UCL DEPARTMENT OF PHYSICS AND ASTRONOMY

UCL

ANNUAL REVIEW 2021

Cover image:
NGC 2359, the “Thor’s Helmet” nebula. Taken with the UCL/UCLO partnered Telescope Live network, using narrow-band (SHO) filters. NGC 2359 is a bubble of ionized gas, blown into the surrounding molecular cloud of interstellar gas by the strong stellar wind of the bright, and massive, star near its centre.
Credit: Ian Howarth

Image page 3:
Droplet of water atop a sheet of hexagonal boron nitride.
Credit: Michael B. Davies

Image page 29:
The Eagle Nebula, catalogued as M16, showing the ‘Pillars of Creation’. The brightest stars are clustered at the same distance as the nebula, while the small dark pockets of dust host newly forming stars.
Credit: Ian Howarth

Image page 35:
Staring down the barrel of a nanotube in ice.
Credit: Michael B Davies

Image page 49
Current advances on detection of COVID-19 and the interpretation of humoral response.
Credit: Nguyen T. K. Thanh and M.A. Huergo

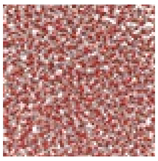
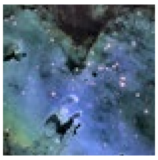
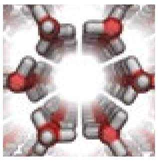
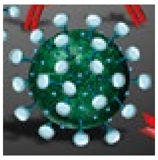
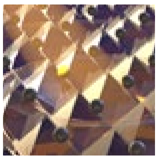
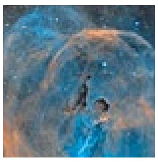
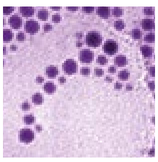
Image page 62:
A laser shone at a magnetic crystal disrupts the magnetic order, which can be tracked on ultrafast timescales by x-ray diffraction.
Credit: Cameron Dashwood

Image page 67:
Although this appears at first sight to be a single complex of glowing gas, the region to the left (west), NGC 3603, is, at a distance of some 20,000 light-years, actually around twice as far from Earth as is the adjacent `Statue of Liberty’ nebula, NGC 3576. However, both regions arise through complex interactions of cold dust, ionized gas, and massive luminous stars.
Credit: Ian Howarth

Back cover image:
Beautiful heart – Cobalt nanoparticles self-assembled naturally to form this image.
100,000 times magnification of 10nm cobalt nanoparticles taken during research of design and fabrication of magnetic nanoparticles for biomedical applications.
Credit: Nguyen T. K. Thanh

Review edited by **Bonita Carboo**, b.carboo@ucl.ac.uk

Contents

Welcome

Welcome to the 2020/21 Annual Review of the UCL Physics and Astronomy Department. What a year it's been! In my many decades in this department this has been by very far the most challenging and surreal twelve months, but it has also been a truly galvanizing period.

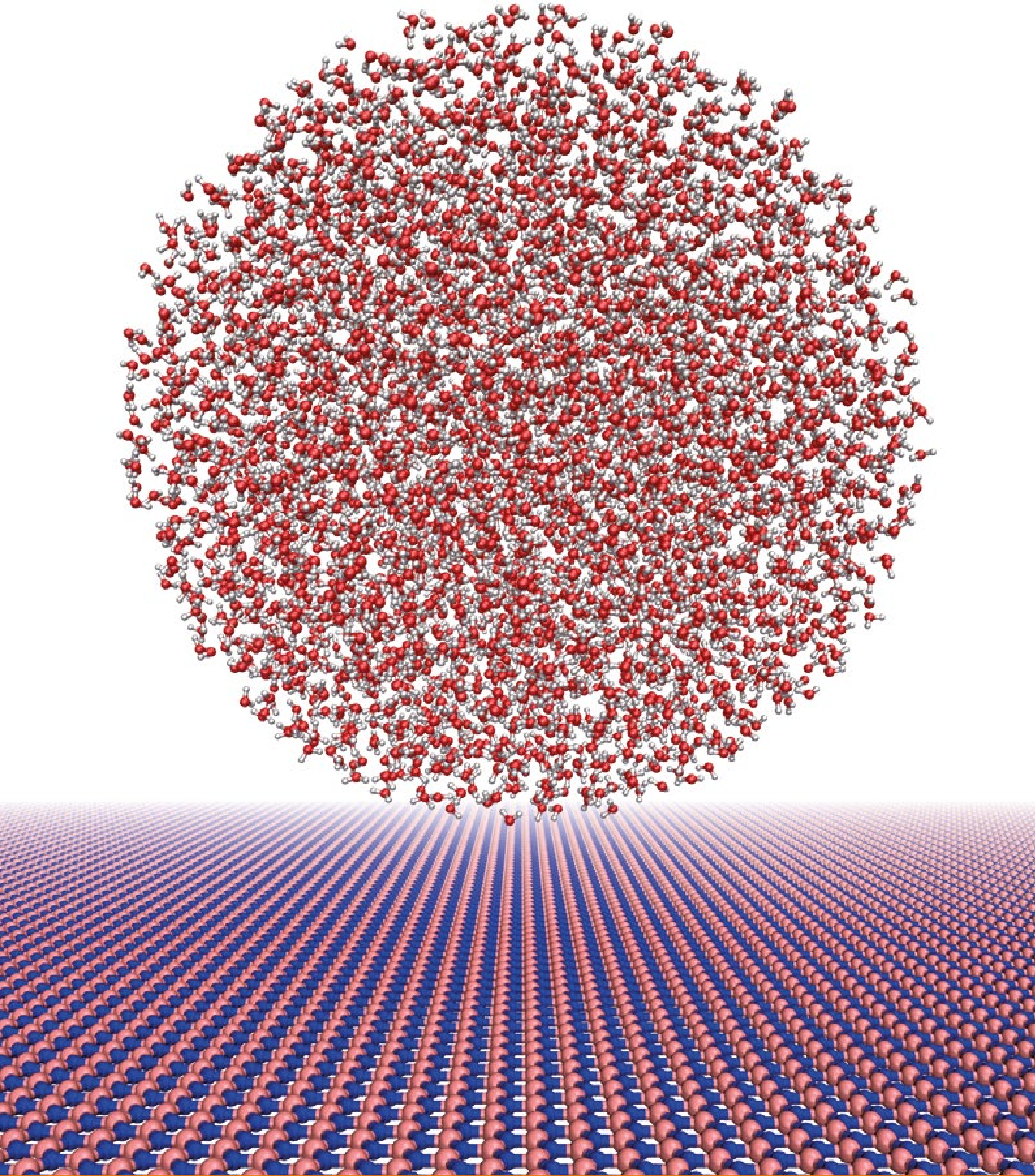
Our department went into remote mode as a consequence of the first national lockdown in March 2020, and some members of our department have not set foot on campus since then. I certainly never imagined our buildings at UCL would have remained on (limited occupancy) 'amber' status for almost 18 months. The adjustments have been exacting, with certainties turned upside down and anxieties raised. The boundary between our personal lives and work has become blurred. Joining Zoom or Teams meetings from the kitchen table while juggling home schooling has become a new daily skill. Remote working has also provided revelations; perhaps meetings aren't always necessary, working a fixed set of hours may not be for everyone, sitting at a desk all day doesn't always mean you're being productive, the daily sardine-special train ride to work doesn't have to be daily, and we certainly do miss our UCL colleagues.

As I write this welcome to you, we approach a major pivot; based on the Government's confidence in the double-vaccination uptake, and the advice of our own (UCL) public health experts, UCL has developed a roadmap to welcome back the remaining staff and students who have been working and studying remotely. The expectation is that staff will be able to start returning to onsite working from summer 2021, with options for blended working patterns. We also very much look forwarding to seeing our buildings buzzing again as we welcome all our students back onto campus in September for the 2021/22 academic year.

The past year has also seen peak activity for the completion and submission of our Research Excellence Framework (REF) 2021 submission. This has been a tremendous endeavour, and my thanks to everyone involved in our department and our joint submission partners in the London Centre for Nanotechnology and Department for Space and Climate Physics. As co-lead on our unit of assessment I have been delighted and enormously impressed by the quality, diversity and ambition of our research, its impact and the research environment. Our submission features a great volume of exciting research outputs bringing together the work of 117 academics, in turn supported by teams of researchers, technicians and engineers. It benchmarks our commitment to a diverse, sustainable, and world-class research culture in our department. Some of the remarkable discoveries arising in our research groups over the past are highlighted in this Annual Review.

We have meanwhile continued the strive to establish dignity, equality and transparency at the core of our processes, and for the department to be recognised as a congenial place for its diverse members to work and fully achieve their potential. These goals take on even greater significant in the post-pandemic future. I recognise we must not be complacent and there is still considerable progress to be made. I am particularly keen that further measures are embedded to support directly young and early career researchers, and our EDI committee has during the past year commissioned postgraduate student, and staff, surveys. The recommended actions arising from these surveys, along with race equality pledges that we have made to the University, will be a priority as we emerge from the darkness of the pandemic.

Professor Raman Prinja
Head of Department



Community Focus

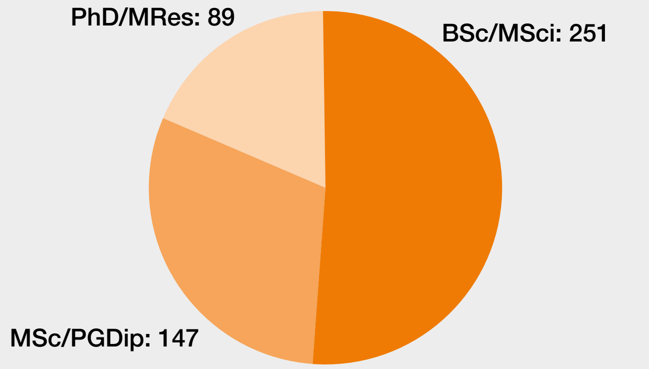
Teaching Lowdown

Teaching in the Physics and Astronomy Department

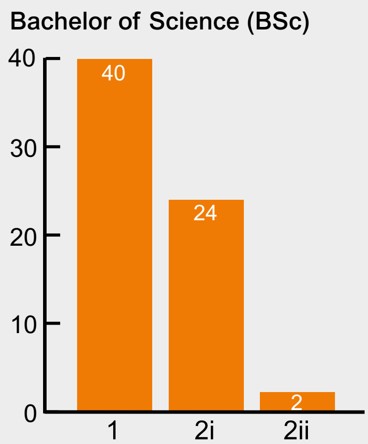
This has been another particularly challenging session for teaching and learning, with most of our planned face-to-face activities being progressively replaced by online remote classes, due to lockdown and other restrictions. Many thanks again to all our students and staff for their hard work, flexibility and patience as we have adjusted to the rapidly changing situation and requirements. Among the teaching and learning highlights this year, eleven undergraduate students from the Department (Mr Lorenzo Braccini, Mr Ryan Brady, Mr Andreas David, Ms Iris Kalien, Mr Xudong Ken Lin, Mr Dominik Kufel, Mr Mark Ma, Ms Thankdikire Madula, Mr James Marsden, Mr Sean Moshe Nassiniha and Mr Zhu Sun) were placed on the Dean's list, which commends outstanding academic performance by graduating students, equivalent to the top 5% of student achievement. Mr Zhu Sun also received a Dean's Commendation, and Mr Leonardo Corsaro was awarded the Jackson Lewis Scholarship for the best continuing 3rd year student in the MAPS Faculty. Harriet Apel (MSc Quantum Technologies) was winner of the 2020 MAPS Faculty Postgraduate Taught Prize. Our Education Support team (Selina Lovell, Helen Copeland, Ryan Edmonds, Sadia Begum, Sarah McGrath, Annalisa Medici, Nadia Waller and Sabrina Samuels) won the MAPS Faculty Education award for excellence, and Helen Copeland and Ryan Edmonds were highly commended in the individual support staff category. Congratulations also to Dr Stephen Fossey, who was promoted to Associate Professor (Teaching) – this new job title reflects UCL's very welcome commitment to promote equality of status and esteem for those with predominantly teaching-oriented contracts. In recognition of the outstanding collaborative effort this session, the Department's annual teaching prize was awarded to our entire teaching and education team.

