UCL DEPARTMENT OF PHYSICS AND ASTRONOMY

UCL

PHYSICS AND ASTRONOMY
ANNUAL REVIEW 2015–16

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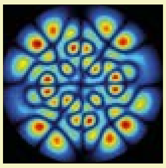
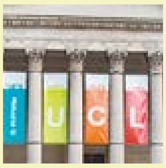


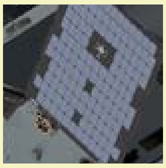

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X-ray beam mode decomposition
Credit: Simone Sala (Department of Physics and Astronomy, UCL)

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UCL Front Quad
Credit: UCL Digital Media

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The lunar eclipse as observed from UCLO over the course during the night of 27–28/09/16
Credit: Steve Fossey and Theo Schlichter, UCLO

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Credit: Ryan Nichol

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An artist's impression of the UCL-led planned space mission TWINKLE, set to analyse the atmospheres of exoplanets
Credit: Twinkle / Surrey Satellite Technology Ltd

Review edited by **Sarah Hutton**, sarah.hutton@ucl.ac.uk

Welcome

The year 2015 saw much excitement and achievement in physics, some of which you will find highlighted in these pages. It also saw many changes in departmental staff, especially in professional services. Our departmental manager, Hilary Wigmore, and her deputy, Kate Heyworth (who held many roles in the department over the years), both left us – they carry our best wishes and gratitude with them, as do other colleagues who have moved on. It is a tribute to their professionalism and that of our new appointments – especially Julie Smith, the new departmental manager who joined us from the Slade School of Fine Art – that the wheels don't seem to have permanently come off anything so far. Many thanks to all staff and students for their patience with any minor dislocations that did occur.

One change that won't be happening just yet: it has been my honour to be head of the department since September 2011, and I was appointed for a five-year term ending in September 2016. However, after consultation, the Provost has recently reappointed me until September 2018.

Looking back over the years up until the end of 2015, we have a lot to be pleased about. We have made many excellent appointments, including five Royal Society Research Fellows, four STFC Ernest Rutherford Fellows, and Professor Richard Ellis FRS. We continue to have great success with the European Research Council, with both Stephen Hogan (AMOPP) and Jochen Blumberger (CMMP), as well as Richard Ellis (Astrophysics), winning major fellowships. We have set up a new research group in BioPhysics, incorporating part of the Institute of Physics of Living Systems, a joint centre with the faculty of Life Sciences supported directly by the Provost. We have established a core of high-quality teaching fellows, providing a context in which research-led teaching can thrive. We were one of the first departments to be awarded both Juno Champion and Athena Swan Silver status in recognition of our commitment to equality and diversity. The quality and quantity of our undergraduate cohort continues to increase. We have established an active postgraduate society, and our undergraduate physics society has been very active of late.

> “Looking back over the years up until the end of 2015, we have a lot to be pleased about.”

We have challenges, of course. We have benefitted from refurbished undergraduate labs and four significant research lab refurbishments, but the works in the Physics Yard and the Kathleen Lonsdale Building have caused major disruption. Our postgraduate (taught) offering is being reshaped to meet a vision of specialisation, with a strong enterprise element and several new courses. We need to ensure continuity and improvement of the technical support provided for our experimentalists. All this is against a background where the financial contributions demanded by UCL centrally have increased rapidly, to generate a surplus to reinvest in infrastructure that should address some of these problems in the long term.

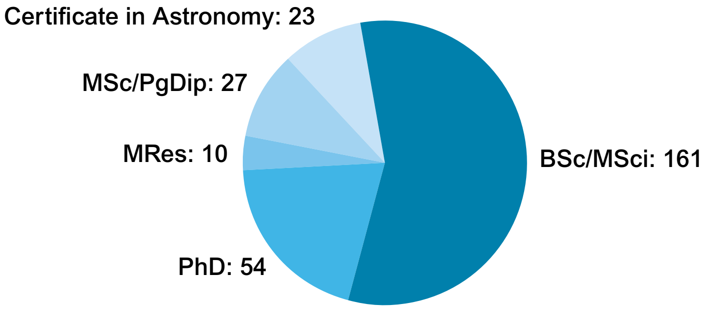
We are a strong Physics & Astronomy department, big and broad enough to address the most exciting research frontiers and reach out into interdisciplinary challenges within and beyond academia. We have excellent and enthusiastic postgraduate and undergraduate student cohorts, who benefit from the opportunities and challenges of being educated within an environment of active research and enterprise. As I hope this review illustrates, we are in a strong position to meet the challenges of the next few years.

Professor Jonathan Butterworth
Head of Department

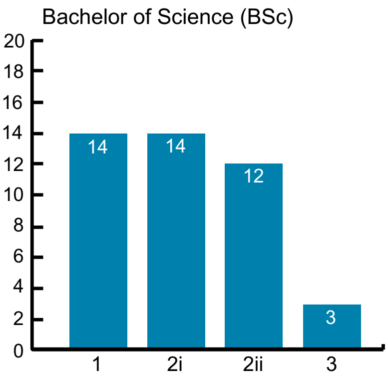
Community Focus

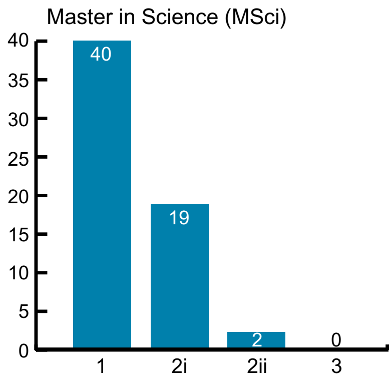
Teaching Lowdown

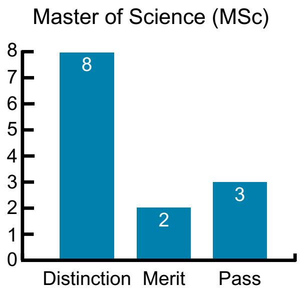
Intake

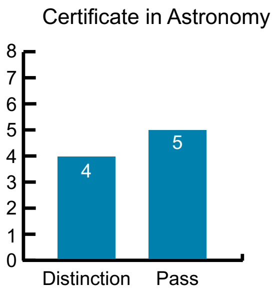


Awards









Teaching in the Physics and Astronomy Department

Among the teaching highlights this year, Bernard Bristoll, one of our laboratory technicians, was awarded a MAPS Faculty Teaching Prize in recognition of the teaching support he provides to our students. Five students from the Department (Daniel Dervovic, Chee Khong On, Nellie Marangou, Felix Priestley, and Mitchell Watts) were placed on the Dean's list, which commends outstanding academic performance by graduating students, equivalent to the top 5% of student achievement. Alexander Guest was awarded the MAPS Faculty PGT prize in 2015 for his outstanding MSc research project on X-ray binary stars, the results from which have been reported in refereed journal papers. Several exciting new initiatives have also been developed this year. In a collaboration with the (now UCL-merged) Institute of Education (IOE) we have established a Physics BSc plus PGCE pathway to promote a route to physics teaching for our students; the Department has also launched new (vocationally targeted) MSc programmes in Scientific Computing and Quantum Technologies.

By Professor Raman Prinja

Headline Research

Astronomers find hottest and most massive touching double star

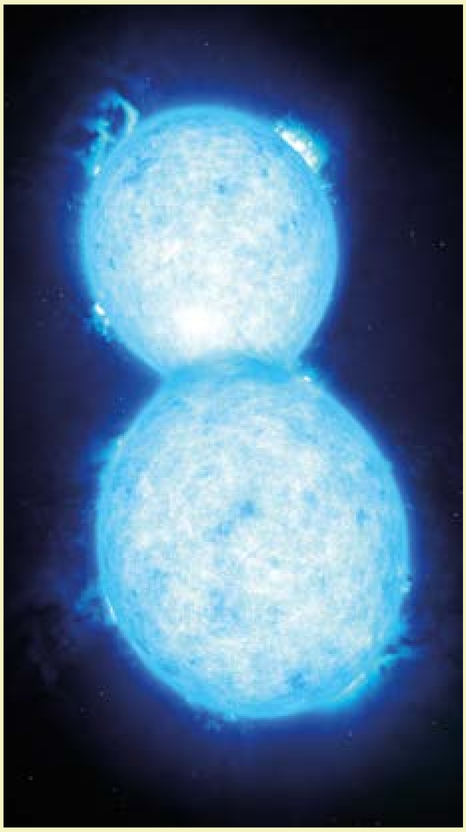
A team of astronomers including UCL's Professor Ian Howarth have found the hottest and most massive double star with components so close that they touch each other.

The discovery was based on observations from the ESO Very Large Telescope.

The two stars in the extreme system VFTS 352 could be heading for a dramatic end, during which the two stars either coalesce to create a single giant star, or form a binary black hole.

Currently the two stars are orbiting each other in little more than a day and as they of almost an identical size, it is thought that material is being shared between the two stars

The double star system VFTS 352 is located about 160 000 light-years away in the Tarantula Nebula.



Artist impression of the stars. Credit:ESO/L. Calcada

Student Accolades

Undergraduate Awards

Departmental Awards

Oliver Lodge Prize
Best performance first year physics
Joanna Lis

Halley Prize
Best performance first year astronomy
Xiaoxi Song

C.A.R. Tayler Prize
Best performance in Communication Skills
Gabriela May Lagunes

Wood Prize
Best performance second year physics
Luke Yeo

Huggins Prize
Best performance second year astronomy
Anusha Gupta

David Pointer Prize
Most improved performance in department first and second year
Markos Karasamanis

Dr Sydney Corrigan Prize
Best performance in experimental work
Zhen Lam

Best Performance Prize
Third year Physics
Emma Slade

Best Performance Prize
Third year Astrophysics
Harry Johnston

Sessional Prize for Merit
Best fourth year project achieving balance between theoretical & practical physics
Jaz Hill-Valler

Burhop Prize
Best performance fourth year Physics
Ruth Ayers

Herschel Prize
Best performance fourth year Astrophysics
Felix Priestley

Brian Duff Memorial Prize
Best fourth year project
Anita Subbaraj

William Bragg Prize
Best overall undergraduate
Daniel Martino Martinez

Tessella Prize for Software
Best use of software in final year projects
Krishna Naidoo

Postgraduate Awards

Harrie Massey Prize
Best overall MSc student
Lorne Whiteway

Marshall Stoneham Prize
Outstanding postgraduate physics research in CMMP (Joint Award)
Ben Warner (Experimental)
Dino Osmanovic (Theoretical)

Carey Foster Prize
Outstanding postgraduate physics research in AMOPP
Duncan Little

HEP Prize
Outstanding postgraduate physics research in HEP
Andrew Edmonds

Jon Darius Memorial Prize
Outstanding postgraduate physics research in Astrophysics
Boris Leistedt

Physics and Astronomy prize winners 2015

Students in Action

Event Horizon

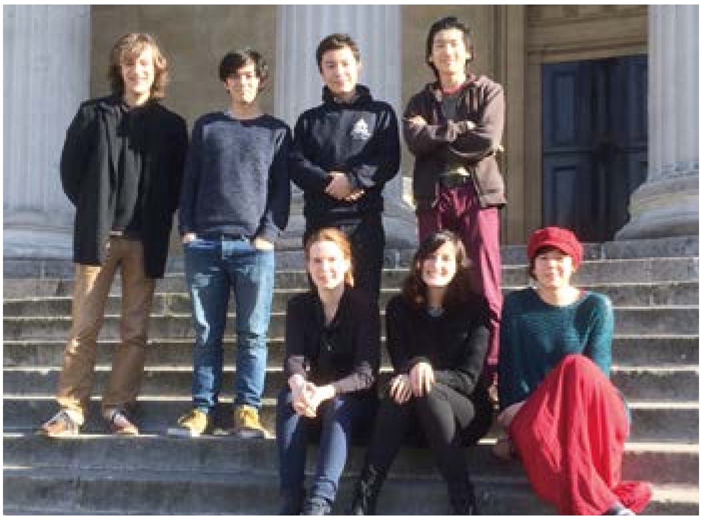
It's been a busy year for Event Horizon, the undergraduate physics society of UCL. We started the academic year by welcoming the new 1st year students with a packed schedule of activities, all within the first two weeks of term. Since then it's been a roller-coaster of various events, both social and academic. As a society our primary goal is to support and enrich the university experience for all the physics undergraduates. We have dedicated committee members who work hard on organising events of all sorts.

On the social side, we've done a number of popular events such as the Physics Boat Party, an UCL vs ICL pub-quiz, a Christmas formal, the massive all-day "kickoff" for the freshers, as well a host of other activities. We're also currently planning an end-of-term trip to Iceland, to see the northern lights.

On the academic side, we've had people like Prof Faye Dowker and Simon Singh give guest lectures. We're also organising lab tours within the department, as well as Café Scientifiques with our own academic staff. One of the biggest and most successful academic events this year was the Physics Undergraduate Research Conference, organised jointly with our counterparts at Imperial College (PhySoc). The aim of the conference was to highlight research done at an undergraduate level, and we hope, based on the success of this year, to make it an annual event.

Throughout the year we've seen Event Horizon as a society increase the scope of its activities. We've also gained a lot of new members, doubling our size. Soon it'll be time for elections for a new committee, and we hope that the society can continue to grow and develop in the next academic year.

Lukas Kikuchi
Vice-President of UCL Event Horizon



The Event Horizon committee of 2015/16

Headline Research

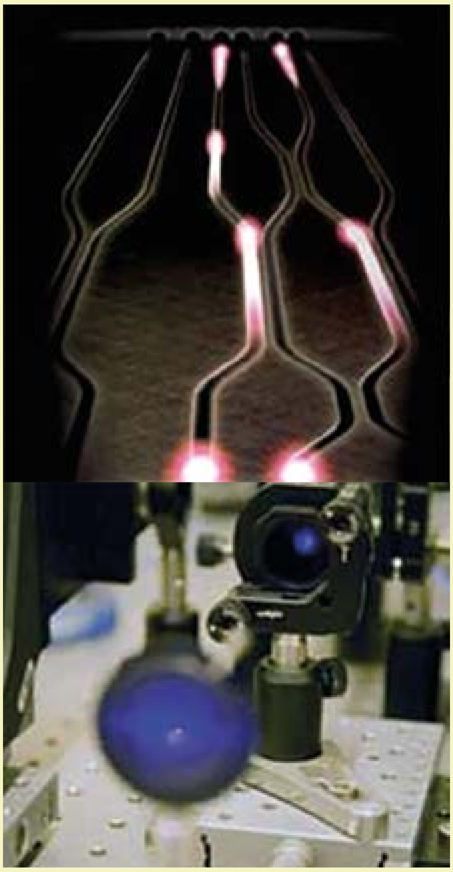
A new blueprint for quantum computing with photons

Quantum computers promise a step change in computational power for some important problems, such as the simulation of the properties of solid materials and chemical reactions.

At a fundamental level, all physical systems behave quantum mechanically, but the quantum mechanical properties needed for quantum computation are extremely fragile. The best way to build a large-scale quantum computer remains an important open research question.

Photons have long thought to be the basis for a quantum computer, but realising this is very difficult and many challenges remain. Great advances have been made in recent years, and the most promising blueprint for building a photonic quantum computer has come out of UCL, with a proposed architecture which overcomes several of the main problems currently known about for quantum computing with photons. (Gimento-Segovia et al., Phys. Rev. Lett. 115, 020502 (2015)).

There are still several challenges facing the team, but they are working through them and are on the road to bringing their theories to experimental realization.



Generating and detecting single photons.
Credit: Carmel King © All rights reserved

Physics Hackathon

The UCL Physics Hackathon held annually pits 5–7 teams of PhD students in a contest to solve a problem and present the results – within 48 hours.

This year's Physics Hackathon resulted in a dead heat between two teams of 5 PhD students. One of the winning teams built two prototype devices to enable physically disabled to send Twitter messages at the push of a button. The second team worked on algorithms to enable hikers to choose to optimise their route so as to stay at good hotels along the way; and an algorithm for pub crawlers to choose the shortest routes between a set of pubs. These two teams shared the winning prize of 300 pounds.

The runner up team built a device to remotely detonate a balloon (Figure 1): they were awarded a special "hacker prize" by the judges, comprising a set of bitcoin wallets.

The Hackathon is organised by the Physics and Astronomy PhD society. This year's event was held in the basement of the Wellcome building on February 9–10. It includes presentations from industry sponsors, which this year included Deloitte Digital and The-ASI (**www.theasi.co**) a data science company set up by recently graduated Physics PhD student Marc Warner (Figure 2). The company also trains PhD students by offering 8-week Fellowships to enable PhD physicists to become data scientists in the many companies and start-ups near UCL.

