes to therapy including cellular transplantation in Huntington's disease and new approaches such as immune modulation in Alzheimer's disease.

In August 2015 the Research Institute gained funding for a further five years. Its ambition now is to bring psychiatric genetics and neuroscience researchers together to form the basis of a new MRC / Wellcome Trust Unit embedded in Cardiff University – the first such Unit in Wales.

Example achievements

The study that is the focus of Professor David Linden's paper, *Multimodal brain imaging reveals structural differences in Alzheimer's disease polygenic risk carriers: A study in healthy young adults* (<http://www.biologicalpsychiatryjournal.com/article/S0006-3223%2816%2931114-3/pdf>) paves the way for further investigation into the effects of Alzheimer's disease risk variants and may become useful for efforts to combine data for risk prediction and to enhance future prevention trials of the disease.

Dr Andrew Pocklington and international colleagues have found the strongest evidence yet of what causes schizophrenia. Their paper *Novel findings from CNVs implicate inhibitory and excitatory signalling complexes in schizophrenia* (<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4460187/>) presents strong evidence that disruption of a delicate chemical balance in the brain is heavily implicated in the disorder. In the largest ever study of its kind, the team found that disease-linked mutations disrupt specific sets of genes contributing to excitatory and inhibitory signalling, the balance of which plays a crucial role in healthy brain development and function.

“Our objective is to develop a sustainable, interdisciplinary Research Institute recognised as one of the world centres for research into the causes and treatment of the major mental illnesses. Our vision is to build an outstanding environment for mental health research that attracts, supports and retains the best scientists and students in Cardiff.”

Professor Jeremy Hall, Director (below)



Key research programmes

Defining Endophenotypes from Integrated Neurosciences (DEFINE). This £5.2m Wellcome Trust Strategic Award involves nine Principal Investigators from the Schools of Medicine, Psychology and Biosciences, led by Professor Mike Owen. Twelve new posts have been created with this award. It is the first Wellcome Trust Strategic Award for Cardiff.

The aim of the study is to understand how genetic risk factors impact on brain function in psychiatric disorders such as schizophrenia, ADHD and autism.

By studying cells, animals and patients all carrying the same genetic risk factors researchers will be able to link abnormalities in brain function and behaviour seen in patients to abnormalities in cells and brain circuits. This will pave the way for the development of a new classification of mental disorders based on biology and to the development of novel approaches for the treatment of these disabling conditions.

£1m donation from the Waterloo Foundation to create the Changing Minds programme.

Three major barriers to progress in mental health research and education have been identified; these are strategically addressed through this programme:

- **Supporting talented young researchers** This programme supports talented young researchers to develop beyond their PhD research to the point that they can attract their own independent funding
- **Responding rapidly to new innovation** Funding is available to allow the rapid development of new technical and research discoveries
- **Public Engagement** Funding is available to engage with the public and professionals. This is achieved through a series of open lectures and conferences, increasing engagement, and also through the appointment of a genetic and biological counsellor in mental health.

£495,000 donation from the Jane Hodge Foundation to support two research rising stars. This donation was to support the brightest and best researchers to the Research Institute to benefit from the environment we have built and to translate our findings into benefits for patients and their families. It is with this human capital that we are able to make a difference and allow us to make rapid progress in understanding and treating these devastating conditions. Two research fellowships have been appointed, one in translational neuroscience – Dr Nichola Brydges and one in translational neurophysiology – Dr Adam Errington.

£1.2m NISCHR Brain Unit - The Brain Repair and Intracranial Neurotherapeutics (BRAIN) Unit directed by Professor William Gray is a Welsh and UK National Centre of Excellence for delivering novel cell/drug/growth factor therapies to patients with currently untreatable neurological and neurodegenerative diseases.

The Unit has three main themes:

- 1) To develop new and refine existing systems for therapeutics delivery into the human brain
- 2) To develop the appropriate infrastructure for capturing relevant high-quality patient data to measure real clinical and social impact, as well and continuing to support ongoing mechanistic translational research
- 3) To build our clinical and health economic outcome, social care and service delivery research portfolio.

Intellectual Disability and Mental Health: Assessing Genomic Impact on Neurodevelopment (IMAGINE). The IMAGINE programme of research aims to identify genomic, environmental and developmental factors that are predictive of mental health outcomes within the intellectually disabled (ID) population. This is an MRC funded programme of research in collaboration with colleagues from University College London and Cambridge.

Hadyn Ellis Building - a hub for major research into
cancer biology and mental health conditions.

To find out more about the impact of our research go to
www.cardiff.ac.uk/research



KEEP IN TOUCH

www.cardiff.ac.uk  [@cardiffuni](https://twitter.com/cardiffuni)  facebook.com/cardiffuni  youtube.com/cardiffuni

To request a copy of Challenge Cardiff in large print format contact
Communications on 029 2087 0298, email challengecardiff@cardiff.ac.uk

Comments and suggestions regarding Challenge Cardiff are welcome
and should be sent to challengecardiff@cardiff.ac.uk

Cardiff University is a registered charity, no. 1136855

Printed on recycled paper, in line with the University's
commitment to sustainability. www.cardiff.ac.uk/sustainability



THE QUEEN'S
ANNIVERSARY PRIZES
FOR HIGHER AND FURTHER EDUCATION
2015



INVESTORS
IN PEOPLE