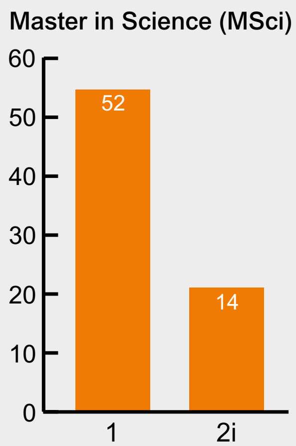
Professor Neal Skipper
Director of Teaching

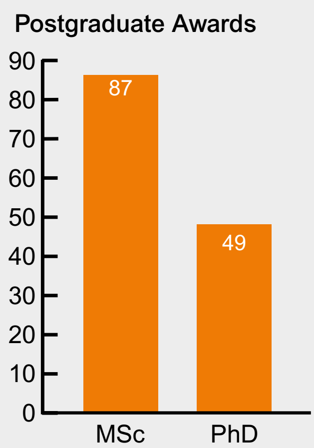
Intake



Awards







Student Accolades

Undergraduate Prizes

C.A.R. Tayler Prize
Best performance in Comm. Skills, based on 1st+2nd year
Mr Lorenzo Braccini

Wood Prize
Best performance 2nd year Physics
Mr Zhu Sun

Huggins Prize
Best performance 2nd year Astrophysics
Ms Nikita Reid

Sydney Corrigan Prize
Best performance in experimental 2nd year work – PHAS0028
Mr Leonardo Corsaro

Best Performance Prize
Third year Physics
Mr Lodovico Scarpa

Best Performance Prize
Third year Astrophysics
Mr James Marsden

Additional Sessional Prize for Merit
Mr Jaime Ruiz-Zapatero

Burhop Prize
Best performance 4th year Physics
Mr Kumail Kermalli

Herschel Prize
Best performance 4th year Astrophysics
Ms Manasvee Saraf

Brian Duff Memorial Prize
Best 4th year project
Ms Tina Lan Yao

William Bragg Prize
Best overall undergraduate
Mr Scott Woolnough

Postgraduate Prizes

Tessella Prize for Software
Best use of software in final year (Astro) Physics project
Mr Cristian-Catalin Ignat

Harrie Massey Prize
MSc Physics Prize **Ms Harriet Apel (Quantum)**
MSc Astrophysics Prize **Mr Alexander Smith**

High Energy Physics Prize
Outstanding postgraduate research in High Energy Physics
Dr David Yallup

Carey Foster Prize
Outstanding postgraduate research in Atomic, Molecular, Optical and Positron Physics (Jointly awarded)
Dr Sofia Qvarfort & Dr Alexandre Morgan

Marshall Stoneham Prize
Outstanding postgraduate research in Condensed Matter and Materials Physics (Jointly awarded)
Dr Richard Juggins & Dr Mitch Watts

Jon Darius Memorial Prize
Outstanding postgraduate physics research in Astrophysics
Dr Billy Edwards

Biological Physics Prize
Outstanding postgraduate physics research in Biological Physics
Dr Adrian Hodel

Christopher Skinner Prize
Outstanding postgraduate research in Astrophysics
Dr Martin Rey

Biological Physics Prize
Outstanding postgraduate research in Biological Physics
Not awarded this year

Alumni Matters

The Physics and Astronomy Virtual Prize Giving Event 2020–21 was held on 19 February 2021. The Annual Physics and Astronomy Lecture and the Annual Gala Dinner had not been able to go ahead as planned this year due to the Covid-19 pandemic.

Professor Raman Prinja, Head of Department, opened the award ceremony and welcomed all staff, students and the alumni: “it is even more important than ever that we celebrate the breadth and excellence of achievement in the department this year, particularly because of the challenges and circumstances that we’ve all faced during this period”. The Alumni Speaker ‘our usual Gala Dinner after dinner speaker’ was given by Professor Barry Dunning, Sam and Helen Worden Professor, Physics and Astronomy, Rice University, Houston, Texas, United States. Professor Barry Dunning entered UCL in September 1963, obtained his BSc in 1966, and PhD in 1969.

Professor Barry Dunning operates a research program exploring the physics of atoms in highly-excited Rydberg states. While continuing to investigate the fundamental physical and chemical properties of these giant atoms, his group is also now using Rydberg atoms as a nanoscale laboratory in which to examine the manipulation and control of atomic wavefunctions, i.e., atomic engineering, and classical-quantum correspondence. Work using strontium Rydberg atoms is pushing towards formation of long-lived two-electron-excited “planetary atoms” whose behavior mimics that of a planetary system and the creation of Rydberg “molecules” comprising a Rydberg atom in whose electron cloud are embedded one, or more, weakly-bound ground-state atoms. In dense ultra-cold gases novel Rydberg molecules comprising hundreds of “atoms within an atom” are being created. The appearance of many-body effects at very high densities, such as the creation of Rydberg polarons, is also being investigated.

You can watch the video recording here:

www.ucl.ac.uk/physics-astronomy/news/2021/mar/physics-and-astronomy-virtual-prize-giving-event-2021

Prof Barry Dunning

We are incredibly proud of our remarkable community of over 6400 alumni, living in over 60 countries worldwide and always enjoy hearing from you. Please do reach out to share your news and connect with us at UCL.

Bonita Carboo
b.carboo@ucl.ac.uk

As UCL alumni, you are a crucial part of UCL’s vibrant global network and there is a huge range of useful services and exclusive benefits available to you.

Please visit the UCL Alumni website to view services available to you, lifelong learning opportunities and opportunities to volunteer and support UCL students:

www.ucl.ac.uk/alumni

Connect with students and alumni in our global community

UCL Bentham Connect is an exclusive personal and professional development network for all UCL alumni, students and staff. Whether you are seeking advice to perfect your CV, looking to break into a particular industry or simply want to make new connections, thousands of alumni are just a click away.

Sign up today: **www.uclbenthamconnect.com**

Dr Andrew Morris (1967–70), President, British Science Association (Education Section) commented on the Annual Review 2019–20 edition:

“*What an amazing Newsletter. I must say the department seems to have come on enormously since I was an undergraduate in 1967–70. In particular, I am impressed by the attention now paid to students and to communicating in plain language for the non-specialist. It's what always interested me about physics and continues to motivate my teaching and writing today.*

I was the first 2nd year member of the staff-student liaison committee formed in the turbulent days of 1968. Harry Massey chaired it and he gave wise advice to me that I took to heart and never forgot: 'if you really want to understand something, teach it' ”.

Professor Sir Roger Penrose, who was an undergraduate at UCL, is among three scientists to have been awarded the Nobel Prize in Physics for work relating to black holes.

Sir Roger, an Emeritus Professor of Mathematics at the University of Oxford, was awarded the prize, the committee said, for his discovery that “*black hole formation is a robust prediction of the general theory of relativity*”.

The other half of the prize went to Professors Reinhard Genzel and Andrea Ghez 'for the discovery of a supermassive compact object at the centre of our galaxy'.

You can read the full article at:

www.ucl.ac.uk/news/2020/oct/ucl-alumnus-professor-sir-roger-penrose-awarded-nobel-prize

Bonita Carboo
Alumni Coordinator

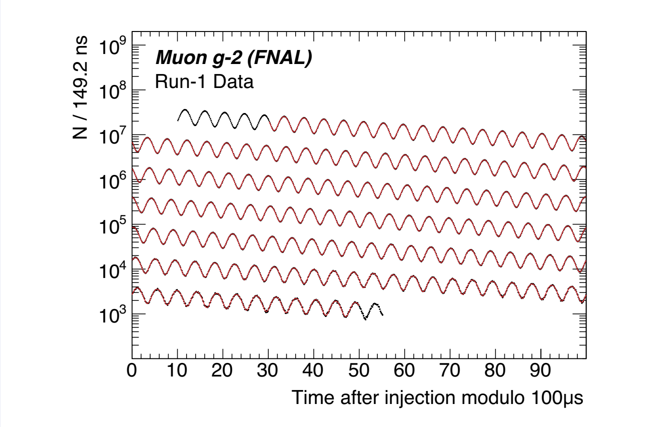
Headline Research

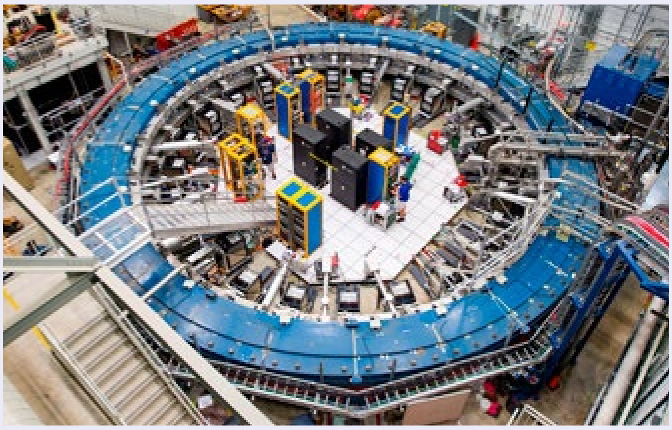
Anomalous muon magnetic dipole moment

'A particle's tiny wobble could upend the known laws of physics' – New York Times, 8th April 2021. In April, the Muon g-2 Experiment at Fermilab (FNAL) made global headlines for a measurement of the anomalous magnetic dipole moment of the muon, $a_\mu = (g-2)/2$. The measurement is made by studying muon spin precession in a storage magnet - the 'wobble' of the headline – and the measurement made at Brookhaven National Laboratory 20 years ago stood a tantalising 3.6 sigma away from the theory prediction, possibly hinting at the existence of physics beyond the Standard Model.