Figure 1

Figure 2

Headline Research

Water droplets surf graphene waves

Atoms and molecules usually move across materials by hopping from one point on their surface to the next. Recently on the basis of computer simulations it has been shown that for graphene – a single layer sheet of carbon atoms – molecules can move at record speeds simply by sticking to and surfing on the wave-like ripples typical of thin sheets of solid materials. Just like people, some molecules make better surfers than others. Water droplets are exceptionally good at it! This new diffusion mechanism differs from others suggested previously for diffusion on surfaces or through nanoporous materials. Furthermore, by tuning the amplitude of the ripples and the type of adsorbate the fundamental design principles that enable fast and controlled motion of adsorbates on layered materials in general have been revealed. This fast transport of water may well be at the root of the promised performance of graphene in filters and sensors.

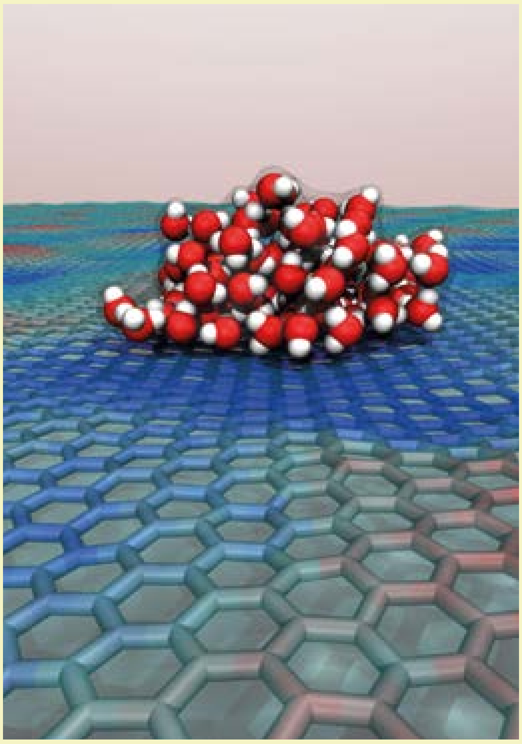
Publication:

Fast diffusion of water nanodroplets on graphene

Ming Ma, Gabriele Tocci, Angelos Michaelides and Gabriel Aeppli

Nature Materials (in press) doi:10.1038/nmat4449

Published online at:
www.nature.com/nmat/journal/vaop/ncurrent/full/nmat4449.html



Snapshot from a computer simulation of a water nanodroplet 'surfing' on graphene.

Physics Postgraduate Society/Committee

The Physics Postgraduate Society is a group of Physics PhD students committed to creating events that encourage intra-departmental socialising whilst also emphasising self-improvement beyond research activities. The society aims to work towards combating the myth of PhD research being an isolated existence with limited skills development. The most frequent of events held by the committee are the student-led evening seminars which are held fortnightly. Whilst the seminars predominantly follow the formula of two PhD students presenting their research work followed by food and refreshments, the event has welcomed a wide range of speakers including the UCL based researcher and BBC presenter Dr Helen Czerski. As well as this staple event, the committee also organise debate evenings, quiz nights and the annual Hackathon. Although the first Hackathon was held as recently as 2015, it has already obtained continued external sponsorship and has developed a strong identity. The ambitious two-day event involves small teams working together on a novel problem with their final work presented to a panel of judges consisting of representatives from industry. The work of previous winners has included development of a solar powered toy, an arduino based device for enabling communication for those with paralysis and an app for planning treks. As is evident from the success of such events, there is not only a desire for a united postgraduate student group but also a need for it.

Headline Research

A new way to sense magnetic fields with a single molecule device

Detecting changes in magnetic fields is crucial for various technologies used in non-volatile data storage. In today's hard drives, for example, the orientation of the magnetic domains that encode data are measured using magnetoresistive effects, in which the electrical resistance of the sensor material changes in the presence of a magnetic field. In an article published this past year in Nature Nanotechnology, a team of scientists from UCL and the University of Liverpool reported an exciting new form of magnetoresistance that occurs in an electrical junction containing just a single magnetic molecule. The effect is 100 times more sensitive to magnetic fields than would normally be expected, and arises because the molecule is more strongly coupled to one side of the electrical junction than the other. In the future, such advances in shrinking sensors down to the smallest possible scale could lead to new increases in data storage capacities.

Published in:

Tunable magnetoresistance in an asymmetrically coupled single-molecule junction

Ben Warner, Fadi El Hallak, Henning Prüser, John Sharp, Mats Persson, Andrew J. Fisher, and Cyrus F. Hirjibehedin

Nature Nanotechnology 10, 259 (2015)

http://dx.doi.org/10.1038/nnano.2014.326

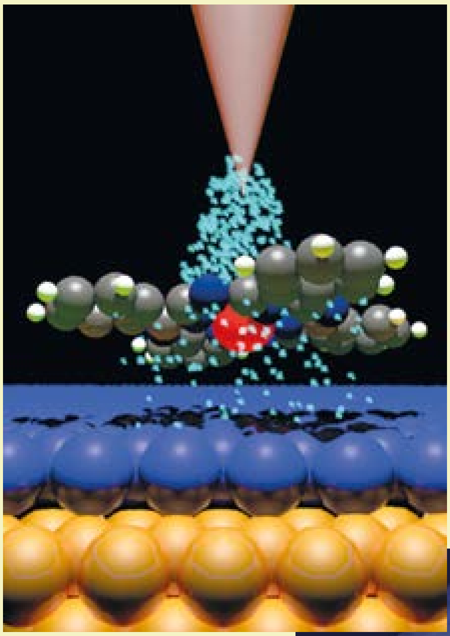
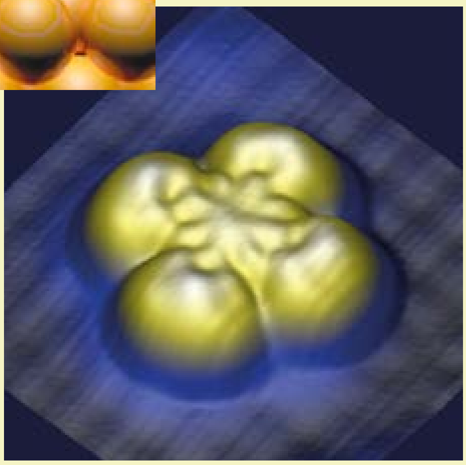


Illustration of a single iron phthalocyanine magnetic molecule in an electrical junction. The sensitivity of the current flowing through the molecule to a magnetic field is enhanced by the asymmetric coupling to the two sides of the junction.



Topographic image of a single iron phthalocyanine magnetic molecule in an electrical junction. The sensitivity of the current flowing through the molecule to a magnetic field is enhanced by the asymmetric coupling to the two sides of the junction.

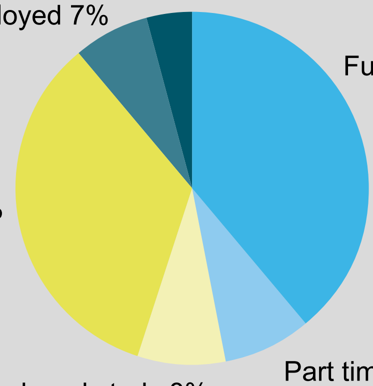
Career Profile

Graduate Destinations

Total Number of Graduates: 112

Response Rate: 71%

Median Salary: £27,000
(full time employment)



Data for 2014 graduating cohort, compiled in June 2015

Heidi Allen

Originally from a rural village in Yorkshire and schooled at Wakefield Girls' High School, Heidi studied Astrophysics at UCL from 1993–1996. Since then, she has worked in operational roles for a number of large multinational organisations in a variety of industries. She has worked both in the private sector for companies such as ExxonMobil and Churchill Insurance and also in the public sector with the Royal Mail. The last ten years of her business career was as the Managing Director of her own motorcycle paint manufacturing business.

However, a huge change of direction came in 2011 when the scenes of the Tottenham riots literally shook her out of her comfort zone. Deeply patriotic and determined to play her part in rebuilding Great Britain plc, she decided to enter the word of politics. Early steps saw her become a district councillor in St Albans in 2012, followed by selection in 2014 as the Conservative parliamentary candidate for South Cambridgeshire when Andrew Lansley announced his intention to retire.

Having chosen this constituency because of its world leading role in scientific research and high economic growth, Heidi found it a good fit. In May 2015 she was elected as the Member of Parliament with a majority of 20594 and 51.1% of the vote.

> "In May 2015 she was elected as the Member of Parliament with a majority of 20594"

Although Parliament is not a usual staging post on the main sequence of an Astrophysics graduate, clear thinking, constant questioning, evidence based logic (and the fact that people don't argue with you if you tell them you have a degree in Astrophysics!) have equipped Heidi to travel in an exciting new orbit.

Equality and Diversity Committee

The departmental Equality and Diversity committee came into being several years ago in order to coordinate the Department's application for the Institute of Physics' Project Juno. Juno is the Institute's award scheme for Departments that have shown commitment to supporting women throughout their careers, and the Department of Physics and Astronomy was awarded the highest possible award, Juno Champion, in 2015. We have also been awarded a Silver Athena SWAN award for our work in addressing gender imbalance in STEM. In 2015 our brief was expanded to cover all forms of equality and diversity: good practice benefits everyone, regardless of their gender, race or sexual orientation. Much remains to be done, but we are making a difference.

The committee is a diverse group with a large membership drawn from all areas of the department. We have representatives from all research groups, teaching, technical and professional services staff, and at all levels from PhD student to professor.

Much of the work of the committee involves sifting through data to maintain an up-to-date picture of our large and changing department. In doing this we're able to quickly spot, and rectify if necessary, any potential problems, for example with recruitment or promotion rates. We also run a biannual survey of all staff in the department to gauge attitudes and concerns, and will be surveying the department's PhD students this spring to try to uncover any previously unknown issues.

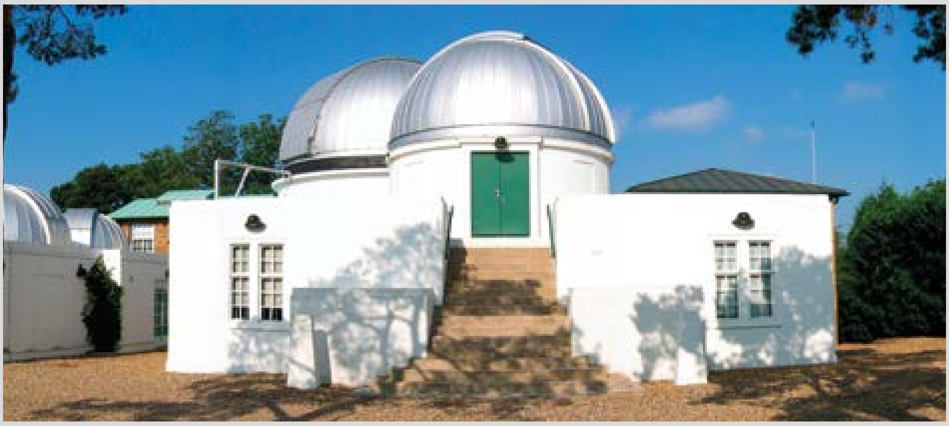
Our proportion of female undergraduates (25% in 2015/16) is higher both than the national average and the proportion of female students taking A-level physics – this is in part due to changes to the format of our interview process, which was one of the examples of good practice highlighted by the Institute's Juno assessment panel. The department was also praised for its arrangements for staff returning from maternity and paternity leave, and for the way we are embedding equality and diversity policies within the Department. Our work continues!

Dr Louise Dash
Chair of the E&D committee

Observatory News

On 14th October 2015 the Board of Trustees of UCL agreed to change the name of the University of London Observatory (ULO) to University College London Observatory (UCLO).

While the observatory was originally established as a University of London facility when it was originally opened in October 1928, the name change has been a long time coming as it has been exclusively operated by UCL since 1951.



2015 has also seen a change in directorship for the observatory, with Prof. Ian Howarth stepping down and Dr. Giorgio Savini taking over. One of the first major jobs that Giorgio will be overseeing is the replacement of the Allen Dome which is due to take place during summer 2016.

Alumni Matters

The third Physics and Astronomy Gala Dinner was held on the 23rd of October 2015 again at the nearby Ambassador Hotel as the Wilkins Building is still undergoing extensive refurbishment. Some 26 under and post graduate prize winners and their guests, 17 members of staff and 51 Alumni came together to meet at the reception and over dinner, be again amazed by the student achievement in the Award ceremony and to listen to the 'After Dinner Speaker' which had been a feature of previous annual Alumni Dinners.

The reception and the dinner were this year preceded by the first Annual Physics Lecture.This well attended lecture was given by Dr Gavin Hesketh, a member of the department's High Energy Particle Physics group on that most topical of subjects '*Life after the Higgs: where next for particle physics?*'.

The after-dinner speech was given by that extremely distinguished observational cosmologist Prof Richard S Ellis CBE FRS who graduated from the UCL Astronomy department in 1971. (The UCL Astronomy and Physics departments were amalgamated soon afterwards). Richard described with humour and humility the remarkable odyssey which took him from Hen Golwyn in North Wales to UCL in 1968 and then in 1971 to a PhD at Oxford. His first academic appointment was at Durham where he had the backing of Arnold Wolfendale, and thence to chair appointments at Cambridge, Oxford and Caltech. It is perhaps fitting and extremely good news, that Richard who has mapped the Universe and is the son of a famous sea captain who sailed the world's oceans is as it were returning to his home port.

I am extremely proud to announce that the after-dinner speaker at the fourth Gala Dinner to be held on 28th October 2016 will be Heidi Allen MP. Heidi Bancroft graduated in Astrophysics from the department in 1996 and was extremely successful in growing a family business to become international. In 2015 she was elected the Conservative MP for South Cambridgeshire and has demonstrated a very independent spirit indeed in Parliament.

By Professor Tegid Wyn Jones

Headline Research

First detection of gases in super-Earth atmosphere

The first successful detection of gases in the atmosphere of a super-Earth reveals the presence of hydrogen and helium, but no water vapour, according to UCL researchers.

The exotic exoplanet, 55 Cancri e, is over eight times the mass of Earth and has previously been dubbed the 'diamond planet' because models based on its mass and radius have led some astronomers to speculate that its interior is carbon-rich.

Using new processing techniques on data from the NASA/ESA Hubble Space Telescope, a UCL-led team of European researchers has been able to examine the atmosphere of 55 Cancri e in unprecedented detail.

"*This result gives a first insight into the atmosphere of a super-Earth. We now have clues as to what the planet is currently like, how it might have formed and evolved, and this has important implications for 55 Cancri e and other super-Earths,*" said Professor Giovanna Tinetti (UCL Physics & Astronomy).

Intriguingly, the data also hinted at a signature for hydrogen cyanide, a marker for carbon-rich atmospheres.

The research at UCL was funded by the Science and Technology Facilities Council and the ERC projects ExoLights and ExoMol.

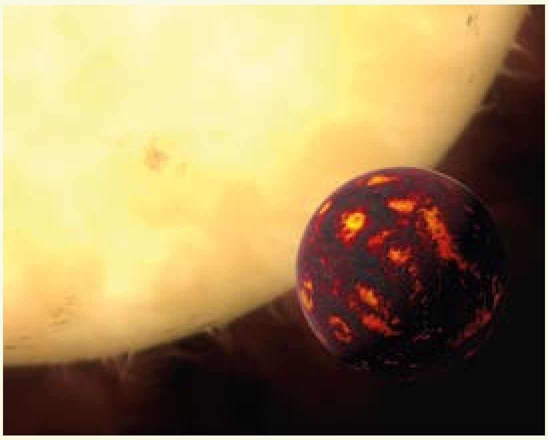


Image: Artist's impression of 55 Cancri e
Credit: NASA/ESA Hubble Space Telescope

Published online at:
www.nature.com/nmat/journal/vaop/ncurrent/full/nmat4449.html

Science in action

Outreach and Public Engagement are words that get used a lot in academia, but what do they mean, and what do we hope to gain by doing them?

Outreach is usually focusing on raising awareness and inspiring children and young adults most commonly through schools and community groups. Public engagement is targeting a wider audience and will cover a larger range of events. Current research shows that if we want to inspire the next generation to become scientists or to be more scientifically literate then just targeting children is not enough we need to encourage their parents and wider family too.

In my mind the outreach that we do has three main, broad aims:

1. To inspire the next generation of scientists
2. To remove gender bias from Physical Sciences
3. To make the next generation more scientifically literate

Each of these are important in their own right, but I would argue that point 3 is the one that with direct intervention in schools, we have the most power to achieve. It's still all too common in the media to see people admit that they are 'rubbish' at Science and Maths but would never admit to being unable to read. If we can enable the generation still at school to be open-minded about science then, even if they do not pursue a career in it, they will be more supportive of their peers that do and when the time comes, will be willing to encourage their children want to follow a STEM based path.