The first FNAL measurement, $a_\mu = 116592040(54) \times 10^{-11}$, has a precision of 0.46 parts-per-million, and confirms the Brookhaven result. The combination of the two now lies 4.2 sigma from the theory prediction, increasing the discrepancy. The new result is based on the first data ('Run 1') and is limited by statistics. Analysis of the next round of data is now ongoing and data taking continues, with the ultimate aim of a factor 4 improvement in precision. There is also ongoing work on the theory prediction, which is expected to improve in precision on the timescale of the next result. Recent calculations based on Lattice QCD are also shedding new light on the discrepancy.

UCL have played an important role in the experiment, leading the data acquisition, tracking algorithms and analysis, as well as Run Coordinator and Spokesperson roles. Our current focus is the first search for a muon electric dipole moment with the FNAL experiment, which will give complementary information on any new physics which may lie behind the a_μ discrepancy.





The Muon g-2 magnetic storage ring at Fermilab. The 24 calorimeter stations inside the ring are used to detect positrons from the muon decays.

Equality, Diversity and Inclusion

Physics and Astronomy and Race

Race as a protected characteristic has recently moved more and more into the focus of equality, diversity, and inclusion (EDI) efforts at UCL, as well as in our department, with a further boost in attention by the global spread of the Black Lives Matter movement in 2020. UCL holds a **Race Equality Charter Mark** since 2015 and has recently updated its submission and action plan. Members of our department are active in both the Race Equality Steering Group and the Equality Charters Group, which drive race equality actions at the institutional level.

While it is tempting to think that inequalities linked to race do not affect the 'hard' sciences like physics, we see clear evidence for these problems across our department. UCL recruits a large number of its undergraduates from Greater London and South-East England where Black British people constitute about 20% of the population at university entry-level age. However, this demographic makes up only 9% of our applications, and 4% of acceptances. Once in the degree, the **Awarding Gap** manifests for Black and other minority ethnic students, also in our department: in the previous academic year UK students from this demographic were 19% less likely to be awarded a good (First and Upper Second) degree than their White peers in Year 2 Physics. This is not far from the UK-national average across all universities and subjects (22% for Black students), whereas the Gap is generally smaller for UCL as a whole, so this is quite concerning. Moreover, the 'leaky pipeline' of academic career progression exists for Black and minority ethnic physics students and researchers as well: we see tentative evidence for a higher drop-out amongst our undergraduates identifying as Black, and Black and other minority ethnic research and academic staff are progressively under-represented with regards to the UK population.

Following a call to action, the Physics and Astronomy Departmental EDI committee, alongside all UCL departments and similar units, prepared four race equality pledges at the start of the 2020/21 Academic Year for whose fulfilment we will be held to account. Covering a broad spectrum from undergraduate and postgraduate teaching to staff to engagement with the scientific community, we have committed to:

1. creating small 'portraits' of eminent scholars from under-represented groups, in particular Black researchers, in all modules. The curriculum we teach may not require the decolonisation often talked about, but the demographics of the leading figures behind our physical world view still reflect the inequalities of society at the time. We need to challenge the notion that physics is a discipline championed by White men only.

2. rolling out a PhD Buddy scheme across all of the department. Successfully established in a subset of research groups already, the scheme provides new starters with informal support to find their feet in our department, helping to establish a sense of belonging which is particularly important for students from under-represented groups.

3. making use of the **Fair Recruitment Specialist Scheme** in at least one senior hire, and encourage a member of the department to train as a new specialist. The scheme trains colleagues who identify as Black, Asian, or minority ethnic as cross-institutional experts for fair recruitment and is currently struggling to meet the high demand, but an expansion is underway.

4. monitor more systematically the diversity of speakers at seminars and colloquia across the department. This came with a plea to take advantage of the profound changes to our ways of working due to the on-going Covid-19 pandemic by soliciting excellent speakers whom we would previously not have reached, be that due to their geographic location, nationality, lack of mobility, or other personal circumstances.

We certainly still have a lot of work before us to fulfil all four pledges. The pressures of the unprecedented challenges caused by the pandemic have meant that EDI and welfare efforts in our department have not progressed as much as we would like this year. As widely reported in the media, those same pressures have acted to worsen inequalities in our society, with race a dimension along which those inequalities are particularly prominent. No doubt, the fallout from the pandemic will continue to affect everyone in the department for years to come and keep EDI work at the top of our agenda. Beyond the four initial pledges, the EDI committee has now created a more comprehensive departmental race equality action plan that will shortly be integrated into the overall EDI action plan for Physics and Astronomy, which will complement our continuing activities largely focussed on gender equality. We are very grateful for the valuable input into these new race-centric actions by engaged individuals and diverse grassroots groups active within the department.

To end on a positive note, the multitude of initiatives, action plans, and pledges does instigate change for the better. For instance, five or so years of effort at the institutional level have led to a small but steady improvement in the share of minority ethnic senior staff (Grades 7 and up), and **tentative signs for a reduction in the Awarding Gap**. Clearly though, the job is far from done.

Benjamin Joachimi
on behalf of the Physics and Astronomy EDI committee

Connected Learning

Connected Learning Internships in Practical Physics

If necessity is the mother of invention, then the unprecedented challenges that we have faced in all walks of life since the outbreak of the pandemic have certainly provided the necessity! Who better to step up and innovate than our own student community of problem solvers?

The summer of 2020 saw the launch of a new kind of Connected Curriculum activity from UCL Arena and UCL Careers – Connected Learning Internships (CLIs). In this scheme, staff across UCL made proposals for paid student collaborative support regarding all aspects of the student experience for the 20/21 academic session. In UCL Physics and Astronomy, CLIs were employed in innovative student-staff collaborations in lecture modules and practical modules. I discuss briefly the latter case here.

Running an experimental physics module without a lab was a challenge too far to realise on my own, so I submitted a CLI proposal for ‘Online Accessibility for Experimental Physics’. UCL allocated two fantastic Physics and Astronomy interns in Balázs Dura-Kovacs (MSci Physics, 2020) and Andrew Austin (BSc Physics, 2020). Both Balázs and Andrew had taken my lab course as second years, so they were familiar with how the course ran ‘pre-Covid’.

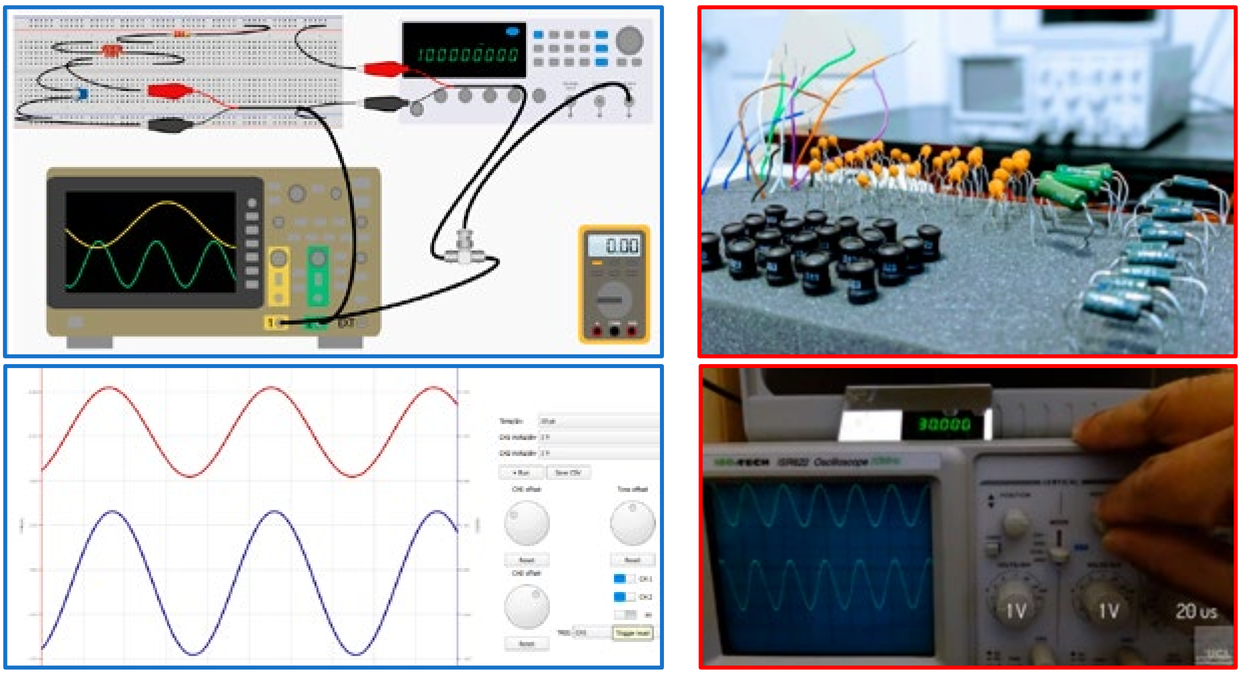
Balázs and Andrew used the coding skills from their degrees to develop online versions of some of the teaching experiments hitherto only performed in person. Andrew created a Python version of our Thermal Fluctuation experiment complete with virtual Low Noise Amplifier; meanwhile, Balázs created an entire breadboard simulator package, complete with signal generator and oscilloscope.

Balázs’ visually striking and user-friendly drag-and-drop interface meant that students taking PHAS0028 this year performed a new variation of the electrical resonance experiment: firstly by building and testing their own series CLR circuits; then comparing their findings to pre-recorded P.O.V. video footage of the same experiment. (The ‘real-life’ version was carried out in my spare bedroom, now a makeshift lab…).

This virtual / real-world approach provided new learning opportunities for our students. Did the video footage agree with the (purposely perfect) virtual simulation? If not, why not? Improving a theoretical model to correct for factors introduced by apparatus is a vital skill for experimental research, and thanks to the Connected Learning Internships our undergraduates experienced this for themselves.

As we make plans to return to the teaching labs this Autumn, does this mean that the work of Andrew and Balázs was a one-off? On the contrary! Their amazing contributions mean that future undergraduates have new online tools to aid their understanding away from campus, and can achieve more with the precious Teaching Lab time. Connected Learning Interns like Andrew and Balázs have unequivocally improved the UCL learning experience and demonstrated emphatically the power of student-staff collaboration at the heart of the Connected Curriculum.

Daven Armoogum
Associate Professor (Teaching)
Departmental co-Tutor (Years 1 and 3)



Thanks to Balázs Dura-Kovacs’ breadboard simulator and virtual oscilloscope, Year 2 Physics undergraduates were able to create their own circuits to investigate electrical resonance and compare their findings with the video footage from Lab 2 equipment.

Students in Action

Women in Physics group

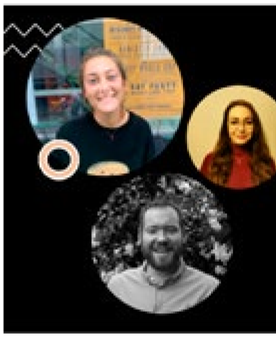
The Women in Physics group (WiPg) at UCL has been championing and celebrating women and their achievements through talks, lunches, and lectures for 15 years, as of this October. As time passes, we see that the issues that Women face in academia aren't so black and white. Instead, they are a complex accumulation of many factors. This is what is known as intersectionality and over the last year we have focused on the importance of addressing and tackling problems that those of intersectionality groups face and not just women!

In the last year we have organised a range of events and collaborated with wonderful people in and out of the department. Firstly, a huge thank you to Dr. Alissa Silva (Teaching Fellow of the CDT in Quantum Technologies) for designing the beautiful WiPg logo – another example of how talented our wonderful staff are! A permanent fixture in the WiPg calendar is our Thursday Evening talks. Since January 2021 we have hosted a variety of people dismantling some important parts of EDI and issues those from intersectionality groups face. We had:

- **Priyanka Dasgupta** (CERN) with "*Communicating women in science: on Equality and Equity*"
- **POCSquared** (Activist Group funded by RAS) with "*Left Leaning Science Ethics in Academia*"
- **Lucy Hogarth** (PhD student Astrophysics UCL) with "*Hidden Spectrum: How the story of autism forgot women and what we can do about it*"
- **Susan Pyne** (Post Doc Cosmology UCL) with "*Lives in and out of physics*"
- **Chetna Krishna** (CERN) with "*A Journey to CERN: From engineering to science communication*"

With the pandemic, we have seen more uncertain perceptions on "jobs after university", whether this is from an undergraduate, Masters, PhD, or Post Doc level and as a group that tries to support problems faced in academia, we thought it was necessary to set up a panel event to address this. Physicists (with different qualification levels) discussed their unusual and alternative career paths, emphasising that a physics education provides a deep skill set that can be applied to almost everything. It was successful and most took away that there is "no one right career" but many paths to follow. From this event we have partnered with the Thomas Young Centre to deliver careers talk every 6 weeks or so, to continue inspiring others about the opportunities and paths one can carve out from a STEM degree skill set.

Most recently, the WiPg has expanded our reach with two special events. The first, lead Organiser Abbie Bray, was invited to give a talk at Kings College London on her journey through EDI (EDI & Me: Navigating a changing tide in academia). The talk used both her professional and personal experiences to assess what the issue are for those from diversity groups in academia. It focused on how institutions need to have more accountability, updated education and knowledge to support their population and make effective change. Our department is also making these changes – WiPg and Physics and Astronomy have co-funded a "Mental Health Literacy" seminar by Dragonfly Mental Health. An evidence-based talk and active discussion on Mental Health in Academia specifically. This includes information about the prevalence of mental health illness in general and academic populations, an overview of signs and symptoms highlighting those seen in academic settings, and the science underlying the causes and treatments of mental illnesses. Implementing effective change and making others aware of needs of those disenfranchised is hard work to do alone, that is why I thank everyone who we have collaborated with!



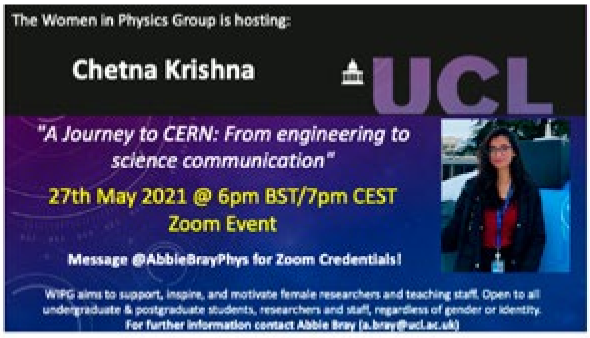
We have numerous events planned for Autumn 2021, so keep an eye out for Thursday evening talks and faculty wide seminars. When organising events one must remember, it is those who are marginalised who do the leg work typically whilst also balancing work, life, and everything in between. Since they are the ones who are affected by systematic racism/classism/ageism/sexism/discrimination and unconscious bias, people often feel pressure to give a talk or participate. So, we must be careful on what our motives are when we ask someone to do EDI work. Do we want to feel "good" that we've given someone a platform, or do we genuinely care about the issue and want to learn how we can help by improving our behaviours and thought processes? There's a difference between being an ally and implementing effective change and it comes down to how you act on the information given to you.

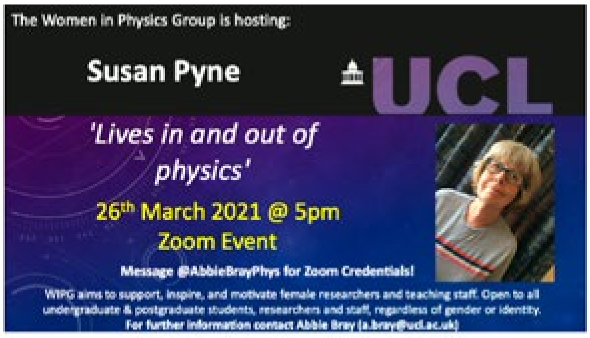
Writing this review, I would have wished to have been able to describe all the in-person events and initiatives we did, but alas we faced another year of lockdown. Our relationship with staying indoors, at home and even in isolation has now been established and well defined and as we begin to open again, we must respect that it might not be for everyone straight away. So, we must respect one another's choices and keep a hybrid form for events so as not to exclude others.

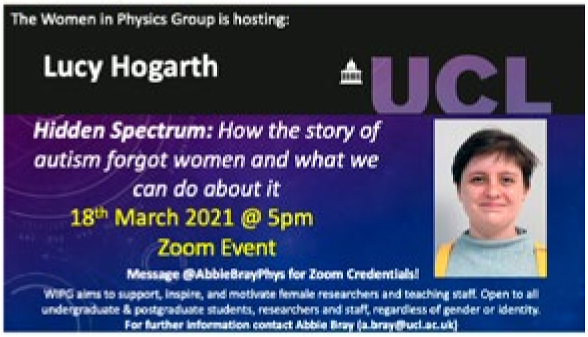
Not everyone is ready to live like it's 2019 again. But, as the world heals, we must take time for ourselves to adjust to life ahead and look forward to building a more diverse, equal, and inclusive future.

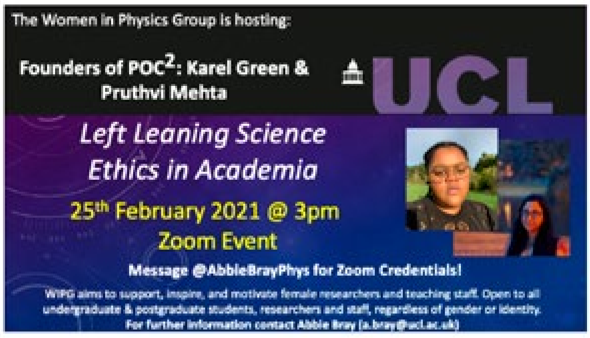
Stay well, be kind
Abbie C. Bray

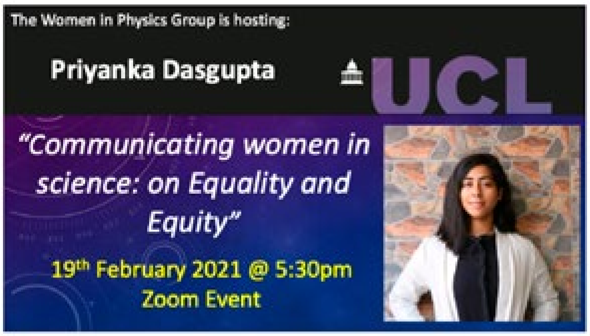
If you have any ideas for an event (virtual or not), please feel free to contact me:
a.bray@ucl.ac.uk or **@AbbieBrayPhy**











Central logo is made by Dr. Alissa Silva and the advertisements were tabulated by Co-organiser Dr Cornelia Hofmann

UCL Physics Society: the year in review

The release of this article marks the end of what has been, for all of us in the Physics Society, a truly remarkable year, in which, despite the dire situation we have all lived through, we were able to host a multitude of extremely high-profile academic events, as well as very engaging social opportunities. We would like to thank all of our members and departmental staff for supporting us: the credit for this success is yours.

Guest Lectures and Seminars

The Academic Officers organised and hosted online talks with leading scientists from all over the world: our guest lectures included Professor Barish's on gravitational waves, Doctor Sousa-Silva's on phosphine and agnostic biosignatures, Professor Rovelli's on the direction of time, and Professor Bell-Burnell's on transient astronomy. Our publicity efforts, for which we thank our IT officer, led in some cases to turnouts of 100+ students.

In addition to the large lectures, we ran two small-group events with UCL academics Dr Boehmer (on modified gravity) and Professor Tinetti (on exoplanets), which allowed students to meet these leading experts in a more personal setting.

Social events

Although the global pandemic severely limited our options for social gatherings, we were successful in bringing the physics community at UCL closer together. The year began with an online scavenger hunt that took the participating groups on a chase through hidden messages in poems, videos and images. An intellectually challenging event was our online pub quiz in which groups answered general knowledge (and physics) questions to win a prize! Other events included an online inter-university chess tournament as well as a murder mystery night.

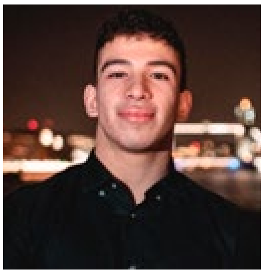
Physics Societies Network

Finally, the UCL Physics Society launched the Physics Societies Network along with the Imperial College London and Oxford University Physics Societies. This network allows students from each of the member societies to attend specific events hosted by other societies within the network. This freedom allows our members to join a range of academic talks and social events hosted by Oxford and Imperial. The first joint event hosted by this network occurred in January, a 2-day conference on the topic of High Energy Physics, featuring six academics, two from each university - for UCL, we had the pleasure to hear from Professor Butterworth and Professor Wing.

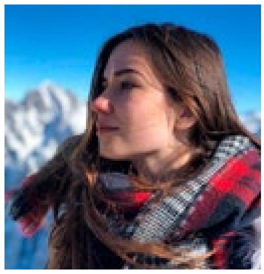
It was a pleasure and a privilege to be on the Physics Society committee, and we wish the best of luck to those who will succeed us next year.