'Science Capital' are the latest buzzwords for the Outreach community and it relates to how much science a child is exposed

Trialing matchstick rocket demonstrations in the rain at UCLO. Credit: Mick Pearson (UCLO)

to in their daily lives. Currently only students who can talk about science at home with their family consider a career in the sciences (excluding medicine). The reasons for this are complex and are only just being to be uncovered at part of a 10-year study into what drives the changing aspirations of students as they move through secondary school.

Over the past year at UCL we have been expanding our outreach and public engagement provisions in order to embed our work more within the communities of the schools at we visit. Our schools partnership is going from strength to strength with undergraduate students going to give talks at the schools and evening lectures for the students and their families being given by academics from the department. Many of our staff and students have become STEM ambassadors, getting involved with a wide range of events that help promote Physics as a viable career option. The Your Universe festival welcomed nearly 600 students from primary and secondary schools across London to learn more about Astrophysics and Particle Physics. At the observatory (UCLO) we have expanded our schools provision running more school visits, astronomy based workshops and teacher training sessions. On the public engagement front both Prof. Jon Butterworth and Prof. Raman Prinja have written well received popular science books on CERN and a children's guide to observing the night sky respectively. Other members of the department have been involved with national and local T.V. and radio shows, done Bright Club performances and have hosted stalls at a wide variety of festivals.

Academic Showcase

Staff News

Appointments

Professor Richard Ellis joins UCL as a Professor of Astrophysics. Richard is returning to UCL, having last been here as an undergraduate from 1968–1971.

Promotions

We are very pleased to announce the latest round of senior promotions; congratulations to the staff listed below on their well-deserved achievements.

Promotion to Professor

Prof. Jochen Blumberger (CMMP)
Professor of Chemical Physics

Prof. David Bowler (CMMP)
Professor of Physics

Prof. Dorothy Duffy (CMMP)
Professor of Physics

Prof. Hiranya Peiris (Astro)
Professor of Astrophysics

Promotion to Reader

Dr. Frank Deppisch (HEP)
Reader of Physics

Dr. Agapi Emmanouilidou (AMOPP)
Reader of Physics

Dr. Alexandra Olaya-Castro (AMOPP)
Reader of Physics

Retirements

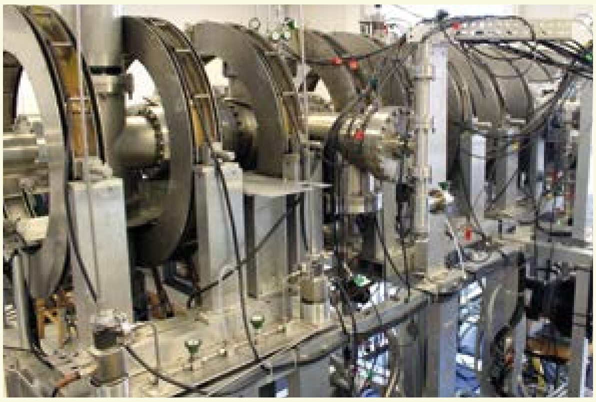
November 2015 saw the retirement of **Hilary Wigmore** who had served as Departmental Manager for 15 years. Hilary will be much missed but the whole department wishes her well as she embarks on a hopefully more relaxing time of life. We have now been joined in the role by **Julie Smith**. Having worked in Higher Education since 2004 and at UCL – firstly in SLMS and latterly at the Slade School of Fine Art – since 2008, Julie comes to us with a wealth of cross-institutional and cross-function knowledge.

Headline Research

First measurements of the differential positronium-formation cross-sections

Positrons are the antimatter version of electrons and so their fate in a matter world is ultimately to annihilate. However, prior to this, a positron may combine with an electron to form a matter-antimatter hybrid called positronium. This is similar to a hydrogen atom with the proton replaced by a positron. Fundamental to our understanding of the physical universe, positron and positronium are these days also acknowledged as being fantastically useful in practical applications such as probing material properties and medical diagnostics. However, there is still much that we do not know for sure about the details of the interactions of these particles with ordinary matter. For example if, in a collision with an atom or molecule, a positron captures an electron, in which directions is the positronium likely to travel and with what probability?

Now researchers at UCL (Shipman et al., Phys. Rev. Lett. 115, 033401) have performed measurements, which can, for the first time, be directly compared with theoretical predictions, mostly in disagreement with one another. This is a substantial advance and solves a critical outstanding problem in the field, finally providing an experimental test of a considerable body of theoretical work developed on the subject over the past 40 years. The work is expected to impact also on the resolution of persistent discrepancies in the broader description of charge-exchange. The ratio of the differential and integrated cross-sections for the targets investigated (namely He, Ar, H_2 and CO_2) exposes the higher propensity for forward-emission of positronium formed from He and H_2.



The Positronium Beam in UCL Physics & Astronomy. Credit: O. Usher (UCL MAPS).

Staff Accolades

UCL Director of the LCN

Awarded to **Professor Andrew Fisher**

Andrew took up his post in October 2015 and is “very proud” to be taking up the mantle passed to him by Professor Des McMorrow who is now the Vice-Dean of Research.

Royal Society Wolfson Research Merit Award

Awarded to **Professor Franco Cacialli**

For his work on the ‘Fundamentals and applications of printable and nanostructured semiconductor.’

Honorary Membership of the Roland Eotvos Physical Society

Awarded to **Professor Gaetana Laricchia**

For her research into Positronium.

UCL MAPS Faculty Award for Support Staff category

Awarded to **Bernard Bristoll**

“The level of Bernard’s commitment to teaching is remarkable, and all students could benefit from his passion to teach and appreciate his competence in electronics.”

UCL Physics & Astronomy Teaching Prize

Awarded to **Professor Ian Howarth**

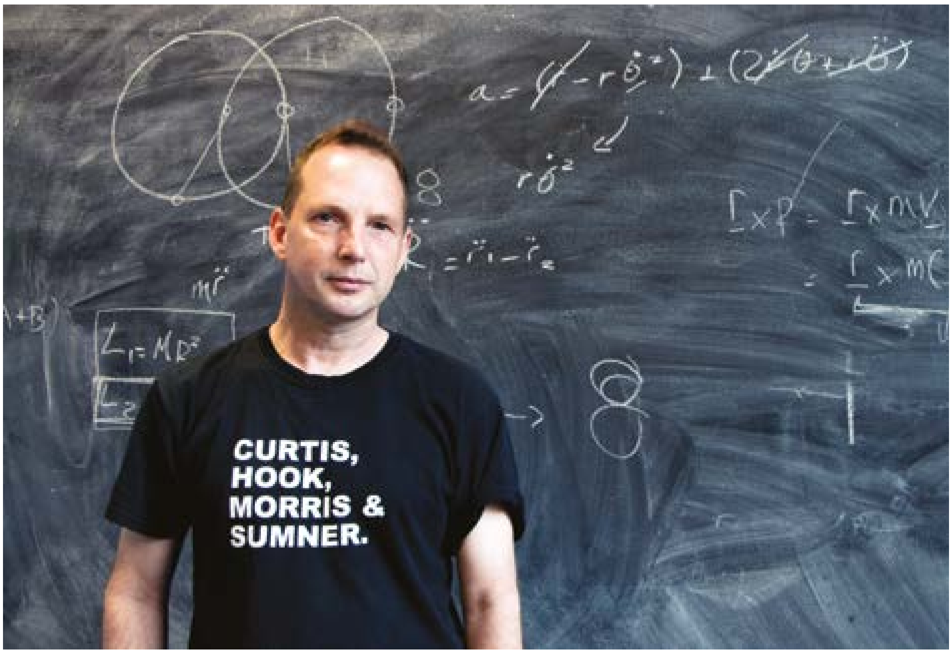
For his inspirational teaching in a range of astrophysics modules, spanning from large first year foundational classes to advanced topics in stellar astrophysics in Years 3 and 4 of the undergraduate degrees.

Portrait of…

Professor Mark Lancaster

In September Mark Lancaster will be stepping down as head of the High Energy Physics (HEP) research group within the department after eight years.

After being born and brought up in that glorious Riviera of the North, Blackpool, Mark began his higher education forays into Physics at Keble College, Oxford where he was convinced to stay on for a DPhil in high energy experimental particle physics, graduating in 1992. Extended stays at the DESY collider in Hambury, Lawrence Berkeley Lab in California and Fermilab in Chicago followed before arriving at UCL as a Lecturer in 1999.



After a fairly quiet two years at UCL, Mark decided to try something different in 2001, taking a sabbatical for a year to try his hand as a software engineer. Despite most of the department being convinced that that would be the last they saw of him, he returned once his year was up, feeling slightly more affluent and with a renewed vigour and appreciation for the academic lifestyle.

Over the next six years Mark served as the departmental school and media liaison officer, a role which prepared him well for when he became head of the High Energy Physics group in 2008 at the height of the STFC funding cuts. As a result of the funding cuts, Mark became one of the heads of the Particle Physics Action Group and was involved in lobbying and being a spokesperson for the group; hosting meetings at UCL and appearing in many T.V. and radio segments. Recovering from the fallout has led Mark to diversify the funding stream for his group and not to take anything for granted, an approach that has been adopted by many other Particle Physics groups up and down the country.

Over the eight years that Mark has headed up the HEP group, it has more than doubled in size, he is proud to be leaving behind the same collegiate atmosphere that made him want to join UCL 17 years ago. Looking forwards, the group are in a strong position involved in a wide range of small experiments working with collaborators all over the world, still supported by the same core technical staff who continue to make the impossible, possible on a daily basis.

On being freed from the constraints of being a head of group and leaving HEP to flourish under the new leadership of Prof. Ruben Saakyan, Mark is going to be dividing his time between here and Fermilab, working on the Muon g-2 experiment considering possibilities of new physics beyond our current understanding of fundamental particles and the Standard Model.

Research Degrees

January – December 2015

Stefano Boseggia
Magnetic order and excitations in perovskite iridates studied with resonant x-ray scattering techniques
(Supervisor: Professor D. F. McMorrow)

Jake L. Stinson
Modelling microscopic clusters of sulphuric acid and water relevant to atmospheric nucleation
(Supervisor: Professor I. J. Ford)

Nihal A. Abdulwahhab
Transport of cold atoms in laser fields
(Supervisor: Profesor F. Renzoni)

Maayane T. Soumagnac
Tipping scales in galaxy surveys: star/galaxy separation and scale-dependent bias
(Supervisor: Professor S. Viti)

Jacqueline S. Edge
Hydrogen adsorption and dynamics in clay minerals
(Supervisor: Professor N. T. Skipper)

Simon N. E. Ward
Spin ladder physics and the effect of random bond disorder
(Supervisor: Dr C. Ruegg)

Maria I. A. J O. Ochoa De Castro
Searching for the Higgs boson in the bb decay channel with the ATLAS experiment
(Supervisor: Professor J. M. Butterworth

Tomasz Kacprzak
Statistical problems in weak gravitational lensing
(Supervisor: Professor S. Viti)

Duncan A. Little
Electron-N_2^+ scattering and dynamics
(Supervisor: Professor J. Tennyson)

Peter D. Edmunds
Trapping ultracold argon atoms
(Supervisor: Professor P. Barker)

Hannah M. Calcutt
The early stages of massive star formation: tracing the physical and chemical conditions in hot cores
(Supervisor: Professor S. Viti)

Antonios Makrymallis
Novel algorithms for the understanding of the chemical cosmos
(Supervisor: Professor S. Viti)

Giulia Tregnago
Photophysics and applications of organic semiconductors
(Supervisor: Professor F. Cacialli)

Michael F. Faulkner
Topological and emergent phenomena in lattice BKT systems
(Supervisor: Professor S. T. Bramwell

Andrew Edmonds
An estimate of the Hadron Production Uncertainty and a measurement of the rate of proton emission after nuclear muon capture for the comet experiment
(Supervisor: Professor M. A. Lancaster)

Bedoor A. I. Alkurtass
A quantum information approach to many-body problems
(Supervisor: Professor S. Bose)

David Zhe Gao
Modelling of adsorption and atomic force microscopy imaging of molecules on insulating surfaces
(Supervisor: Professor A. Shulger)

Matthew Bibby
The development of automatic on-machine metrology
(Supervisor: Professor D. D. Walker)

Paul Moseley
Novel RF quasi-optical components for THz astronomy
(Supervisor: Dr G. Savini)

Marian Breuer
Computational studies of electron transfer in the bacterial deca-heme cytochrome MtrF
(Supervisor: Professor J. Blumberger)

Robert G. Antonio
Quantum computation and communication in strongly interacting systems
(Supervisor: Professor S. Bose)

Richard P. Rollins
Chemical and statistical models of the interstellar medium and star-forming regions
(Supervisor: Professor J. M. C. Rawlings)

Elinor J. Bailey
Polarised fluorescence and stimulated emission depletion studies of excited state dynamics
(Supervisor: Dr A. J. Bain)

Rafael P. Miranda
Efficient multiconfigurational time-dependent simulation of conjugated polymers
(Supervisor: Professor A. J. Fisher)

Setrak J. Balian
Quantum-bath decoherence of hybrid electron-nuclear spin qubits
(Supervisor: Professor T. Monteiro)

Clara Sousa Silva
Modelling phosphine spectra for the atmospheric characterization of cool stars and exoplanets
(Supervisor: Professor J. Tennyson)

Martin Uhrin
Understanding the structure of materials at the intersection of rationalisation, prediction and big data
(Supervisor: Professor C. Pickard)

Silvia Martinavarro Armengol
A Herschel study of AGB stars in the Milky Way
(Supervisor: Professor B. M. Swinyard)

Nicholas E. Shuttleworth
Gap phenomena in graphite and its MC6 intercalation compounds
(Supervisor: Dr M. Ellerby)

Tomas E. Gonzalo Velasco
Model building and phenomenology in grand unified theories
(Supervisor: Dr F. F. Deppisch)

Al-Moatasem B. EL-Sayed
Atomistic modelling of charge trapping defects in silicon dioxide
(Supervisor: Professor A. Shluger)

Hugh A. W. Stace
Chemical-MHD modelling of collapsing pre-stellar cores
(Supervisor: Professor J. M. C. Rawlings)

Victor A. Montenegro Tobar
Quantum entanglement and networking with spin-optomechanics
(Supervisor: Professor S. Bose)

Wilhelmus A. C. M. Messelink
Numerical methods for the manufacture of optics using sub-aperture tools
(Supervisor: Professor D. D. Walker)

David J. Buckley
Processing of single-walled carbon nanotubes by reduction in metal-ammonia solutions
(Supervisor: Professor N. T. Skipper)

Guillaume Eurin
Search for the double-beta decay of 96Zr withe the NEMO-3 detector and ultra-low radioactivity measurements for the SuperNEMO experiment using the BiPo-3 detector
(Supervisor: Professor D. S. Waters)

Patrick L. Cullen
Spontaneous dissolution of two dimensional nanosheets from layered materials (Supervisor: *Professor N. T. Skipper)*

Michele Avalle
Transfer process and typicality of noisy quantum systems with discrete time edynamics
(Supervisor: Dr A. Serafini)

Kian A. Rahnejat
Capturing complex reaction pathways step by step: organic molecules on the Si(001) surface
(Supervisor: Dr S. R. Schofield)

James A. Holloway
Generating brilliant X-ray pulses from particle-driven plasma wakefields
(Supervisor: Professor M. Wing)

Research Spotlight

Astrophysics

Project in focus

Genetically modified galaxies

Aim

To understand the relationship between the history of a galaxy and its observed morphology.

Results to Date

The team have shown that it's possible to make controlled modifications to early-universe quantum ripples in computer simulations. The modifications subtly alter the history of individual galaxies, and so allow the complex relationship between history of a galaxy and its current appearance to be better understood.

UCL Involvement

The project is being led by UCL researchers Andrew Pontzen, Nina Roth and Hiranya Peiris.

Astrophysics encompasses pretty much anything beyond ground level, from the Earth's upper atmosphere to the furthest reaches of space and time. Many within UCL's astrophysics group focus on understanding what the universe is made out of, and especially on unpicking the enigmatic dark side to our cosmos. Current estimates chalk up only 5% of the mass of the universe to familiar particles comprising the everyday world immediately around us. The remainder is in the form of dark matter (26%) and dark energy (69%).

Dark matter is thought to be made out of particles that are much like the standard model particles making up atoms and molecules – with the important distinction that dark matter doesn't interact with light or electromagnetic forces. For that reason, it's completely invisible in itself. Dark energy is weirder still, providing a repulsive anti-gravity force which is leading to an acceleration in the expansion of the universe. Neither substance can be seen directly.

The universe is observed through light reaching us here on Earth, making it crucial to understand how these dominant but invisible components impact on the visible properties of the cosmos. To generate this link with rigour and precision, computer simulations are essential tools, probing the formation of cosmic structure through the interactions between different types of matter; UCL's expertise in high-performance computational facilities and massive datasets is placing it at the forefront in several areas.

Marc Manera generates mock catalogues of galaxies to aid interpretation of observational data, using local UCL physics supercomputers and time awarded to him on the national 'Dirac' facility. Starting from the early universe – a time when matter was spread almost uniformly through space – he simulates the growth of structure due to tiny imbalances in gravitational force which arise from initially barely-perceptible ripples.

> “Marc Manera generates mock catalogues of galaxies to aid interpretation of observational data, using local UCL physics supercomputers…”

As the computer-based universe develops, individual structures emerge where a large number of particles are held together by their mutual gravity. These are the equivalent of galaxies in the observed universe. By assuming a range of behaviours for dark energy, simulating the universe for each assumption and making mock observations from within each virtual cosmos, this work generates a crucial point of reference. It underpins our interpretation of the results from future sky surveys that will locate millions of galaxies (Figure 1).

Yet galaxies are complex, swirling masses of gas, stars and dust, coming in many different shapes and sizes (Figure 2). One of the major unresolved questions in cosmology is how the particular type and form of an individual galaxy is decided and responds to the nature of dark matter (given that dark energy is thought to be a

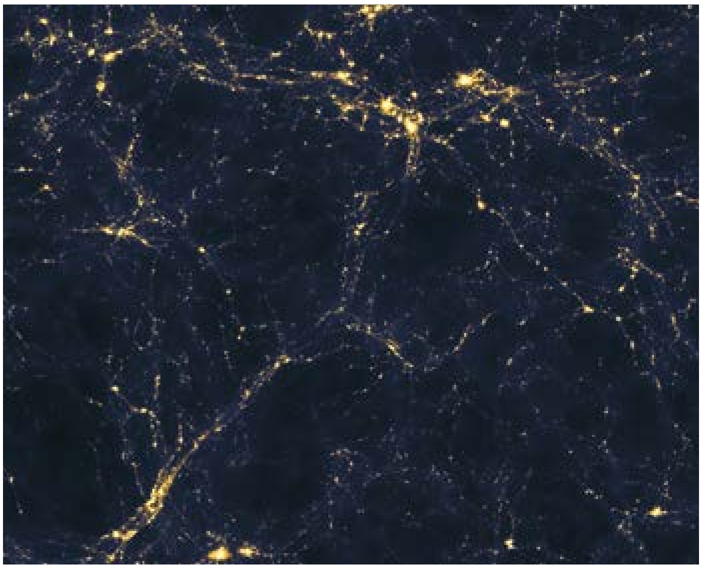


Figure 1.
The distribution of galaxies in a computer simulation on vast scales (more than 50 million light years across). Each pin-prick of light here is an individual galaxy. Credit: Andrew Pontzen/Fabio Governato

secondary effect on the scale of individual objects). So even if we can understand the implications of the overall pattern of galaxies in the universe, many questions remain over the meaning of the individuals.

Observational work such as that by Amélie Saintonge reveals a deep interrelationship between the amount of gas in a galaxy, its observed morphology, and its rate of forming new stars. The physical mechanisms underlying this correlation are far from certain. Worse, it seems that they arise from a detailed interaction between the large scale conditions in the universe surrounding the galaxy, and the relatively tiny scales on which individual stars are formed out of collapsing clouds of gas. This poses a problematic tension for simulations which – even with the world's most powerful supercomputers – do not have the power to simultaneously track millions of galaxies while also resolving the small-scale details of their internal structure.

Andrew Pontzen, Nina Roth and Hiranya Peiris are pioneering a novel solution to this problem by carefully quantifying the relationship between an individual galaxy's detailed history and its observable traits. Using time awarded to Andrew Pontzen on Dirac and on international-tier computer clusters such as NASA's Pleiades facility, they study how individual galaxies develop from the early universe to the present day. The entire computational power of these exceptional computers is focussed on resolving a single object at a time. Rather than stop and study that single output, the team take a copy – then make very slight, tightly-controlled changes to the ripples in their early universe. Finally, the "genetically modified" region of the universe is re-inserted into the simulation, and a different galaxy emerges which can be studied alongside the original.

By studying how the galaxy changes as its history is altered in this way, the team are able to deduce the overall mechanisms at play in setting observed characteristics in the real universe. Without the genetic modification technique, huge samples of randomly-selected galaxies are instead required to pull out subtle trends from statistical scatter. With finite computer time available, these older studies have had to make approximations and short-cuts. Conversely the new approach is able to follow the small-scale physics responsible for forming stars and black holes, and so understand the emergent physics of galaxy formation in a more rigorous way.

While the main effort is devoted to making very small, tightly-controlled changes, the team have recently been experimenting with more extreme modifications. The single most extreme change that can be made to the early density ripples is to invert them entirely, replacing every peak by a trough and vice versa. This transformation has the effect, in the final present-day universe, of replacing each galaxy by an empty cosmic void. The cosmology community have been realising over the last few years that voids may be just as useful as galaxies in placing constraints on the behaviour of dark energy – if we can understand the physics of their formation well enough. The UCL work relates the growth of the two types of structure and so has the potential to put these ideas on a newly robust footing.

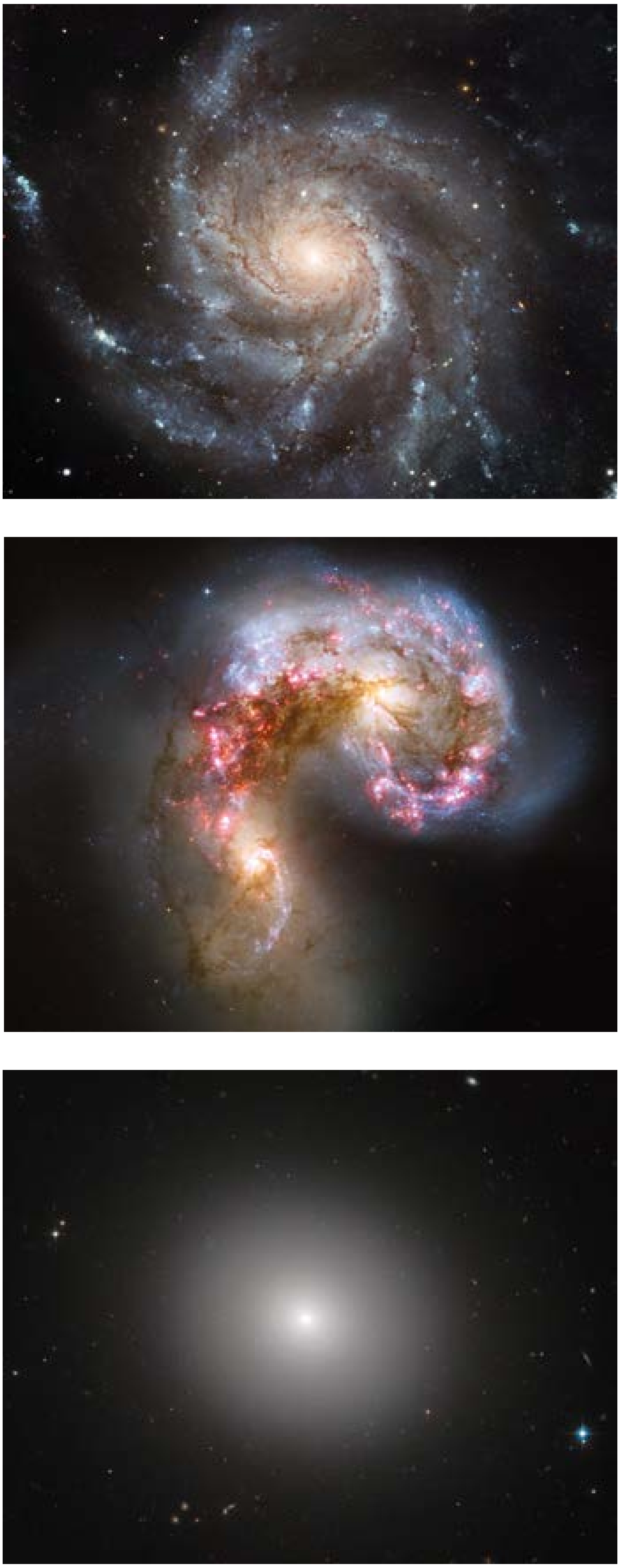


Figure 2.
The galaxies themselves come in many shapes and sizes. The particular appearance of a galaxy holds clues to its past, but the link is poorly understood at present; UCL researchers are using new techniques to study the relationship. Credit: NASA/ESA

Atomic, Molecular, Optical and Positron Physics (AMOPP)

Project in focus
Collective effects in strongly coupled light-matter systems

Aim
The aim is to understand how quantum collective phenomena are affected by non-equilibrium conditions caused by short photon lifetime in strongly coupled light-matter systems -- one of the most promising platforms for quantum technologies.

Results
We determined that the phase transition between ordered and disordered phases in a two-dimensional non-equilibrium driven quantum system is caused by vortices. We also explored vortex and half-vortex dynamics in a non-linear spinor polariton fluid.

UCL Involvement
UCL developed the theoretical description and numerical modeling in close collaboration with experimental group in Lecce, Italy.

It is well understood that there cannot be absolute order in the structure of any fluid as the mechanisms that cause disorder are just too strong. Nevertheless, there can be an enormous difference between systems of lesser and greater order (e.g., between an ordinary fluid such as water and a superfluid such as liquid helium). The latter can flow without any friction and even escape up and over its container walls. The transition between superfluid and normal behavior in two dimensions, even for closed systems that are allowed to equilibrate, is particularly dramatic: It is caused by the appearance of a large number of topological defects in the form of vortices—tiny tornadoes—that destroy the more ordered state. An open question is what causes the transition for particles that cannot be perfectly trapped and equilibrated in any container, such as photons. Their inevitable escape has to be counterbalanced by an external influx to keep the situation steady. We find that the transition is still caused by proliferating tornadoes.

Our research focuses on a quantum fluid of polaritons, and our analysis, based on a stochastic field formalism, accounts for topological defects and fluctuations. Surprisingly, we find that systems that are externally disturbed can remain a superfluid in an overall less-ordered state than their equilibrium counterparts. Whether these systems are more robust to vortex proliferation or simply more disordered by collective fluctuations remains to be determined. This externally overshaken-but-not-stirred quantum fluid clearly constitutes an interesting new laboratory to explore nonequilibrium phases of matter.

We expect that our results will motivate future studies of nonequilibrium phase transitions in driven-dissipative systems, particularly optical ones.

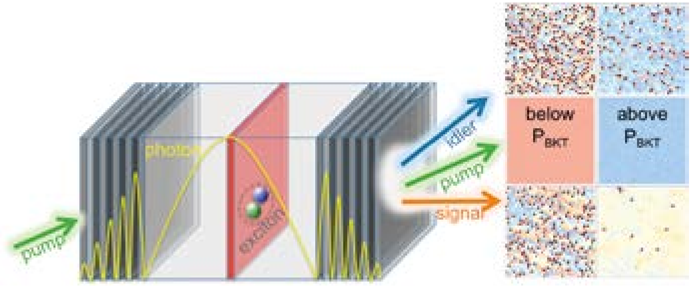


Figure 1.
Normal to superfluid transition in polariton system (sketch).

Vortex and half-vortex dynamics in a nonlinear spinor quantum fluid

One of the intriguing properties of the polariton superfluid is the possibility to have quantized vortices states. Since the bosonic fluid has got its own wavefunction with an amplitude and phase, in order for a vortex to be a quasi-stable state or solution, it must reconnect with itself when performing a loop around the central ‘phase singularity’. In the same way that an atomic orbital is quantized since the electron phase must be reconnected with itself, so the phase of the fluid must overtake one, two, three or more discrete 2π turns when rotating around the vortex core. Despite the finite size of both inner and external radius of the vortex core and surrounding condensate, and the number of particles in it, the phase singularities appear as truly point-like and quantized quasiparticles, which can exhibit quantized events as couple generation, annihilation and merging.

> “We expect that our results will motivate future studies of nonequilibrium phase transitions in driven-dissipative systems, particularly optical ones.”

Vortices are archetypal objects that recur in the universe across the scale of complexity, from subatomic particles to galaxies and black holes. Their appearance is connected with spontaneous symmetry breaking and phase transitions. In Bose-Einstein condensates and superfluids, vortices are both point-like and quantized quasiparticles. We use a two-dimensional (2D) fluid of polaritons, bosonic particles constituted by hybrid photonic and electronic oscillations, to study quantum vortex dynamics. Polaritons benefit from easiness of wave function phase detection, a spinor nature sustaining half-integer vorticity, strong nonlinearity, and tuning of the background disorder. In collaboration with an experimental group in Lecce we can directly generate by resonant pulsed excitations a polariton condensate carrying either a full or half-integer vortex as initial condition and follow their coherent evolution using ultrafast imaging on the picosecond scale. The observations (both experimental and numerical) highlight a rich phenomenology, such as the spiraling of the half-vortex and the joint path of the twin charges of a full vortex, until the moment of their splitting. Furthermore, we observe the ordered branching into newly generated secondary couples, associated with the breaking of radial and azimuthal symmetries. This allows us to devise the interplay of nonlinearity and sample disorder in shaping the fluid and driving the vortex dynamics. In addition, our observations (experimental and numerical) suggest that phase singularities may be seen as fundamental particles whose quantized events span from pair creation and recombination to 2D+t topological vortex strings.

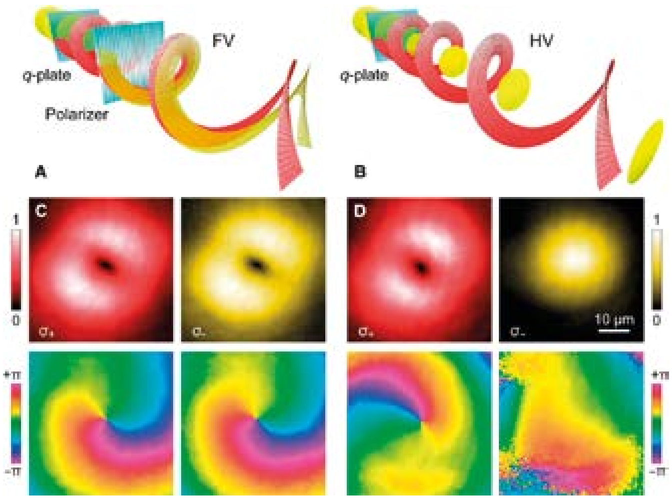


Figure 2.
Generation of optical and polariton Full Vortices (FV) and Half Vortices (HV).

Single spin sensing

The development of magnetic resonance imaging revolutionized medical and biological science. Now, recent technical developments offer the comparable prospect of imaging single molecular and biological structures. As in magnetic resonance imaging, single-spin sensing also exploits measurements of the temporal decay of the coherence of quantum spins to infer detailed information. The field of single-spin sensing is at a comparatively early stage, but one day it could have a transformative effect on biological and chemical physics. Here, we show how one can exploit the well-known fact that a quantum system exposed to a periodic potential acquires very different spectral characteristics. We analyze time-periodic sensing protocols using Floquet theory and show it is potentially useful for a wider range of scenarios than standard methods, including many-body interactions and strong quantum entanglement.

In dynamical-decoupling sensing, noise from environmental spins is amplified by a sequence of microwave pulses and detected by a sensor (such as a nitrogen-vacancy color center in diamond). The coherence behavior is often analyzed using signal-processing ideas that rely on the frequency of the pulses becoming resonant with a characteristic frequency in the environment, which leads to a single sharp “dip” in the coherence. We show here that such a restriction is unnecessary. By looking at the nonresonant regime, we identify new information-rich structures that can be interpreted using Floquet spectroscopy but might be overlooked in current experiments since they lie in regimes that do not yield single sharp dips. In particular, we show that transverse magnetic field scans of coherence of nitrogen-vacancy centers in diamond reveal a set of striking diamond-shaped coherence envelopes with sharp boundaries that depend on the interesting frequencies. The power of Floquet theory is that it is applicable to both resonant and nonresonant driving, and it works for a range of coupling strengths.

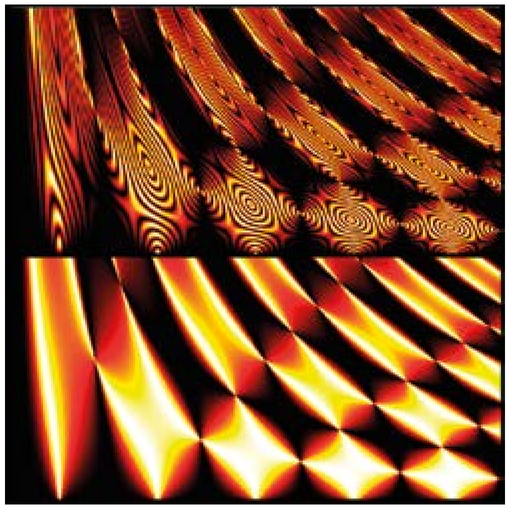


Figure 3.
NV-center decoherence ‘diamonds’. While typical experimental studies scan along parallel field component (thus remaining in weak-coupling, single-dip regime), scanning the transverse magnetic field would produce diamond pattern of high-decoherence regions, as avoided crossings widen (and even overlap) then narrow.