Zahra Heussen and **Lorenzo Pica Ciamarra**, *Academic Officers*
Simeon Hatzopoulos, Social Secretary
Shuresh Saheli, President
on behalf of the 2020–2021 committee

The 2021 Committee



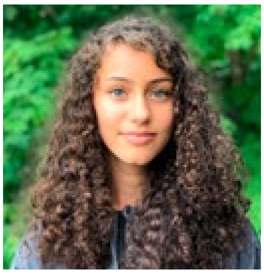
Shuresh Saheli
President



Maya Maciurzynska
Vice President

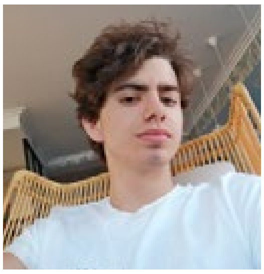
Joe Saffer
Treasurer

Lorenzo Pica Ciamarra
Academic Officer



Zahra Heussen
Academic Officer

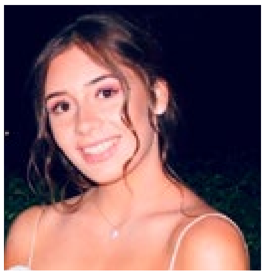
Simeon Hatzopoulos
Social Secretary



Juan Jose Juan Castella
Social Secretary

Laura Sanchez – Careers & Sponsorships Officer

Nancy Yang – Careers & Sponsorships Officer



Maria Avramidou
IT Officer

TV News interviews on solar system

In coordination with UCL Media Relations and MAPS Communications, my TV interviews this year have been on line and mostly on the International Space Station and the long-term exploration of the solar system.

Here is a selection of interviews:

The successful Chinese Chang'e 5 mission to collect sub-surface samples by drilling 2 metres inside a recent lava field on the Moon was a major item for Euronews. This robotic mission was a (unmanned) miniature replica of the Apollo project. The capsule with nearly 2kg of lunar material landed in Mongolia.

The 60th anniversary of Yuri Gagarin's flight was covered by Aljazeera English News, while Skynews featured the first Space-x mission sending astronauts to the International Space Station. In both cases we had discussions about space races and competitions. As always, I replied with the hopeful idea that solar system exploration must be a truly global enterprise, not a race, but an international collaboration under strict international regulations.

This is becoming a major issue, given the emergent diversity of independent actors such as single countries, commercial corporations and even private entrepreneurs (promoting space tourism), who would spoil pristine environments full of invaluable scientific evidence on the origin of the solar system and life within it.

Dr Francisco Diego Quintana

Lecturer (Teaching)

Interview by Euronews about the successful landing of NASA's Perseverance rover, the most ambitious Martian mission so far. This interview was followed by one about the first flight of the Ingenuity helicopter.

Headline Research

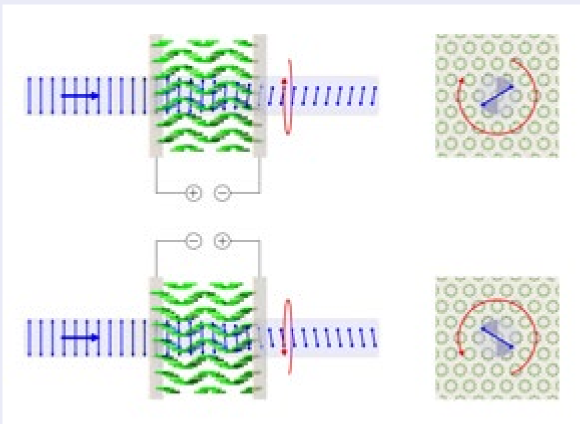
Helical ordering of electric dipoles

Electric dipoles are commonplace in condensed matter and can give rise to important properties such as ferroelectricity, where dipoles align like the magnetic moments in a ferromagnet (hence the prefix 'ferro' as in iron). In fact the analogy between magnetic dipoles (atomic magnetic moments) and electric dipoles is quite far reaching, giving rise, for example, to the classification of antiferroelectrics, where dipoles anti-align as in an antiferromagnet.

However, many exotic types of ordering of magnetic dipoles are known, such as helical or cycloidal orders, that until now, have seemed to have no electrical analogy. In work published in Science magazine, the CMMP's Dr. Roger Johnson and colleagues from STFC, UCL, Oxford University, and the National Institute of Materials Science in Japan, have described the first known case of helical ordering of electric dipoles in the crystalline material $BiCu_xMn_{7-x}O_{12}$. This discovery comes nearly sixty years after the discovery of analogous helical order in magnetic systems, and greatly extends the analogy between ordering of magnetic and electric dipoles in the solid state.

The authors further predict that the chirality ('handedness') of the electric dipole helix can be switched by application of an electric field. If demonstrated, this functionality would have technological implications, through, for example, electric control of optical activity in optoelectronic components.

DD Khalyavin, RD Johnson, F Orlandi, PG Radaelli, P Manuel and AA Belik. Emergent helical texture of electric dipoles, *Science* **369** 680 (2020).



How the newly-discovered helical ordering of electrical dipoles might find a use in the manipulation of polarised light.

Phys FilmMakers

2020 was the year we all became film makers, whether we liked it or not. The pandemic meant that all of our teaching had to go online. This of course meant filming lectures. Pivoting along with everyone else, Phys Film Makers went from being a student focussed initiative to assisting lecturers with the production of teaching material.

Recording and broadcasting studios

Very early, it was realised that good online teaching would require good filming equipment. Discussions with staff led to prioritising the acquisition of two filming studios: one whiteboard studio and one lightboard studio.

The whiteboard studio utilised an existing whiteboard (Figure 1). The lightboard was suggested by teaching staff who had seen them being used on popular YouTube channels. These allow the lecturer to face the camera and write on a pane of glass with fluorescent markers (Figure 2). The video is then flipped to make the text appear the right way around to the viewer, a good example of flipped learning in action.

Whilst these studios were originally designed for filming of lectures, a camera software update later added the capability to live stream from them as well. In fact, the whiteboard ended up being used this way most of the time, generating positive feedback both from the lecturers and the students.

Term 1 2021/2022 promises greater utilisation when we are all hybrid teaching. I can't wait to see what the lecturers produce with these studios once we find a permanent home for them.

Practical courses via video

Practical courses pose unique challenges for remote delivery. This applies particularly to the third-year laboratory where the experiments are more complex and designed to introduce a more research-based approach to experimentation. As such, once students were allowed to return to campus in Term 1 2020/2021, we adopted a method of low-risk practical lab sessions. Some students opted for face-to-face sessions whilst others selected remote delivery. Those who chose to attend in-person performed the experiment with demonstrator guidance, communicating and collaborating with the rest of their group via a live webcam relay. If more than one member of a particular group opted for in-lab sessions, then the students would rotate, so that only one was present in the lab from that group at any time.

Overall, as a first hybrid iteration, this method of practical teaching was successful. On the whole students were engaged, motivated in part by being the in-lab experiment 'lead', or because of the 'spotlight effect' of being on video (Figure 3).

Other practical classes were taught in a different way. Second year experiments were taught by recording the experiment being done and allowing the students to review the footage as if they were doing it themselves, taking readings and making observations as they went along. Recording the experiments in this way required a very ingenious use of the equipment available, with little regard to appearance (Figure 4).

Next year we hope to return to a student facing programme of making educational physics videos and encouraging widening participation and showcasing the department.Fingers crossed.

Kelvin Vine
PFM Coordinator

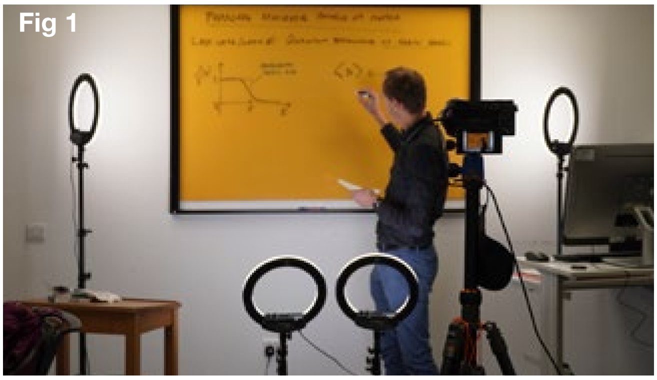


Fig 1


Fig 2


Fig 3


Fig 4

Innovation of experimental physics teaching during the pandemic

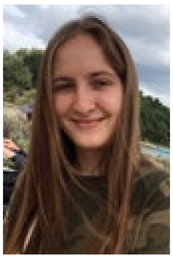
Approaching the summer of 2020, it became clear our work would have to change drastically due to the pandemic, including developing novel methods for teaching experimental physics skills. This has led to immensely valuable collaborations between staff and students, creating output which has been used across degree programmes.

Debbie Mok (Physics) and Olivia Cichon (Natural Sciences) were awarded internships to develop a range of experiments to be carried out at home by our Natural Sciences students taking PHAS0011. Supported by the MAPS Caring Fund, Olivia and Debbie trialed many experiments which required minimal equipment but linked to topics our students would have encountered. They provided detailed reports on equipment or mobile phone apps required, how the experiments related to year 1 modules and which were best for teaching experimental skills students would need for future lab modules.

From their work, we were able to offer PHAS0011 students a unique experience – paired according to geographical location, students carried out their experiments over a two week period, each pair meeting with demonstrators at least three times for guidance and assessment. This approach ensured an extremely high level of engagement with students producing some of the most impressive final reports I have ever marked! Much of Debbie and Olivia's work was also used for the PHAS0007 lab component. This project was presented both at a Physics Learning and Teaching in Higher Education meeting and at a Physics and Astronomy Teaching Forum, where Olivia and Debbie presented their work to much excitement, but we'll let them speak for themselves!

Debbie Mok BSc Physics

This internship gave me the opportunity to test my experimental skills. We developed experiments using only resources available at home, as well as explored how to incorporate a smart phone's functionality into an experiment. When some of these 'at-home' experiments failed, Olivia and I really had to collaborate to find new methods for these experiments or to adjust the experimental aim, putting our problem-solving skills to great use!



Olivia Cichon MSci Natural Sciences

I found the internship incredibly rewarding. Exploiting the capabilities of frequently used resources (such as mobile phones), I was able to nurture my passion for instrumentation development – something that then influenced the focus of my third- and fourth-year projects. I was also able to develop connections with another student, and work under the supervision of a teaching fellow, in a way that I could/did not otherwise encounter until my third/fourth years of university study. Presenting the work, alongside my partner, to the Physics & Astronomy department at UCL, was also an invaluable experience; despite it being my first time speaking before such a large, and specialised, audience, the relatively relaxed setting and continuous guidance enabled me to build confidence in a way few/no experiences can.

This internship is something that I will be forever grateful for: it helped me build connections for which I cannot express my gratitude enough, and continues to guide me in my studies, practical work, and future job considerations today.

Jasvir Bhamrah
Lecturer (Teaching)

Postgraduate Physics Society

The key to a successful PhD is balancing work and play. For many students, however, the latter is often overshadowed by constant meetings, deadlines, and broken code. Normally, most students would not have the opportunity to meet people from other research groups. The goal of the student-run Postgraduate Physics society (PGPS) is to provide opportunities for students across all sub-departments in physics to meet, share ideas, and have fun over pizza and refreshments (or simply online).