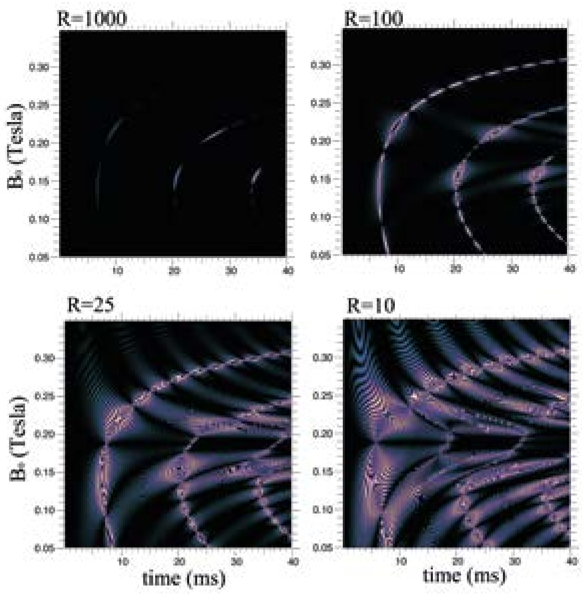


Figure 4.
Coherence decay behavior for an electron spin detecting a flip-flopping pair of nuclear spins, for a donor in silicon system with tunable interactions. It exhibits a rich structure in the two-dimensional plane, which is not evident in the normal traces at constant B0. The decoherence map is shown for different $R=\Delta A/C_{12}$, ($\Delta A=A_1-A_2$). Large R corresponds to weaker dipolar coupling C12, and the maps trace the locus of a set of isolated sharp dips in coherence. For smaller R, there are no longer single dips; nevertheless, the envelopes [given by $F(\tau)$] are well defined and track the behavior of the underlying Floquet avoided crossings.

High Energy Physics (HEP)

Project in focus

Advancing the understanding of neutrino oscillations

Aim

To untangle the mysteries of the neutrino by measuring neutrino oscillation parameters and potentially discovering neutrinoless double-beta decay.

Results to Date

MINOS currently holds the world's best measurement of the atmospheric neutrino mass splitting and some of the best limits excluding sterile neutrinos. NEMO-3 has made world-leading measurements of double-beta decay and placed stringent bounds on neutrinoless decay modes.

UCL Involvement

UCL had led the construction of the tracking detector for SuperNEMO, the successor of NEMO-3, and will be instrumental in analysing the first data once the experiment starts taking data later this year.

The Nobel Prize for Physics in 2015 was awarded for the discovery of neutrino oscillations, proving that these abundant yet elusive particles have non-zero mass. The field of neutrino physics worldwide has never been busier or more exciting, as we seek to complete our understanding of the neutrino sector and perhaps shine light on some of the big outstanding puzzles in particle physics such as the origin of the matter-antimatter asymmetry in the universe.

The UCL HEP group is at the forefront of several international efforts to further our understanding of neutrinos. Current and future long-baseline experiments aim to discover CP violation and unravel the mass-ordering of the neutrinos, while searches for neutrinoless double-beta decay can tell us whether neutrinos are their own anti-particles or not and, in addition, provide constraints on neutrino masses complementary to those that can be obtained from cosmological and other observations. Dr. Anna Holin and Prof. David Waters describe below two of these projects in which UCL is playing leading roles.

Figure 1. The NOvA Far Detector at Ash River in Minnesota. The detector has a mass of 14kilotons and consists of 896 layers of extruded PVC cells that are filled with a total of 11 Megaliters of liquid scintillator and are instrumented with wavelength-shifting fibers and read out by APDs. The NOvA Far detector is 15.6m tall and 60m long and reads out a total of 344000 channels!

Neutrino oscillations experiments

Neutrinos oscillations physics world-wide is thriving and UCL is involved in several world-leading current and future neutrino oscillations experiments. The principle of most oscillations experiments is simple: observe how neutrinos have oscillated from one flavour of neutrino into others as they travel, either through the vacuum of space or through matter. As neutrinos interact with matter barely at all we need very big detectors to accumulate enough neutrino interactions to make our measurements. UCL was a founding member of the MINOS(+) experiment that is expected to finish taking data this year and uses a design feature now replicated in many newly designed neutrino oscillation experiments – a Near detector close to the neutrino beam source (in this case the NuMI neutrino beam at Fermilab in the USA) to observe the neutrino beam before oscillations, and a Far detector 735km away in the Soudan mine in Minnesota to observe how the neutrino beam has changed as the neutrinos traverse the earth between the detectors. This use of two functionally identical detectors allows to cancel many systematic errors associated with neutrino flux and cross-sections and means that despite having taken data for almost 11 years now, MINOS still holds the world's best measurement of the atmospheric neutrino mass splitting. Recently, in mid-2015, the UCL HEP group also joined the NOvA experiment, MINOS's higher resolution and newer sibling. NOvA has been taking data for over 2 years now and is located in the NuMI beam off-axis so as to see a narrow-band lower energy neutrino spectrum which is focused on the oscillation maximum. This means that NOvA can use the appearance of electron neutrinos in its Far detector at Ash River in Minnesota (see Figure 1) to potentially measure both the neutrino mass hierarchy and Charge-Parity violation in neutrinos – if the latter is confirmed to be non-zero it would truly be revolutionary and will go a long way to explaining the matter-antimatter asymmetry of the universe.

The UCL HEP group is currently working on two future long-baseline neutrino experiments: CHIPS and DUNE. The idea for CHIPS was born at UCL and is a development of the large water Cherenkov detector concept. The idea is to place detectors consisting of a pure water volume surrounded by a light-proof membrane at the bottom of disused mine pits in the path of a neutrino beam, such as the Wentworth pit in the NuMI beam. The lake water provides both overburden to shield the detector from cosmic rays, and structural support for the detectors. PMTs are used to read out the Cherenkov light. CHIPS is unique because it can be extended almost at will relatively cheaply without the necessity to build expensive underground caverns. CHIPS has already built 2 small CHIPS-M prototypes that were put into the lake for several months at a time and the hope is to build the first larger 30m diameter detector slice next.

DUNE is the next US flagship neutrino oscillation experiment and is projected to start taking data around 2025. It is a long-term project that requires a new high-power neutrino beam which will be pointed towards the Sanford Underground Research Facility 1300km away and is hoping to measure both the neutrino mass-ordering and the Charge-Parity violation phase to 5σ or better, i.e. discovery level. DUNE will use time-projection-chambers (TPCs) as detectors filled with 40kilotons of liquid argon (LAr) in total to achieve mm-level spatial

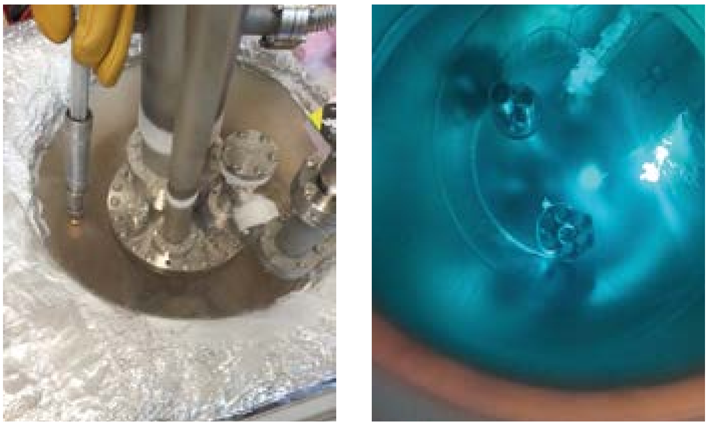


Figure 2. LARA: our own Liquid Argon Research Area (test cryostat) at UCL, one of only a handful in Europe. The left-hand picture shows the filling of the external dewar with regular (non-purified) liquid argon in order to cool the inner dewar. The inner dewar is first evacuated using an ultra-high-vacuum pump, and then flooded with clean pure gas argon that liquefies upon touching the cold walls of the inner dewar. The right-hand picture shows the inner dewar illuminated with an LED and half-filled with liquefied argon.

resolution. No giant LAr detector of this size has ever been built, with the largest so far being ICARUS at 600tons, 2 orders of magnitude smaller. Because of this, there are several smaller interim LAr detectors currently being built. UCL is building the high-voltage feedthrough for SBND at Fermilab, a short-baseline neutrino oscillation experiment looking for potential ‘sterile’ neutrinos which would contribute to neutrino oscillations but essentially interact only gravitationally once created. UCL is also working on the DUNE double-phase prototype being built at CERN. To support its DUNE/LAr work, the HEP UCL group has built a small LAr cryostat called LARA (figure 2) which is used for detector R&D and to test the components we are building. LARA is one of only a handful of small LAr cryostats at universities in Europe.

The SuperNEMO experiment

Can neutrinos turn into anti-neutrinos as they cross a nucleus? Answering this question is the goal of several experiments around the world seeking to discover the process of neutrinoless double-beta decay, whereby two simultaneous beta-decays take place but no neutrinos emerge. The neutrinos effectively annihilate with one another inside the nucleus and all the energy is carried away by the two electrons. If this process does exist, as predicted by many theories, then it will tell us that neutrinos and anti-neutrinos are not really distinct but rather the same particle in different spin configurations; if this is true, it’s very likely that neutrinos played a key role in generating an excess of matter over anti-matter in the very early universe.

The SuperNEMO experiment aims to search for this process in a unique way, by directly reconstructing the two decay electrons in giant tracking detectors before measuring their energies in precise calorimeters. The tracking detectors are being assembled at MSSL (Figure 3) where we take advantage of the unique engineering expertise and clean-room facilities usually dedicated to the construction of large space instruments. Indeed, the cleanliness requirements are extremely demanding since we are attempting to measure half-lives that are billions of times longer than the age of the universe; the slightest radio-impurity can easily overwhelm such a rare signal.

The SuperNEMO project achieved a major milestone in 2015 with the delivery of the first UK-built tracker module to the LSM, the deep underground laboratory in France that is hosting the fully assembled SuperNEMO detector.

Figure 3. Banks of Geiger cells being inserted into the 3rd SuperNEMO tracking detector module at the Mullard Space Science Laboratory (MSSL) in January 2016. The fourth and final module is scheduled for completion in June 2016, marking the completion of UK construction phase for the project.

Figure 4. Preparing for the arrival of the first SuperNEMO tracking detector module at the Laboratoire Souterrain de Modane (LSM), situated mid-way along the Fréjus road tunnel running underneath the alps between France & Italy.

This was a major logistical exercise involving teams from the UK and France to ensure that the highly delicate 3.5 tonne tracking detector survived the 700 mile journey intact from MSSL to the town of Modane (near Chambéry) intact (see Figure 4). Delivery to the laboratory itself was only possible with a night-time closure of the main road tunnel between France & Italy and required clearances of just a few centimetres to be negotiated under tight time constraints. Fortunately, all of our post-transport checks indicate that the instrument has been delivered without any damage whatsoever.

We are now looking forward to the delivery of the three remaining tracker modules and indeed the assembly of the whole detector in 2016. This will conclude one of the largest construction projects undertaken by the UCL HEP group in recent years, requiring tireless effort from the large group of engineers, technicians and detector physicists that have been involved. It has been an extremely useful training ground for a generation of PhD students, who, while participating in the construction of SuperNEMO, have also been publishing world-leading measurements of double-beta decay processes in isotopes such as 100Mo and 48Ca using existing datasets.

SuperNEMO “first-light” is expected in early 2017. We will work intensively for a year or more to understand the performance of the detector, and wait patiently for a few more years after that in order to maximise our sensitivity to any neutrinoless double-beta decay signal. In parallel we will be planning and performing R&D for future generations of experiments, which may well be required to conclusively prove or disprove the existence of neutrinoless double-beta decay.

Condensed Matter and Materials Physics (CMMP)

Project in focus

Fluctuation-driven ordering phenomena near quantum criticality

Aim

To unravel the generic principles behind the phase reconstruction near quantum phase transitions, explain experimentally observed phases, and predict the appearance of novel forms of quantum order that could be of technological benefit.

Results to Date

The fermionic quantum order by disorder theory successfully explains fluctuation-driven ordering phenomena such as the formation of complex modulated magnetic states in PrPtAl or the unusual hard-axis ordering of magnetic moments in metallic ferromagnets.

UCL Involvement

UCL members of staff have pioneered and developed the fermionic quantum order by disorder theory. In collaboration with an international experimental team they apply the theory to real materials.

The CMMP group at UCL is one of the largest condensed matter groups in the UK, currently comprising around 90 academic and research staff members. They tackle a wide range of important contemporary challenges in condensed matter research, including those in energy materials, geophysics, organic electronics, soft matter, quantum information, magnetism, and strongly correlated electron systems.

Many of our staff hold joint appointments within the London Centre for Nanotechnology (LCN), a multidisciplinary enterprise concerned with the design, fabrication and analysis of nanoscale systems for the purposes of information processing, healthcare, energy and environment.

The CMMP group also plays a leading role in the development and use of national and international neutron and X-ray scattering facilities, for example the ISIS Neutron and Muon and Diamond Light Sources at the Harwell Science and Innovation Campus in Oxfordshire.

One particular area of interest within the group lies in the theoretical and experimental investigation of novel forms of quantum matter such as electronic analogues of nematic liquid crystals, unconventional superconductors, and states with exotic magnetic and orbital order. A new theory known as 'fermionic quantum order by disorder' developed by **Dr Frank Kruger** and **Prof Andrew Green** explains how strong quantum fluctuations close to zero-temperature phase transitions can lead to the formation of new phases of matter.

Escaping the quantum critical singularity; modulated magnetism in PrPtAl

The transition between ferromagnetism and paramagnetism in metals is one of the simplest examples of a continuous phase transition. Interesting behaviour is expected when the transition temperature becomes small because incoherent fluctuations above the transition temperature then exist to low temperatures. Ultimately for lower transition temperatures, either the transition must become first order or new forms of order must appear to satisfy the third law of thermodynamics. The "fermionic quantum order by disorder" theory clarifies how the fluctuations associated with different competing ground states may stabilise new forms of order under these circumstances. In collaboration with an international experimental team led by Prof Andrew Huxley from the University of Edinburgh, Dr Frank Kruger and Prof Andrew Green provided the first concrete vindication of one of the predictions of this approach; the formation of modulated magnetic structures.

Resonant X-ray diffraction studies at the ESRF, elastic neutron-scattering experiments at ILL and NIST, as well as lab-based measurements have allowed them to detect and characterise complex spiral magnetic states at the border of ferromagnetism in high-quality single crystals of PrPtAl. Characteristic changes are also seen in the magnetic excitation spectra which have been measured with the OSIRIS time of flight spectrometer at ISIS.

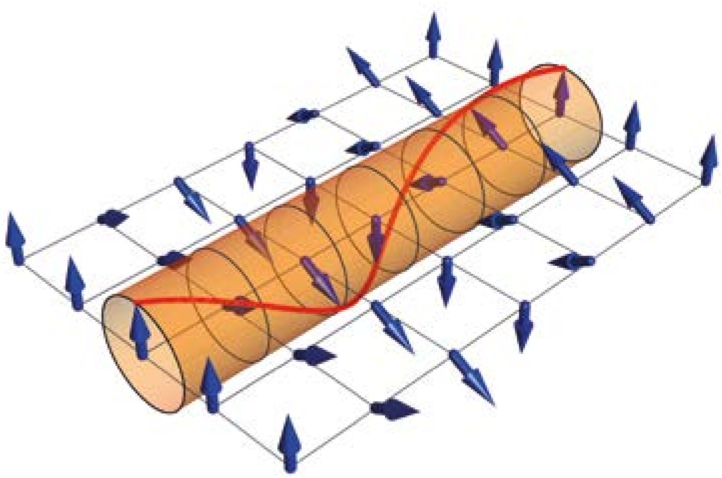


Figure 1
Illustration of spatially modulated, helical magnetic order. Such states have been predicted to form as a consequence of electronic quantum fluctuations if ferromagnetic phase transitions are tuned to very low temperatures. The complex spiral magnetic states observed in PrPtAl provide the first example of such a fluctuation-driven phase reconstruction.

Much of the observed behaviour is consistent with the predictions of the order by disorder theory, including the increase of the helical modulation vector with temperature, the appearance of a strong third harmonic, and the fragility of the modulated order against very small magnetic fields. Surprisingly, the phase diagram of PrPtAl is even more complex, exhibiting a second modulated phase with two collinear incommensurate ordering vectors.

This work reveals a new way to achieve complex magnetic structures not requiring Fermi-surface nesting, anti-symmetric exchange interactions or magnetic frustration. Given recent interest in complex magnetic structures such as skyrmions for spintronic applications this could form the basis for enabling technology in the longer term. The current emphasis is on better understanding the conditions that bring about the modulated states in preference to a simple first order transition and the complex phase diagram with multiple transitions.

Stabilising hard axis ferromagnetism by a quantum Indian rope trick

It might seem counter intuitive that quantum fluctuations can stabilise new ordered ground states. Random forces usually have a destabilising effect. A tightrope walker would rather not experience gusts of wind, for example. There are, however, cases where random forces can stabilize a system in a state that would otherwise be unstable. The essential ingredient is that the random forces or noise experienced by the system should depend upon the state of the system. For example, a multiply-jointed pendulum can be stabilised in an inverted configuration – without the need for feedback or control – if it is driven with certain random horizontal forces at its support. The spectrum of fluctuating forces experienced by the pendulum changes depending upon its orientation such that it is subtly corralled into the formerly unstable vertical orientation. This notion – when the driving force is periodic rather than noisy – was first described by Kapitza. For the multi-jointed pendulum, it is sometimes called an Indian rope trick, with reference to the famous conjuring trick.

Fluctuations due to the intrinsic uncertainty of quantum mechanics can have a similar effect. At certain points in the phase diagram of a magnet – determined by values of pressure, magnetic field etc. – quantum fluctuations can become dramatically enhanced. These enhanced fluctuations can stabilise new phases, e.g. the complex helical magnetic order in PrPtAl.

Dr Frank Kruger, **Dr Chris Pedder**, and **Prof Andrew G. Green** have uncovered perhaps the simplest example of such an effect in a quantum system. Certain ferromagnets when probed at temperatures above their ferromagnetic transition show a propensity to order along a particular direction. When the temperature is lowered, however, the magnetic ordering occurs perpendicular to this direction. A simple model shows that this may be due to the state-dependence of the quantum fluctuations favouring a direction of magnetic ordering that would otherwise have been unstable. This is rather like the multi-jointed pendulum described above; by adopting an inverted configuration in the presence of fluctuations – the ferromagnet performs a quantum Indian rope trick!

The quantum order-by-disorder approach provides a conceptually simple way to describe these effects. The hope is that this understanding will ultimately help us to harness and control such effects of quantum fluctuations to produce material with properties of technological benefit.

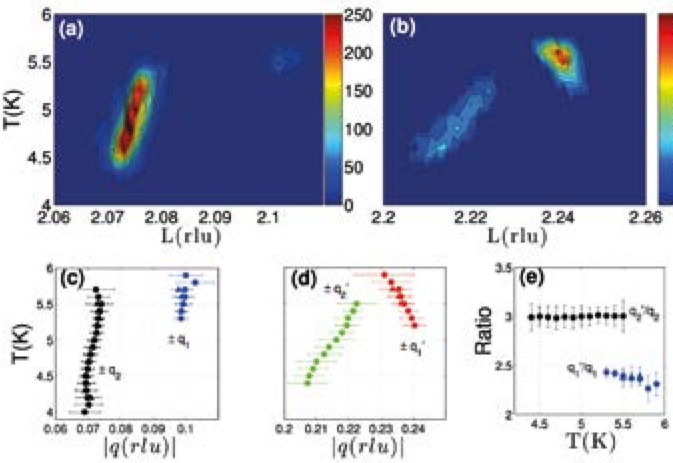


Figure 2
Detection of modulated magnetic order in PrPtAl by resonant X-ray diffraction at the ESRF. The figure shows intensity maps around satellites at (00L) near to the (002) Bragg peak as a function of temperature, measured on BM 28 at the Pr LII edge. At lower temperatures a single modulation wavevector q≈0.07 (rlu) and 3rd harmonic are seen. The change of wavevector of this peak with temperature and the strong 3rd harmonic are well explained by the 'fermionic order by disorder' theory. Just before 6 K two new vectors appear.

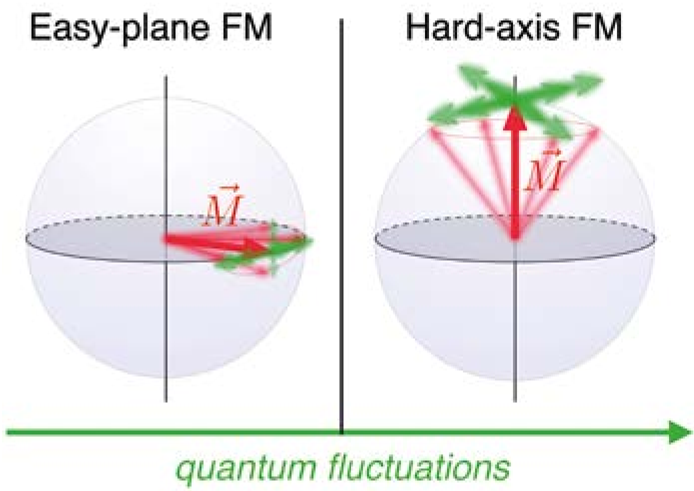


Figure 3
The quantum Indian rope trick of a metallic ferromagnet: when quantum fluctuations are weak (left panel), the system selects the expected orientation for the magnetization (analogous to the Kapitza pendulum collapsed flat on a table). As the fluctuations grow (right panel) they stabilize a new ground state, where the magnetic field points along a new, unexpected direction, like the Kapitza pendulum standing vertically upwards.

Biological Physics (BioP)

Project in focus

Collective effects in strongly coupled light-matter systems

Aim

Developing a new method to grow gold nanorods to precise dimensions.

Results

Significant results highlight the success in this project so far with gold nanorods grown to set dimensions and an expansion of the project to investigate the use of nanorods in cancer diagnostics.

UCL Involvement

This project is led by the Biological Physics group at UCL working in collaboration with institutions across the world.

The Biological Physics group continues to go from strength to strength. Here Prof. Thanh Nguyen talks about her group's research into growing gold nanorods and their use as a non-invasive tool to help diagnose cancer.

New method for the growth of gold nanorods with precise dimensions

When the dimensions of noble metals, such as gold or silver, are reduced at nanoscale, their properties change and some unique features appear. For example, the golden colour of gold is turned into red when gold is crafted as small rod-shape nanoparticles called gold nanorods. Interestingly, the optical and electronic properties of those nanomaterials not only depend on their size but also on their shape. For example, when the length of the rods is decreased, their colour changes. Gold nanorods are widely used in several biomedical fields such as diagnostics, cancer therapy and medical imaging. Every application requires gold nanorods with different characteristics; therefore methods for precise-tuning gold nanorod properties are essential for their future success. In our lab we have developed a new method to customize the gold nanorod properties in order to adjust them to their final application. Our method is based on using inorganic salts to control the growth of those nanoparticles.

We are able to fine-tune the aspect ratio of the rods with a remarkable precision of 0.1 and the longitudinal absorption band from 777 to 960nm. By being able to manipulate the rods so precisely this allows us to explore new applications for nanorods that were previously thought to be impossible.

Using gold nanorods for cancer diagnostics

In addition to the new synthesis of gold nanorods, we have also worked on their application in cancer diagnostics.

> "...we have developed a new method to customize the gold nanorod properties in order to adjust them to their final application"

Currently, biopsy is the only method that can diagnose cancer with absolute certainty. This medical test involves the removal of tissue from the patient to determine the presence and extent of the abnormal cell growth. Several non-invasive alternatives have been developed, such as body fluid analysis. However, the lack of sensitivity and specificity of the most serum cancer biomarkers has prevented the use of body fluid analysis as definitive non-invasive sensing technique for cancer diagnostics.

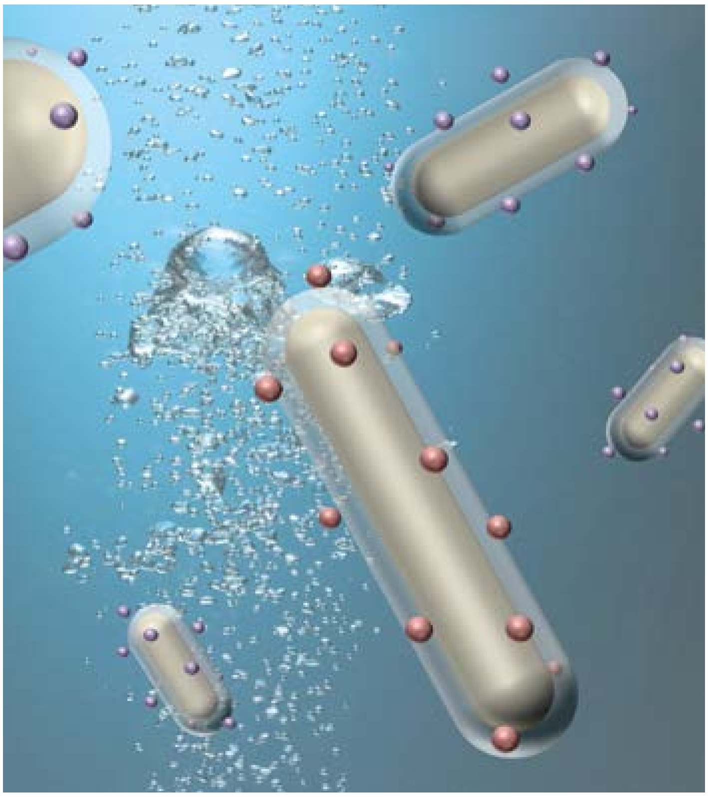


Figure 1
Illustration of gold nanorod growth controlled by inorganic salts.

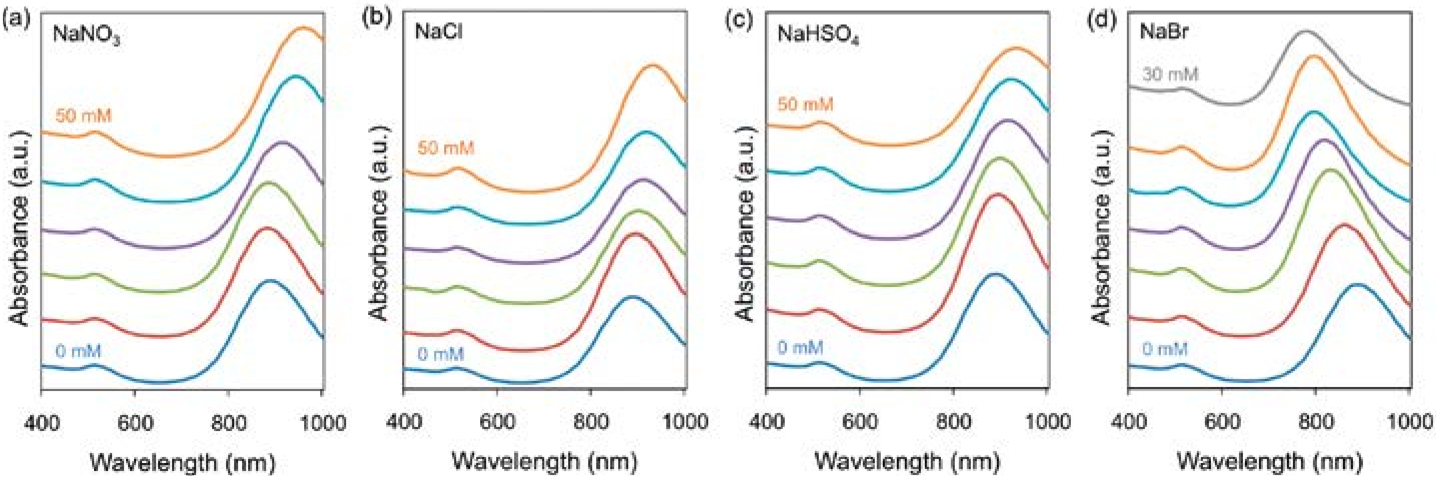


Figure 2
Normalized extinction spectra of Au NRs grown in the presence of additional amounts of Hofmeister salts. For (a)–(c) the salt concentrations are 0 mM (blue), 10 mM (red), 20 mM (green), 30 mM (purple), 40 mM (turquoise) and 50 mM (orange) from bottom to top. For (d), the salt concentrations are 0 mM (blue), 5 mM (red), 10 mM (green), 15 mM (purple), 20 mM (turquoise), 25 mM (orange) and 30 mM (grey) from bottom to top. All the spectra have been offset for easier comprehension.

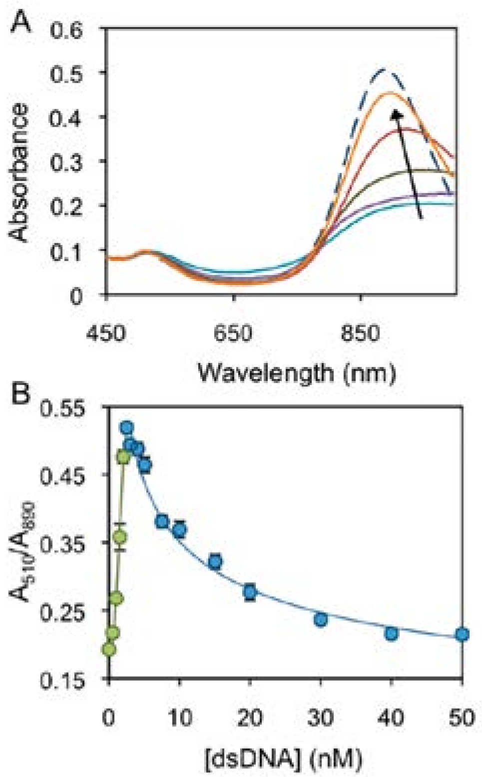


Figure 3
Characterisation of AuNRs (OD890 = 0.48), mixed with different amounts of dsDNA (180 bp) in 8 mM Tris buffer. A) UV-vis spectra at 0nM (dashed line), 2, 5, 10, 20 and 40nM DNA (solid lines). B) Absorbance ratio intensities at 510 and 890nm as the function of DNA concentration. The lower and higher concentration regimes are highlighted in green and blue, respectively.

Nevertheless, the analysis of circulating cell-free DNA (cfDNA), i.e. extracellular DNA found in blood, serum and plasma, has recently emerged as a promising new non-invasive liquid biopsy, which allows monitoring the patient's therapeutic response and disease progression. Even though a few commercial kits are available, providing fast and easy-to-use DNA quantification, most of them are not able to cover all the physiological cfDNA concentration range. Therefore, new analytical methods are required for a robust quantification of cfDNA at low concentration range. In our lab, we have developed an alternative analytical assay that overcomes the limitations of the commercial kits without involving complex designs. We have demonstrated a nanosensor for cfDNA with inverse sensitivity, i.e. the lower the concentration of the analyte, the higher the response intensity.

"...we have developed an alternative analytical assay that overcomes the limitations of the commercial kits"

The inverse sensitivity is achieved by the unusual concentration-dependent interaction between DNA and AuNR, which can be measured by UV-Vis spectroscopy. This sensor is fast (10 min), straightforward and easy-to-use (one-step, mixture of three solutions), enabling a higher reliability for low concentration analyte detection.

Research Statistics

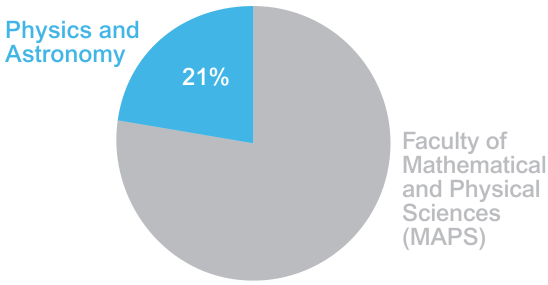
Research Statistics
Jan 2015–Dec 2015

Publication Summary

Research Group	Number of publications in refereed journals
Astro	137
AMOPP	113
CMMP	94
HEP	179

Active Grants and Contracts

In the last financial year (August 2014 – July 2015), the MAPS faculty as a whole yielded £52,226,507, with the Department of Physics and Astronomy contributing £10,803,651 (21%) of the total research income for the MAPS faculty.



Notable Grants

Dr. Stephen Hogan (AMOPP) and Prof. Jochen Blumberger were both awarded ERC consolidator fellowships of £524,578 and £321,327 respectively.

The HEP rolling grant was renewed with the group being awarded £4,763,816.