Throughout the academic year, the PGPS hosts monthly 'PhD Talks', where UCL students are invited to give a short 20-minute presentation about their research topic. These events provide a relaxed setting where a student working on planet formation can learn about particle physics detectors, exoplanets and vice versa.

The PhD talks series aside, we also hosted a pub quiz, where the students got a chance to show off their general knowledge. The quizzes are usually very well-attended and seem to be a favourite amongst the students. This year we also ran online game nights.

In the Postgraduate Physics Society we're continuously maintaining and improving the wonderful community that's been built in Physics and Astronomy, and looking forward to continuing this next year!

Catarina Alves and Johannes Heyl
on behalf of the
Postgraduate Physics Society

Science in Action

PandA Day Review

The 9th of June 2021 saw a special online version of ‘PandA Day’ – a celebration of the people in Physics and Astronomy, and their talents outside of physics. The first iteration of the event was held in January 2020 and was met with an overwhelmingly positive reception. This year, due to coronavirus, the event was held online after Rebecca Chislett’s talk on new muon physics.

The stream, hosted by undergraduates James Henderson and Charlie Drury, kicked off with Sergey Yurchenko’s legendary parody: “Toss a Coin to Your Lecturer”. Eva Aw gave an excellent cover of Cyndi Lauper’s “True Colours” and was joined by Matthew Cheng for “Let It Be”. Undergraduate Noor-Ines Boudjema performed fabulous renditions of Chopin’s “Valse” and Liszt’s “Liebestraum”. First year Avanija Menon stepped up to the plate in a series of mental maths challenges against a calculator; winning resounding victory after victory and showing off some serious chops.

The event was interspersed with a variety of comedy sketches created by the PandA team: from tongue-in-cheek skits about dark matter to more experimental sketches like “Lunch Sketch”. Though rough around the edges, they saw a lot of laughs, and featured our very own Jim Levin’s stellar performance in “Zombie Sketch” as “Zombie 3”. More music came from James and Charlie, with a pop-funk mashup of Katy Perry’s Teenage Dream performed with a Vulfpeck twist. The hotly contest prize of the short video contest (an Amazon voucher, what else?) was claimed by Maggie Chen, Ryan Brady and Saad Shaikh with their original pop-punk composition, aptly named “The Phat Phys Jam”. Ryan Brady’s shredding guitar solo was an absolute highlight.

This impromptu event serves as a teaser for future PandA events, and doubles as an invitation to all members of the department to showcase their creativity and talents. Future events will once again return to the in-person ‘variety night’ style, so if you’ve a creative outlet you’d like to share with people, an idea for a short film or talk, or just want to get involved: get in touch and PandA will help make it happen!
If you missed the event, all of the music and sketches can be found on **PandA’s YouTube channel: www.youtube.com/channel/UChoCPXy_HFM_xl92HZmLp-A/videos**

PandA Committee
panda@live.ucl.ac.uk

Sergey, Saad, Alex, Noor, Eva and Pete performing Sergey’s parody song ‘Toss a Coin to your Lecturer’.

Hosts of the PandA stream: James Henderson (left) and Charlie Drury (right).

Saad reprising his role as Head of Department, Raman Prinja, in ‘Zombie Sketch’.

ORBYTS wins NEON award

On Thursday 10 June 2021 at a virtual award ceremony, ORBYTS won the Widening Initiative (Outreach) category at the prestigious NEON Awards 2021. NEON received over 100 nominations but the judges were impressed by the number of students involved in published scientific research.

ORBYTS partners researchers with schools to empower school students to undertake their own scientific research and to provide them with relatable science role models, who dispel stereotypes about who can be scientists and what science is. The founding principle of ORBYTS is to widen participation in science, broadening aspirations and scientific literacy amongst students who would have historically been excluded from science.

ORBYTS has pioneered and evolved the researcher-in-schools model successfully by combining the pupil-PhD mentor model with cutting-edge scientific research. Since 2018, more than 150 school students have authored scientific papers with ORBYTS. Schools involved in the programme at GCSE also report 100% increases in, for example, girls taking A-level physics, addressing long-standing diversity issues in science.

Dr William Dunn
Planetary Science and Astrophysics Research Fellow:
"*These long-term engagements partnering researchers with schools are so transformative; shifting perceptions of science and scientists while empowering school students.*"

Hannah Osborne
PhD Mentor on ORBYTS and part of the organising committee:
"*It has been such a joy to be part of the organising team for this incredible programme and its really kept me motivated during what has been a very difficult time to start a PhD, hopefully we can continue to build in the future to allow more school researcher partnerships*"

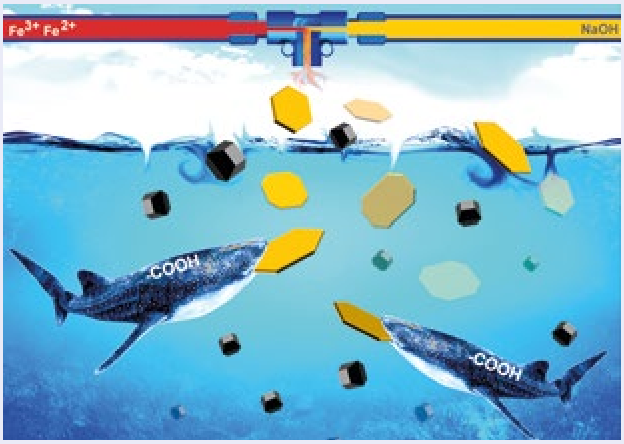
Collage showing student groups giving ORBYTS talks using slides from some of their own presentations.

Headline Research

Small IONPs for replacing T_1 MRI contrast agent

A collaboration between Prof Nguyen T. K. Thanh's team in Biophysics Group with UCL Chemical Engineering and the IPCMS University of Strasbourg led to a novel flow synthesis of iron oxide nanoparticles (IONPs), practically unfeasible in batch reactors. A combination of fast mixing and precisely timed reagent addition stopping particles from growing, made it possible to synthesise small (≤5 nm) and colloidally stable particles. The particles' high-surface to volume ratio makes them a promising material for T_1 MRI contrast enhancement with longitudinal relaxivities (r_1) higher than 10mM^{-1} s^{-1}. Such values have never been achieved with scalable and green water-based synthesis. This novel flow chemistry approach described in a Nanoscale publication brings one step closer the utilisation of IONPs as MRI contrast agents, that can be used as a replacement of current Gd complexes. The work is being patented.

Besenhard M. O., Panariello, L., Kiefer, C., LaGrow, A. P., Storozhuk, L., Perton F., Begin, S., Damien Mertz, D., Thanh, N. T. K.* and Gavriilidis, A. (2021)



Small Iron Oxide Nanoparticles as MRI T1 Contrast Agent: Scalable Inexpensive Water-Based Synthesis Using a Flow Reactor. Nanoscale. DOI: 10.1039/D1NR00877C. Gold Open Access. FRONT COVER PAGE

Outreach

Outreach – Going Virtual

ULCO Tours and UCLO Explore game

With physical tours of the UCL Observatory unable to go ahead this academic year, we quickly developed a virtual tour of the site, so that our public engagement and schools outreach work could continue. Selected to share our experiences with others at various events: for the Royal Astronomical Society; how we built and maintained communities at VICEPHEC and Engage conferences. This demonstrates how important our outreach work is to the academic campus and beyond.

UCLO Explore launched – Pay the UCL Observatory a virtual visit!

UCLO Explore is a short educational video game where you can explore the UCL Observatory site to learn about and interact with our five astronomical telescopes.

Launched this year, UCLO Explore gives members of the public the opportunity to visit the UCL Observatory without leaving home. Players can explore a faithful rendition of the Observatory and can interact with all five of the astronomical telescopes, viewing images and videos taken directly through the telescopes themselves.

UCLO Explore runs on the Unity engine, and was developed by Shana Sullivan, one of the technicians based at UCLO. To play the game, visit the public engagement pages of the UCLO website.

An image taken from the UCLO Explore game, showing the virtual Radcliffe telescope.

www.ucl.ac.uk/ucl-observatory/public-outreach/uclo-explore

Online Mentoring in collaboration with The Ogden Trust featuring UCL undergraduates as mentors

UCL undergraduates from the Department of Physics and Astronomy are taking part in an online mentoring program supporting students from widening participation backgrounds make the transition into University life.

HEP Masterclass

Dr Ben Waugh, staff and students from the High Energy Physics group hosted A-level pupils for a virtual masterclass. Completing the challenging tasks allowed the pupils to contribute data and be part of a link up with schools across Europe to share their results at an end of event conference virtually broadcast from CERN.

Quotes from pupils who took part:

“A brilliant insight into the world of physics given by the very best in an accessible manner, thank you so much and I would thoroughly recommend!”

“I really enjoyed it! I thought it was so inspiring and the hands-on sessions were very interesting.”

Headline Research

NeutriKnow Coding

Following success in 2018, 2019 and 2020, fourth-year students, Fern Pannell and Danny Gold, ran virtually adapted third and fourth iterations of their Intro to Computational Physics course in the summers of 2020 and 2021. With funding from UCL Widening Participation, they've been able to further develop the course, adding a session based around Medical Physics (Proton Beam Therapy). Around 110+ students have taken the course to date, and Danny & Fern are looking forward to welcoming more students to their course in the future!

Fern Pannell and Danny Gold organised their virtual NeutriKnow Coding Intro to Computational Physics course for the summer of 2020/21.

Mark Fuller
Outreach Co-ordinator and
Ogden Science Officer

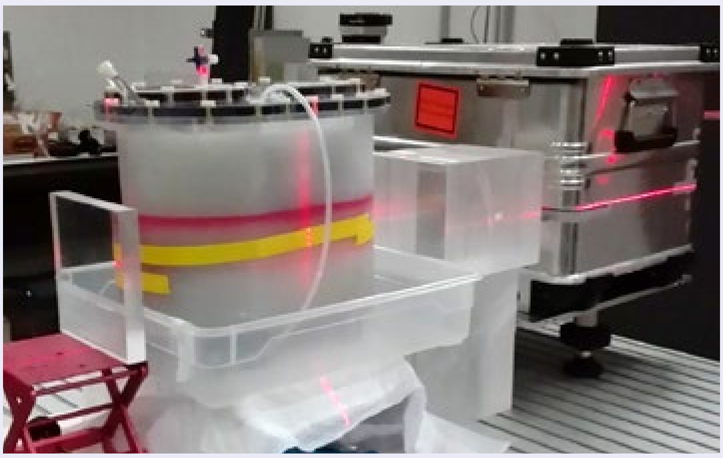
Mixed Ion Beam Radiotherapy

While ion beam radiotherapy — primarily with carbon ions — offers greater precision and dose localisation than conventional X-ray radiotherapy and the more advanced proton beam therapy, such dose localisation means the accuracy of dose delivery must be correspondingly much better than for other forms of radiotherapy.

A technique has been explored by a team led by Joao Seco at DKFZ in Heidelberg and Simon Jolly at UCL that proposes the use of mixed Helium-Carbon beams for in-vivo dose verification. This work was shortlisted for the Physics World Breakthrough of the Year Award in 2020. In this technique, a patient's tumour is treated with Carbon ions. Simultaneously, smaller quantities of lighter Helium ions are delivered: due to their smaller mass, they pass straight through the patient and can be detected with a residual range detector. These Helium ions are highly sensitive to tissue inhomogeneities within the patient and provide a method of in-vivo range verification.

Due to the virtually identical charge-to-mass ratio of fully stripped Helium and Carbon ions, both species can be accelerated and delivered to the patient simultaneously. However, present accelerator technology is limited to accelerating each ion separately, so the experiments carried out by the UCL-DKFZ team at the Heidelberg Ion-Beam Therapy Centre (HIT) irradiated test phantoms sequentially with helium- and carbon-ion beams of similar energy-per-nucleon, using a 10:1 carbon-to-helium ratio. The residual range of the helium beam and the carbon ion fragments were measured with a novel plastic scintillator-based range telescope developed at UCL. These measurements showed that changes in the Helium range could be observed with air volumes as small as 2mm.

The findings reveal the potential of using a mixed helium/carbon beam to monitor intra-fractional anatomy changes. The ability to detect range modulation from a narrow air gap affecting less than a quarter of the beam demonstrates the method's relative sensitivity. And for the more realistic cases, measurements showed the mixed beam could help detect bowel gas movements and small patient rotations.



A pelvis phantom being used to test the feasibility of dual ion beam radiotherapy.

Your Universe, the UCL festival of Astronomy and Particle Physics

Your Universe 2021 was the 16th edition of this festival. This time we faced, as everyone else, a major challenge moving all our events on-line, using the UCL-ZOOM platform. The festival ran from June 21st to July 2nd.

The general format was the usual one: pre-booked school groups on weekdays and a panel discussion for the general public on the last evening of the festival.

Once again, I had a very efficient team. Mark Fuller, was in charge of logistics and scheduling school groups, allocating the corresponding lecturer/demonstrators, while Chiara Circosta, was in charge of recruiting demonstrators within the astrophysics group. Both produced an impressive programme of more than 10 sessions on a variety of topics. As usual, our enthusiastic diploma/certificate alumni also contributed well prepared and imaginative presentations (see pictures). There were large school groups to record numbers over 600 pupils.

The festival concluded with the traditional Panel Discussion on 2nd July 2021.

I decided on a very topical and attractive theme and was lucky to put together a superb and diverse panel.

Theme: **To The Moon and Mars in the 21s Century.**

International panelists:

Prof Ian Crawford, UCL, Birkbeck,
'Why we should build a Moon Base'

Prof Andrew Coates, UCL-MSSL
'Europe goes to Mars'

Dr Jacqueline Campbell, UCL-MSSL
'Water on Marss and the Moon'

Prof Pascal Lee, SETI, NASA-Ames, California
'Human Exploration of the Moon and Mars'

Hosts/moderators:

Francisco Diego, **Aysha Aamer**, UCL
Tim Parsons, UCL/certificate alumnus
and PhD Candidate

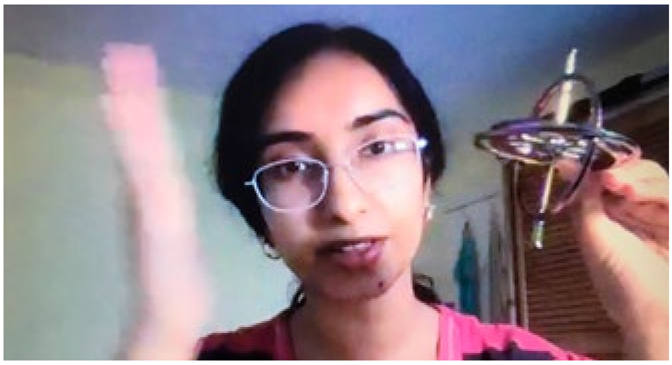
School moderator:

Shirin Sheikh-Bahai, Harris Federation,
IoE PhD candidate.

I found it very helpful to bring the panelists and moderators together in a networking call the day before, so they could meet each other and exchange ideas. This resulted in a very dynamic and friendly (one hour long!) discussion with the audience after their presentations.

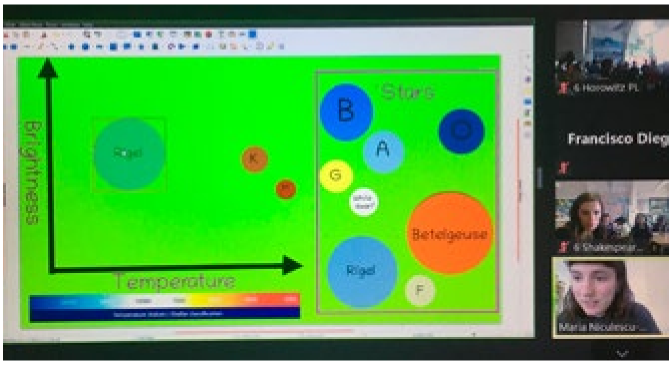
James Salmon, certificate alumnus, produced a scale model of the solar system where the sun was a grapefruit. The scale planets were located to scale along his street.

Chiara Circosta produced an excellent presentation about galaxy formation.

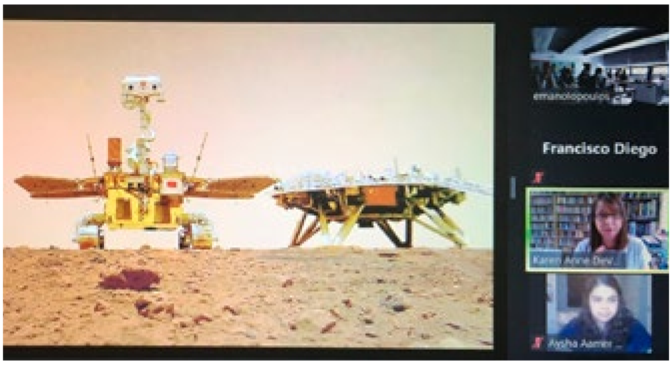


Vinooja Thurairethinam explained how the HST is pointed to the sky using a working gyroscope.

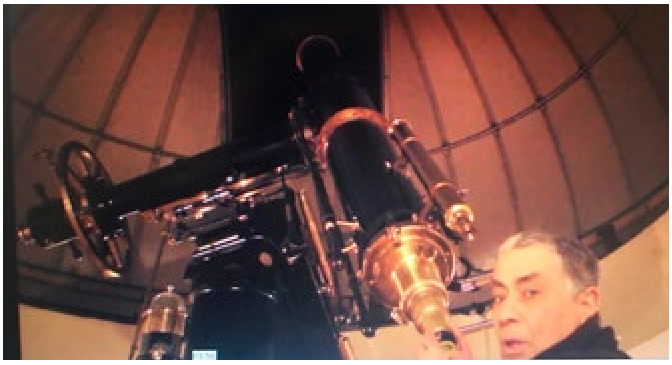
Phil Halper, certificate alumnus, describes his experiences as an aurora chaser.



Maria Niculescu-Duvaz uses her interactive HR diagram following instructions from pupils to place stars in their right places.



Karen Devoil, certificate alumna, describes her presentation on Mars exploration by recent rovers. In this case the chinese Tianwen-1 mission.



Francisco Diego explains in a video the use of the Fry telescope at the UCL observatory to look at the moon.

South region of the Moon. Frame taken from the video recorded with the UCLO Fry Telescope.

The international audience (including Mexico obviously!) was over 130.

Some selected (literal) transcriptions of the eleven year olds' questions (over their microphones), skilfully moderated by Shirin:

Hazel… 'you hear me? thank you for letting me ask my question. My question is: can scientists make a type of robot where they can pick up a piece of ice from a crater and put it into a cool box in which they can experiment on it back on earth?'

Samuel… 'hello? Thank you for letting me speak. I have a couple of questions.'

The first one would be, can the historical records – this is for Ian Crawford by the way – can the historical records preserved by the Moon have medical or environmental impacts good or bad?'

Ozan… 'so, thank you for giving me this opportunity, so my question is: you said you found water on the Moon but where does it come from?'

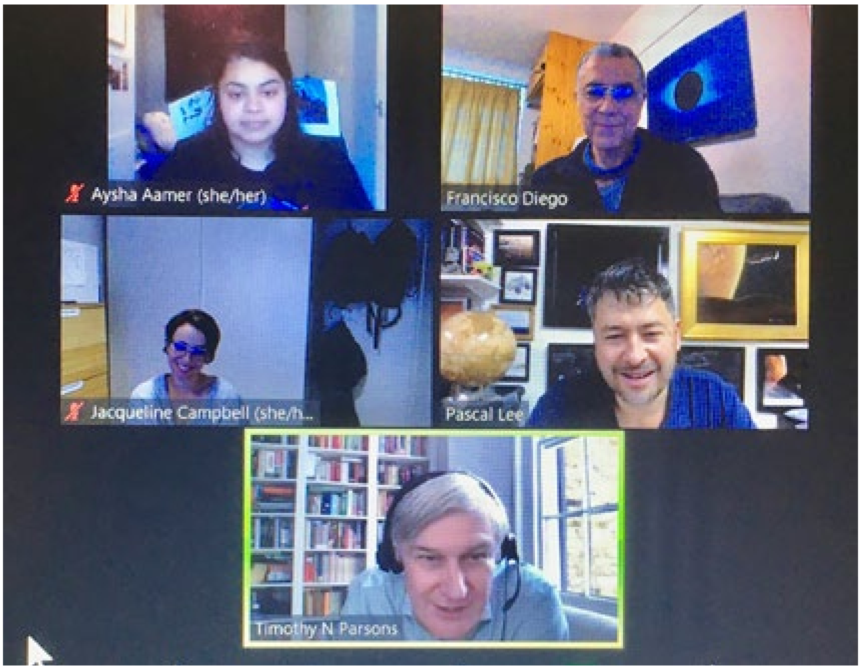
Steven… 'Is there oil on Mars?, because if there is oil, that means there is life there.'

A question from **Isabel** (from Mexico City) (translated from Spanish)…'In which way our planet will benefit from the information from planet Mars?'

Isabel's question triggered a philosophical discussion between our panelists, about the cosmic relevance of our planet and the eventual understanding of the origin and development of life here and elsewhere. Ian Crawford described how a planetary perspective should be applied to treat the Moon and Mars as borderless bodies, something that should also be applied here on Earth (topic for further events!).