Astrophysics

Euclid Implementation Phase (UKSA) PI: Dr Filipe Abdalla, £545,358

University Research Fellowship Renewal (Royal Society) PI: Dr Filipe Abdalla, £317,537

SKA preconstruction phase at UCL (STFC) PI: Dr Filipe Abdalla, £281,909

UCL Astrophysics consolidated grant (STFC) PI: Dr Filipe Abdalla, £252,696

EUCLID Implementation Phase 2015-2020 (STFC) PI: Dr Filipe Abdalla, £654,666

DEDALE Data learning on manifolds and future challenges (European Commission H2020) PI: Dr Filipe Abdalla, £315,508

Fellowship: Filipe Abdalla (European Commission FP7) PI: Dr Filipe Abdalla, £224,669

UCL Astrophysics consolidated grant (STFC) PI: Nick Achilleos, £52,668

Impact studentship: Improving the representation of the thermosphere and ionosphere for space weather (UK Met Office) PI: Dr Anasuya Aruliah, £31,627

Observations of thermospheric winds in the presence of TIDs (Royal Society) PI: Dr Anasuya Aruliah, £67,940

An observational and modelling study of upwelling in the auroral thermosphere (Air Force Office for Scientific Research) PI: Dr Anasuya Aruliah, £33,475

ESPAS: Near-Earth space data infrastructures for e-science (European Commission FP7) PI: Prof Alan Aylward, £199,537

UCL Astrophysics consolidated grant (STFC) PI: Prof Michael Barlow, £352,889

The properties of crab nebula molecules (STFC) PI: Prof Michael Barlow, £1,438

UCL Astrophysics consolidated grant 2015-2018 (STFC) PI: Prof Michael Barlow, £540,456

An ongoing study of dwarf carbon stars (STFC) PI: Dr Carolina Bergfors, £857

An ongoing study of dwarf carbon stars (STFC) PI: Dr Carolina Bergfors, £1,512

COGS – capitalising on gravitational shear (European Commission FP7) PI: Prof Sarah Bridle, £571,516

Centre for earth observation instrumentation and space technology (UK Space Agency) PI: Dr David Brooks, £14,640

Think Universe! Fundamental science master classes for school teachers at KS2 (STFC) PI: Dr Francisco Diego, £9,481

The dark energy spectroscopic instrument (STFC) PI: Prof Peter Doel, £742,939

UCL Astrophysics consolidated grant 2015-2018 (STFC) PI: Prof Peter Doel, £351,112

Early star-forming galaxies and cosmic reionisation (European Commission H2020) PI: Prof Richard Ellis, £1,597,963

Archaeology of exo-terrestrial planetary systems and a search for water (STFC) PI: Dr Jay Farihi, £318,089

Kinematics galactic age chemistry and water fraction of asteroid polluted white dwarfs from the Sloan Digital Sky Survey (STFC) PI: Dr Jay Farihi, £180,237

Are all dwarf carbon stars binary? (STFC) PI: Dr Jay Farihi, £1,512

An ongoing study of dwarf carbon stars (STFC) PI: Dr Jay Farihi, £1,764

Radial velocity monitoring of WD+DM binaries spatially unresolved with the Hubble Space Telescope (STFC) PI: Dr Jay Farihi, £927

IOSPOT: Monitoring the IO plasma torus (RAS) PI: Dr Stephen Fossey, £2,000

Fellowship: Massive star formation with new generation interferometers (STFC) PI: Dr Izaksun Jimenez-Serra, £451,297

Chemical pathways to life: amino acids and their precursors in the ISM (STFC) PI: Dr Izaksun Jimenez-Serra, £241,742

Ernest Rutherford Fellowship: Advancing weak lensing and intrinsic galaxy alignment studies to the era of precision cosmology (STFC) PI: Dr Benjamin Joachimi, £351,642

A multi-probe strategy to pin down the nature of gravity and dark energy (STFC) PI: Dr Benjamin Joachimi, £218,171

TESTDE: Testing the dark energy paradigm and measuring neutrino mass with the dark energy survey (European Commission FP7) PI: Prof Ofer Lahav, £1,844,558

UCL Astrophysics consolidated grant (STFC) PI: Prof Ofer Lahav, £732,484

UCL Astrophysics consolidated grant 2015-2018 (STFC) PI: Prof Ofer Lahav, £122,431

Fellowship: Glimpse - Understanding the dark universe through 3D weak lensing reconstructions (European Commission FP7) PI: Dr Adrienne Leonard, £166,205

Daphne Jackson Fellowship (Daphne Jackson Fellowship Trust) PI: Dr Maria Mendes Marcha, £77,401

Europlanet 2020 research infrastructure – EPN2020-RI (European Commission H2020) PI: Prof Steve Miller, £247,980

Cosmic Dawn – understanding the origins of cosmic structure (EU FP7) PI: Dr Hiranya Peiris, £1,119,800

UCL Astrophysics consolidated grant (STFC) PI: Prof Raman Prinja, £203,329

UCL Astrophysics consolidated grant: 2015-2018 (STFC) PI: Prof Raman Prinja, £393,273

UCL Astrophysics consolidated grant: 2015-2018 (STFC) PI: Prof Jonathan Rawlings, £355,311

University Research Fellowship (Royal Society) PI: Dr Amelie Saintonge, £466,973

Cold gas and the chemical evolution of galaxies (Royal Society) PI: Dr Amelie Saintonge, £69,577

Self-consistent modelling of the interstellar medium of galactic scales (Royal Society) PI: Dr Amelie Saintonge, £14,205

Star formation efficiencies and XCO in intermediate mass galaxies (STFC) PI: Dr Amelie Saintonge, £512

BETTII – the balloon experimental twin telescope for far infrared interferometry (STFC) PI: Dr Giorgio Savini, £115,636

FISICA – far infra-red space interferometer critical assessment: scientific definition and technology development for the next generation THZ space interferometer (EU FP7) PI: Dr Giorgio Savini, £270,117

Critical technology advancement of the locus mission: toward future space light (UK Space Agency) PI: Dr Giorgio Savini, £669,241

Supa-terahertz technology for atmospheric and lower thermosphere (NERC) PI: Prof Bruce Swinyard, £3,101

University Research Fellowship Renewal: The exoplanet revolution (Royal Society) PI: Prof Giovanna Tinetti, £311,958

Exolights – Decoding lights from exotic worlds (European Research Council) PI: Prof Giovanna Tinetti, £1,560,377

UCL Astrophysics Consolidated Grant (STFC) PI: Prof Serena Viti, £318,935

Mapping CS in starburst galaxies: Disentangling and characterising dense gas (STFC) PI: Prof Serena Viti, £2,349

Linking solid-state astronomical observations and gas-grain models to laboratory data (STFC) PI: Prof Serena Viti, £41,305

Novel mathematical techniques for advanced tool-paths to transform high value optical fabrication (STFC) PI: Prof David Walker, £281,780

Market and supply chain study (UK Space Agency) PI: Prof David Walker, £10,000

STFC DiRAC Project Office 2014 – 2017 (STFC) PI: Dr Jeremy Yates, £377,026

AMOPP

LIn situ quantification of metabolic function using florescence lifetime imaging (BBSRC) PI: Dr Angus Bain, £218,061

Cavity optomechanics: Towards sensing at the quantum limit (EPSRC) PI: Prof Peter Barker, £814,269

Nonclassicalities and quantum control at the nanoscale (EPSRC) PI: Prof Sougato Bose, £1,166,350

Nanoelectronic based quantum physics – technology and applications (EPSRC) PI: Prof Sougato Bose, £441,672

PACOMANEDIA: Partially coherent many-body non-equilibrium dynamics for information applications (European Commission FP7) PI: Prof Sougato Bose, £933,809

Verification of models of quantum computing (EPSRC) PI: Dr Dan Browne, £19,007

Gravitational free fall experiments with positronium (Leverhulme Trust) PI: Dr David Cassidy, £147,622

Production and manipulation of Rydberg positronium for a matter-antimatter gravitational freefall measurement (EPSRC) PI: Dr David Cassidy, £693,517

Spectroscopy of Positronium: Atom control and gravity measurments (European Commission) PI: Dr David Cassidy, £75,000

Career Acceleration Fellowship (CAF): Ionisation of multi-electron atomic and molecular systems driven by intense and ultrashort laser pulses (EPSRC) PI: Dr Agapi Emmanouilidou, £994,556

Control and imaging of processes triggered by x-ray pulses in multi-centre molecules (EPSRC) PI: Dr Agapi Emmanouilidou, £309,665

Orbit-based methods for multi-electron systems in strong fields (EPSRC) PI: Dr Carla Figueira De Morisson Faria, £313,960

Career Acceleration Fellowship (CAF): Star formation and the ism evolution of galaxies across cosmic time (STFC) PI: Dr Thomas Greve, £471,898

Tracing large-scale structure growth with SCUBA-2 (STFC) PI: Dr Thomas Greve, £1,514

Hybrid cavity-QED with Rydberg atoms and microwave circuits (EPSRC) PI: Dr Stephen Hogan, £524,578

Impact Studentship: Sono-acoustical trapping of microbubbles (NPL Management) PI: Dr Philip Jones, £35,618

Ultrasensitive fluorescence detection and novel magnetic force spectroscopy (Royal Society) PI: Dr Isabel Llorente Garcia, £15,000

A fast fluorescence and photonic force microscope with nanometre and femtonewton resolution (MRC) PI: Dr Isabel Llorente Garcia, £50,000

Quantum dynamics in atomic molecular and optical physics (EPSRC) PI: Prof Tania Monteiro, £167,723

Phonon-assisted processes for energy transfer and sensing (EU FP7) PI: Dr Alexandra Olaya-Castro, £184,320

Coherence in excitonic-plasmonic systems: towards novel frequency filters and lasing mediums (EPSRC) PI: Dr Alexandra Olaya-Castro, £17,534

Fellowship: Quantum information science: Tools and applications for fundamental physics (EPSRC) PI: Prof Jonathan Oppenheim, £984,329

Wolfson Research Merit Award (Royal Society) PI: Prof Jonathan Oppenheim, £60,000

Studentship: What are the laws of quantum thermodynamics? (FQXi) PI: Prof Jonathan Oppenheim, £40,360

IT from QUBIT: quantum fields, gravity and information (Simons Foundation) PI: Prof Jonathan Oppenheim, £251,429

Control of atomic motion with AC fields (Royal Society) PI: Prof Ferruccio Renzoni, £12,000

Exploring stochastic thermodynamics with optical traps (Leverhulme Trust) PI: Prof Ferruccio Renzoni, £149,040

Studentship: Identifying and characterising materials using magnetic field interrogation (Atomic Weapons Establishment) PI: Prof Ferruccio Renzoni, £66,035

Modelling condensed matter systems with quantum gases in optical cavities (EPSRC) PI: Prof Ferruccio Renzoni, £806,753

COSMA – coherent optics sensors for medical applications (European Commission FP7) PI: Prof Ferruccio Renzoni, £23,550

Impact Studentship: Atomic magnetometers for medical applications (NPL Management Ltd) PI: Prof Ferruccio Renzoni, £32,583

Studentship: Application of quantum magnetometers to security and defence screening (Defence Science and Technology Laboratory) PI: Prof Ferruccio Renzoni, £124,662

All optical magnetometer for heart magnetic induction tomography (EPSRC) PI: Prof Ferruccio Renzoni, £17,068

Studentship: Cylindrical magnetic imaging tomography (Atomic Weapons Establishment) PI: Prof Ferruccio Renzoni, £61,500

Studentship: Magnetic sensor systems for the detection of metallic objects (Atomic Weapons Establishment) PI: Prof Ferruccio Renzoni, £75,035

Localisation of arrythmogenic foci with a radio-frequency atomic magnetometer (Wellcome Trust) PI: Prof Ferruccio Renzoni, £44,688

Fellowship: Luca Marmugi – Gammalas towards gamma-ray lasers via super-radiance in a Bose-Einstein condesate of 135mCs isomers (European Commission H2020) PI: Prof Ferruccio Renzoni, £128,418

Ultra-low frequency magnetic induction tomography with atomic magnetometers for security and defence applications (EPSRC) PI: Prof Ferruccio Renzoni, £76,135

UK APAP Network (STFC) PI: Prof Peter Storey, £27,006

Coherent quantum matter out of equilibrium from fundamental physics towards applications (EPSRC Fellowship) Fellow: Dr Marzena Szymanska, £1,222,168

Novel superfluid phenomena in semiconductor microcavities (EPSRC) PI: Dr Marzena Szymanska, £295,981

The UK theory of condensed matter summer school (EPSRC) PI: Dr Marzena Szymanska, £170,029

EXOMOL - molecular line lists for exoplanet atmospheres (European Commission FP7) PI: Prof Jonathan Tennyson FRS, £1,878,425

Wolfson Research Merit Award: Molecular line lists for extra solar planet and other hot bodies (Royal Society) PI: Prof Jonathan Tennyson FRS, £72,000

Impact Studentship: Dan Underwood – sulphur trioxide/oxide high-temperature spectroscopic databases (Technical University of Denmark) PI: Prof Jonathan Tennyson FRS, £33,591

UCL Astrophysics consolidated grant (STFC) PI: Prof Jonathan Tennyson FRS, £222,822

Studentship: James Hamilton – Electronic impact vibrational excitation of water molecules (Quantemol Ltd.) PI: Prof Jonathan Tennyson FRS, £12,900

Studentship: Modelling of spectra of hot molecules (Servomex Ltd.) PI: Prof Jonathan Tennyson FRS, £18,150

Atomic and molecular data services for astrophysics (STFC) PI: Prof Jonathan Tennyson FRS, £47,110

Studentship: Emma Burton – Line lists for hot chlorine containing molecules (Danish Technical University) PI: Prof Jonathan Tennyson FRS, £32,583

High accuracy transition intensities for ozone (NERC) PI: Prof Jonathan Tennyson FRS, £347,048

EXODATA: a commercially support space telescope (European Commission H2020) PI: Prof Jonathan Tennyson FRS, £90,645

Direct measurement of correlation driven electron dynamics in an amino acid (EPSRC) PI: Dr Jonathan Underwood, £6,990

Fellowship: RichMol - Optical activity of molecules with rotational chirality (European Commission) PI: Dr Sergey Yurchenko, £173,462

UCL Astrophysics Consolidated Grant 2015-2018 (STFC) PI: Dr Sergey Yurchenko, £234,536

CMMP

Many CMMP grants are held through the London Centre for Nanotechnology (LCN)

Impact Studentship: A computational investigation of charge transfer in organic semiconducting materials (PNNL) PI: Dr Jochen Blumberger, £34,167

Characterisation of electron transport in bacterial nano-wire proteins through high performance computing and experimentation (EPSRC) PI: Dr Jochen Blumberger, £321,327

Impact Studentship: Exploration of the performance of a CDFT for the calculation of parameters that govern the thermodynamics and kinetics of interfacial ET reactions (PNNL) PI: Dr Jochen Blumberger, £12,365

Studentship: O(N) density functional theory for dye sensitised solar cells (Jiangsu Kuga Digital Group Co.) PI: Dr David Bowler, £29,257

Complementary Zinc-oxide optoelectronics (Leverhulme Trust) PI: Prof Franco Cacialli, £245,618

CONTEST: Collaborative network for training in electronic skin technology (European Commission FP7) PI: Prof Franco Cacialli, £480,418

Impact Studentship: Giuseppe Maria Paterno – nanoscale characterisation and radiation damage testing of organic solar cells using neutron scattering techniques (STFC) PI: Prof Franco Cacialli, £42,676

SYNCHRONICS: Supramolecularly engineered architectures for optoelectrics and photonics: a multi-site initial training action (European Commission H2020) PI: Prof Franco Cacialli, £781,498

Fellowship: Semiconducting Nanostructures (Royal Society) PI: Prof Franco Cacialli, £62,500

Impact Studentship: Directing crystal growth with functional surfaces (PNNL) PI: Dr Dorothy Duffy, £37,515

Modelling nano-ferroelectrics (NPL Management Ltd) PI: Dr Dorothy Duffy, £30,000

Studies of domain dynamics in nano-ferroelectrics (NPL Management Ltd) PI: Dr Dorothy Duffy, £31,505

Studentship: Heavy metal ions (IHI Corporation) PI: Prof Dorothy Duffy, £30,000

Consequence analysis postdoctoral research associate (Ministry of Defence) PI: Prof Ian Ford, £227,288

MIIA – driving the 2D materials revolution: A scalable method for dissolving layered materials (EPSRC) PI: Dr Chris Howard, £17,752

Graphene based revolutions in ICT and beyond (European Commission) PI: Dr Chris Howard, £9,559

Support for the UKCP consortium (EPSRC) PI: Prof Chris Pickard, £6,457

TOUCAN: Towards an understanding of catalysts and nanoalloys (EPSRC) PI: Prof Chris Pickard, £269,504

Quantum feedback control of levitating opto-mechanics (EPSRC) PI: Dr Alessio Serafini, £579,937

EngD Studentship: Advanced gate stack and dielectric in resistive memory material (International Sematech) PI: Prof Alexander Shluger, £48,047

EngD Studentship: Jonathan Cottom – ab-initio simulations in bulk and interface defects (Infineon Technologies Austria AG) PI: Prof Alexander Shluger, £30,000

EngD Studentship: Oliver Dicks – Tuning electronic properties of thin films and interfaces using defects (Argonne National Laboratory) PI: Prof Alexander Shluger, £58,412

Impact Studentship: Ashley Garvin - laser materials interaction (PNNL) PI: Prof Alexander Shluger, £45,400

MORDRED - modelling of the reliability and degradation of next generation nanoelectronic devices (European Commission FP7) PI: Prof Alexander Shluger, £413,099

Studentship: Atomistic modelling of reliability limiting point defects in silicon carbide and near the interface to silicon dioxide or contacting metals (Infineon Technologies Austria AG) PI: Prof Alexander Shluger, £35,000

Studentship: David Ingram – Regeneration of H2 storage materials (CELLA Acquisition Ltd) PI: Prof Neal Skipper, £36,000

University Research Fellowship Renewal: Charge donors and traps in complex oxides (Royal Society) PI: Dr Peter Sushko, £322,387

Effect of framework modification on the electronic structure of 12CaO.7Al203 (Lockheed Martin Corporation) PI: Dr Peter Sushko, £85,635

OPTIMAX – Optimal imaging with present and future coherent x-ray sources (European Research Council) PI: Dr Pierre Thibault, £901,675

Studentship: High resolution tomography of energy materials with hard x-rays (Diamond Light Source Ltd) PI: Dr Pierre Thibault, £2,100

Studentship: Development and application of ptycho-tomography at 113 (Diamond Light Source Ltd) PI: Dr Pierre Thibault, £34,707

Studentship: Speckle-based x-ray phase contrast imaging (Diamond Light Source Ltd) PI: Dr Pierre Thibault, £44,791

UCL cross-disciplinary advanced x-ray imaging centre (EPSRC) PI: Dr Pierre Thibault, £317,189

HEP

TORCH: A large-area detector for precision time-of-light measurements (EU H2020) PI: Prof Nick Brook, £18,454

Development and maintenance of atlas run time tester (STFC) PI: Prof Jonathan Butterworth, £327,246

Fellowship: Event simulation for the large hadron collider at high precision (STFC) PI: Prof Jonathan Butterworth/Dr Rikkert Hendrik Frederix, £428,325

Giving Physics a boost at RUN-II of the LHC (Durham University) PI: Prof Jonathan Butterworth, £5,000

Systematic treatment of effective operators in neutrinoless double beta decay (Royal Society) PI: Dr Frank Deppisch, £5,950

UK Involvement in direct dark matter searches (STFC) PI: Dr Chamkaur Ghag, £93,748

Sample preparation equipment for ultra-low background screening with ICP-MS (STFC) PI: Dr Chamkaur Ghag, £99,845

Meeting radioactivity requirements for the discovery of dark matter (Royal Society) PI: Dr Chamkaur Ghag, £11,029

The LUX-ZEPLIN (LZ) dark matter search (STFC) PI: Dr Chamkaur Ghag, £346,111

IPPP Associateship 2013 -2015 (University of Durham) PI: Dr Keith Hamilton, £1,000

University Research Fellowship: Higgs physics and the mystery of particle masses (Royal Society) PI: Dr Gavin Hesketh, £532,834

Modelling of Higgs backgrounds at the LHC (University of Durham) PI: Dr Gavin Hesketh, £3,000

Dorothy Hodgkin Fellowship: Investigating the neutrino with MINOS and liquid argon detector technology (Royal Society) PI: Dr Anna Holin, £464,226

Front end test stand continuation (STFC) PI: Dr Simon Jolly, £45,046

Calorimetry for proton therapy (STFC) PI: Dr Simon Jolly, £49,531

Studentship: A calorimeter for proton therapy (NPL Management Ltd.) PI: Dr Simon Jolly, £34,107

ATLAS upgrade (Phase 1) (STFC) PI: Prof Nikos Konstantinidis, £245,246

ATLAS Phase II upgrades 2014-15 (STFC) PI: Prof Nikos Konstantinidis, £87,810

ATLAS Phase II upgrades 2015-16 (STFC) PI: Prof Nikos Konstantinidis, £123,290

Ernest Rutherford Fellowship: Heavy quarks a window into new physics at ATLAS (STFC) PI: Dr Andreas Korn, £363,285

Beam diagnostics for PETS and PXIE (STFC) PI: Mark Lancaster, £128,859

Measurement of the anomalous magnetic moment of the muon to 0.14ppm using the FNAL G-2 experiment (STFC) PI: Prof Mark Lancaster, £246,429

LBNE and the Fermilab liquid argon detector programme (STFC) PI: Dr Ryan Nichol, £4,058

Probing the ultra-high energy universe with ANITA and ARA (Leverhulme Trust) PI: Dr Ryan Nichol, £220,205

Investigating the nature of the neutrino with MINOS (+) and LAR detector development for DUNE (URA) PI: Dr Ryan Nichol, £12,914

UCL experimental particle physics consolidated grant: 2015-2019 (STFC) PI: Dr Ryan Nichol, £4,763,816

Training network for Monte Carlo event generators for LHC physics (EU FP7) PI: Dr Emily Nurse, £177,938

University Research Fellowship: Search for a vector boson fusion produced Higgs boson at Atlas (Royal Society) Fellow: Dr Emily Nurse, £406,633

University Research Fellowship Renewal: Higgs studies and a search for dark matter at the Atlas experiment (Royal Society) Fellow: Dr Emily Nurse, £274,703

Determining the properties of the Higgs Boson (Royal Society) PI: Dr Andrew Pilkington, £71,371

Establishing the nature of electroweak symmetry breaking (Royal Society) Fellowship PI: Dr Andrew Pilkington, £484,076

Low background techniques for particle physics and astrophysics (STFC) PI: Prof Ruben Saakyan, £33,310

University Research Fellowship: Determining the true nature of the Higgs-like particle (Royal Society) PI: Dr Tim Scanlon, £483,706

Determining the true nature of the Higgs-like particle (Royal Society), PI: Dr Tim Scanlon, £85,277

Feasibility studies for mega-tonne scale neutrino detectors (Royal Society) PI: Prof Jennifer Thomas CBE, £12,000

MINOS+ (STFC) PI: Prof Jennifer Thomas CBE, £239,618

The path to CP violation in the neutrino sector: mega-ton water detectors (Leverhulme Trust) PI: Prof Jennifer Thomas CBE, £383,431

IPPP Associateships 2009-15 (University of Durham) PI: Prof Robert Thorne, £17,000

Theory Consolidated Grant – Standard Model Phenomenology and beyond (STFC) PI: Prof Robert Thorne, £410,047

Particle physics phenomenology (STFC) PI: Prof Robert Thorne, £343,107

Terauniverse - Exploring the terauniverse with the LHC, astrophysics and cosmology (European Commission FP7) PI: Prof Robert Thorne, £360,514

Experimental Particle Physics Consolidated Grant 2012 – 2016 (STFC) PI: Dr David Waters £4,340,016

Supernemo commissioning and sensitivity demonstration (STFC) PI: Prof David Waters, £420,768

Enhanced European coordination for accelerator research and development (EU FP7) PI: Prof Matthew Wing, £93,794

European XFEL clock and control system (European X-Ray Free-Electron Laser Facility GmbH) PI: Prof Matthew Wing, £686,926

Photon-driven plasma Wakefield acceleration – a new route to a TeV e+e- collider (STFC) PI: Prof Matthew Wing, £26,777

AIDA 2020: Advanced European structure for detectors and accelerators (European Commission H2020) PI: Prof Matthew Wing, £245,000

Biophysics

Nanoparticle probes carrying single DNA molecules for biomolecular detection (Royal Society) PI: Prof Thanh Nguyen, £12,000

Nanoscale magnetism in next generation magnetic nanoparticles (Air Force Office of Scientific Research) PI: Prof Thanh Nguyen, £46,397

Fellowship: Tan Kuan Boone - Carbon nanotube-magnetic nanoparticle hybrid system for expansion of umbilical cord blood stem cells (Royal Society) PI: Prof Thanh Nguyen, £99,000

Advanced flow technology for healthcare materials manufacturing (EPSRC) PI: Prof Thanh Nguyen, £324,223

Magnetic nanoparticle engineering via microreaction (EPSRC) PI: Prof Thanh Nguyen, £403,869

Engineering multi-functional magnetic nanoparticles for enhanced oil recovery (RAENG) PI: Prof Thanh Nguyen, £24,000

Staff Snapshot

Head of Department

Professor J. M. Butterworth

Deputy Head of Department

Professor R. K. Prinja

Astrophysics

Head of Group: Professor M. J. Barlow

Professors:
M. J. Barlow, A. P. Doel, R. Ellis, I. D. Howarth, O. Lahav, S. Miller, H. Peiris, R. K. Prinja, J. M. C. Rawlings, G. Tinetti, S. Viti

Professorial Research Fellow: D. D. Walker

Readers and Senior Lecturers:
F. Abdalla, N. Achilleos, A. L. Aruliah, G. Savini

Lecturers:
J. Farihi, T. Greve, B. Joachimi, A. Pontzen, A. Saintonge

Senior Research Associates:
F. Diego, I. Jimenez Serra, J. Yates

Research Associates:
H. Baghsiahi, S. Balan, C. Bergfors, J. Braden, A. Coutens, I. De Looze, F. Elsner, D. Fenech, P. Guio, G. Harker, S. Jouvel, D. Kirk,A. Leonard, M. Lochner, M. Manera, M. Marcha, A. Merson, M. Rivi, N. Roth, M. Tessenyi, E. Van Uitert, I. Waldmann, C. Watkinson, L. Whiteway

Support Staff:
S. Betts, D. Brooks, J. Deacon, J. Fabbri, C. Jenner, K. Nakum, M. Rangrej

Atomic, Molecular, Optical and Positron Physics

Head of Group: Professor P. Barker

Professors:
P. Barker, S. Bose, G. Laricchia, T. Monteiro, J. Oppenheim, F. Renzoni, J. Tennyson

Reader and Senior Lecturers :
A. Bain, D. Browne, D. Cassidy, A. Emmanouilidou, C. Figueira de Morisson Faria, S. Hogan, P. H. Jones, A. Olaya-Castro, A. Serafini, M. Szymanska

Lecturer: J. Underwood

Senior Research Fellow: I. Llorente Garcia

Senior Research Associate:
S. Yurchenko

Research Associates:
G. Argentieri, L. Banchi, A. Bayat, T. Blacker, S. Brawley, A. Deller, Gentil Dias de Moraes Neto, O. Duarte, P. Edmunds, M. Genoni, C. Hill, D. Holdaway, D. Little, L. Lodi, B. Mant, L. Marmugi, L. Masanes, T. Mavrogordatos, L. McKemmish, T. Meltze, O. Polyansky, M. Woods, A. Yachmenev, C. Zagoya Montiel, A. Zamora, D. Zaouris, V. Zhelyazkova

Support Staff:
K. Bouzgan, R. Jawad, S. Khan

Biological Physics

Heads of Group: Dr B. Hoogenboom, Dr P. Jones

Professors:
J. Blumberger, Nguyen TK Thanh, I. Robinson

Readers and Senior Lecturers:
A. Bain (AMOPP), B. Hoogenboom, P. Jones, A. Olaya-Castro (AMOPP)

Senior Research Fellow:
I. Llorente Garcia (AMOPP)

Research Fellow:
A. Pyne

Research Associates:
A. Carof, B. Chen, Nguyen H. D., X. Jiang, V. Khot, Tung D. L., K. B. Tan, M. Yusuf

Support Staff:
A. Tyrrell

Condensed Matter and Materials Physics

Head of Group: Professor N. Skipper

Professors:
J. Blumberger, D. Bowler, S. Bramwell, F. Cacialli, D. Duffy, A. Fisher, I. Ford, A. Green, G. Materlik, D. McMorrow, A. Michaelides, Nguyen TK Thanh, I. Robinson, A. Shluger, N. Skipper

Readers and Senior Lecturers:
C. Hirjibehedin, B. Hoogenboom, M. Szymanska, S. Zochowski

Lecturers:
C. Howard, F. Kruger, R. Perry, S. Schofield, P. Zubko

Research Associates:
S. Azadi, L. Bovo, V. Brazdova, A. Carof, B. Chen, A. Cote, Z. Feng, K. Fraser, D. Gao, M. Graziano, H. Hedgeland, A. James, C. Leung, A. Lim, A. Minotto, G. Morrison, S. Murphy, C. O'Rourke, J. Schwenke, I. Skarmoutsos, V. Stojevic, V. Tileli, M. Warner, B. Warner, M. Watkins, M. Yusef, F. Zhang

Most Research staff are employed through the LCN

Support Staff:
J. Gill-Thind, A. Gormanly, D. Ottley, F. Sidoli

High Energy Physics

Head of Group: Professor M. A. Lancaster

Professors:
J. M. Butterworth, N. Konstantinidis, A. Korn, M. A. Lancaster, R. Saakyan, J. A. Thomas, R. S. Thorne, D. Waters, M. Wing

Readers and Senior Lecturers:
M. Campanelli, R. Nichol, E Nurse

Lecturers:
F. Deppisch, C. Ghag, K. Hamilton, G. Hesketh, S. Jolly

Royal Society Fellowship:
A. Holin (Dorothy Hodgkin), T. Scanlon

Principal and Senior Research Associates:
R. Flack, P. Sherwood, B. Waugh

Research Associates:
A. Chislett, L. Cremonesi, L. Deacon, J. Dobson, A. Freshville, S. Germani, K. Gregersen, N. Gutierrez, L. Harland-Lang, K. Leney, P. Litchfield, A. Martyniuk, J. McFayden, D. Wardrope, L. Whitehead

Support Staff:
D. Attree, K. Bouzgan, M. Cascella, G. Crone, T. Hoare, S. Kilani, E. Motuk, M. Warren

Teaching

Director of Teaching: Professor R. K. Prinja

Director of Postgraduate Studies:
T. S. Monteiro

Director of Laboratories:
F. Renzoni

Principle Teaching Fellow:
P. Bartlett

Teaching Fellows:
D. Armoogum, E. Bailey, J. Bhamrah Harley, L. Dash, N. Nicolaou

Laboratory Superintendent: D. Thomas

Laboratory Technicians:
B. T. Bristoll, M. A. Sterling, K. Vine

IT Systems Manager (Teaching & Learning):
T. Wriedt

Admissions Tutors:
F. Cacialli (MSc), J. C. Rawlings (Astronomy Certificate), R. S. Thorne (Postgraduate Research), D. Waters (Undergraduate)

Programme Tutors:
D. Duffy (MSc), M. M. Dworetsky (Astronomy Certificate), S. W. Zochowski (Physics and Astronomy)

UCL Observatory

Director: G. Savini

Teaching Fellows:
S. J. Boyle, S. J. Fossey

Computing and Instrumentation Officer:
T. Schlichter

Technical Support:
M. Pearson

Maps Workshop

Superintendent: R. Gollay

Technicians:
J. Benbow, J. F. Percival

Professional Services

Departmental Manager: J. Smith

Examinations and Staffing Officer:
B. Carboo

Grants Officer:
J. Davies

Accounts Officer:
C. Nalty

Finance Officer: J. Levin

Finance and Postgraduate Administrator:
N. Waller

Senior Teaching and Learning Administrator:
A. Keegan

Teaching Support and CMMP Research Group Administrator: J. Gill-Thind

Astrophysics Research Group and Observatory Administrator: K Nakum

Reception, Purchasing and AMOPP & HEP Administrator: K Bouzgan

Biophysics Administrator: A. Tyrrell

IT Co-ordinator: B. Waugh

Safety Officer and Estates Manager:
L. Bebbington

Outreach and Public Engagement

Outreach Coordinator and Ogden Science Officer: S. Hutton

Science Centre Organiser: S. Kadifachi

Visiting Professors and Emeritus Staff

A. Aylward, A. Boksenburg, F. W. Bullock, M. Coupland, D. H. Davis, M. M. Dworetsky, M. Ellerby, M. Esten, J. L. Finney, J. Fordham, I. Furniss, M. J. Gillan, T. C. Griffith, A. H. Harker, T. Harker, C. Hilsum, P. Hobson, J. W. Humberston, T. W. Jones, G. E. Kalmus, M. Longair, B. Lynn, K. A. McEwen, J. McKenzie, B. R. Martin, D. J. Miller, W. Newell, G. Peach, P. G. Radaelli, H. Saraph, A. C. Smith, W. Sommerville, P. J. Storey, D. N. Tovee, C. Wilkin, D. A. Williams, A. J. Willis

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