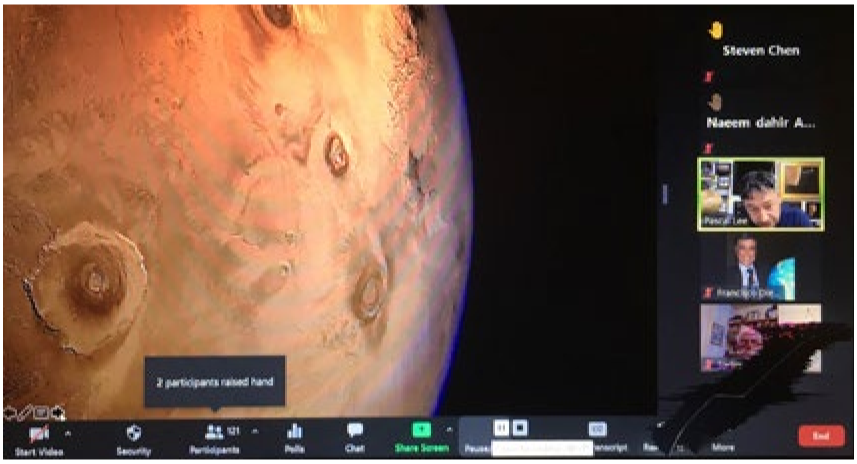
Panelist comment:

The Your Universe 2021 'To the Moon and Mars' Panel Discussion was a real pleasure to take part in. The speakers covered a wide range of scientific and philosophical topics regarding solar system exploration. The audience contributions were really valuable, particularly those from the younger participants. I always love to hear from the next generation of potential scientists, and their insightful and imaginative questions really got the panel talking and thinking about the challenges and ethics around sending humans to the Moon and Mars (Dr Jacqueline Campbell).



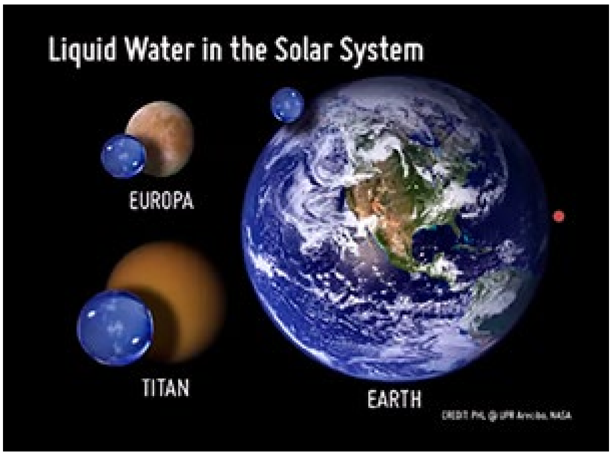
Preliminary networking meeting of members of the panel with the hosts and moderators. This meeting had a positive effect in the discussion with the audience.

Drawing of the lunar surface based on the Moon video recorded with the Fry telescope at the UCLO.
Credit: Victoria, age 11 years.



Panelist Prof Pascal Lee (SETI, NASA-Ames) explains the relevance of Mars volacanism towards the end of his presentation.

Prof Coates started his presentation by showing the evolution of the martian environment, prompting questions about what were the causes of such drastic transformation and the planetary lessons to be learned.



This image concludes Dr Campbell's presentation and illustrates to relative scale the volume of water found in several bodies of the Solar System.

A Moon base will be essential to explore the Lunar surface and establish unique scientific experiments, according to Prof Crawford.

I would really encourage you to watch the video recording: **www.youtube.com/watch?v=VSdmpbXAE0I**

Details of all these events can be found on the festival website: **www.ucl.ac.uk/your-universe**

Your Universe 2022 is planned for next March, back to the cloisters and lecture theatres, if conditions allow!

Francisco Diego,
Founder and director
of Your Universe Festival

Headline Research

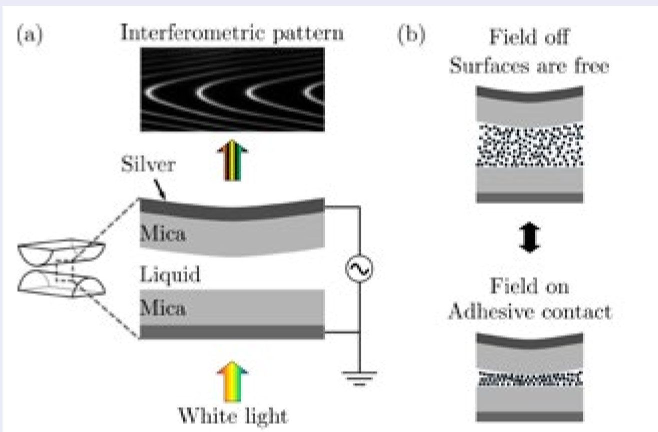
Electric Field Control of Adhesion

The switching on or off of a device will often involve adhesion – the sticking together of two surfaces. The CMMP's Dr. Carla Perez Martinez, along with collaborators from Oxford University, have published a paper in *Journal of Physics: Condensed Matter* that describes how to use electric fields to control the adhesion of two surfaces separated by a liquid. Their method controls of the number of molecule layers separating the surfaces, which has potential impact in the controlled release of particles and electro-actuation at the nanoscale.

The experiments were performed in a setup known as a Surface Force Balance, shown in figure. Two crossed cylinders are placed on top of one another, so as to create a point contact between them. Each cylinder is covered with mica, which has been back silvered. Some liquid is introduced in between the two mica surfaces. The thin silver surfaces work as electrodes with which electric fields may be applied, and they also function as mirrors for interferometry. When white light is shone in the setup, an interferometric pattern is created, which can be used to measure, with sub-molecular resolution, the separation between the surfaces.

A very special type of liquid is then introduced between the surfaces – an ionic liquid, which is composed solely of charged molecules. When squeezed in between the mica surfaces to separations of about 10 molecules or less, the ionic liquid molecules arrange themselves neatly into layers. With just a few liquid layers in between them, the mica surfaces are effectively adhered to one another, with the adhesive force between them determined by the number of molecular layers between them. The electric field can be used to bring the mica surfaces together: by controlling the strength of the electric field, the number of layers separating the surfaces, and hence the adhesive force between the surfaces can be controlled. When the electric field is reversed, the surfaces are brought apart, as shown in figure (b) below. This new method of actuation is useful since it requires no moving parts and can be used to control surface interactions delicately and reversibly.

Carla S. Perez-Martinez , Timothy S. Groves & Susan Perkin. Controlling adhesion using AC electric fields across fluid films, J. Phys.: Condens. Matter 33 31LT02 (2021).



How to control adhesion by applied electric field

The Centre for Doctoral Training in Data Intensive Science

UCL's Centre for Doctoral Training in Data Intensive Science (CDT DIS) welcomed its 4th cohort in September 2020, bringing the overall number of students in the Centre up to 45. A further cohort will start in September 2021, who will work with their peers on subjects across High Energy Physics and Astronomy. The CDT is particularly excited at the prospect of graduating its first students, as many of the initial cohort of students who joined in 2017 come to the end of their studies.

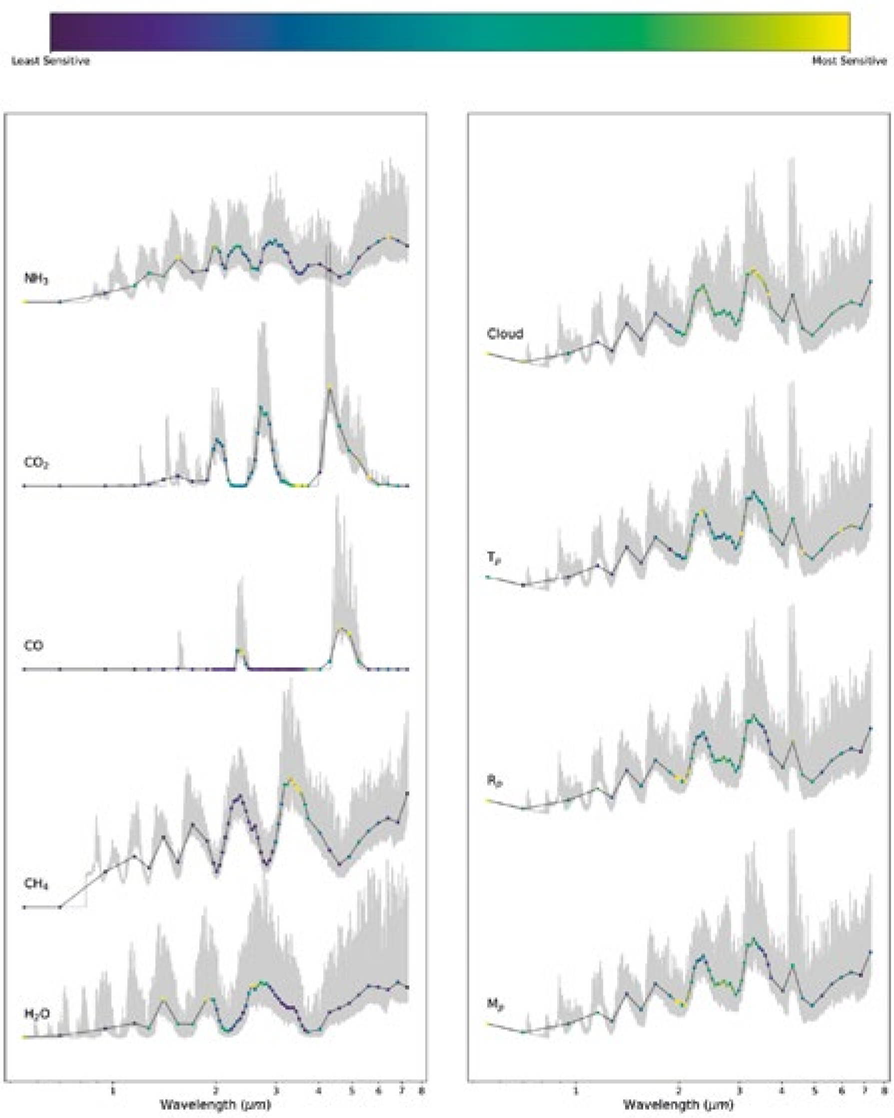
The CDT has formed close links with the interdisciplinary MSc programme in Scientific and Data Intensive Computing over the last year. This programme, which has attracted 85 students for its most current cohort, has helped develop a community of scholarship around shared interests in data science and machine learning. This partnership has built on experiences enabled by a Newton Fund grant to build capacity in data science in Jordan, for which the CDT DIS has provided a model for expert training.

The Centre has also continued to run its successful Seminar series, which has used the new opportunities of an online-based research environment to broaden the range of invited speakers. Aside from university-based experts, this programme has seen successful invited talks from experts employed within industry. This series has also been developed alongside a careers-based seminar series, which has given research students across Physics and Astronomy the opportunity to consider their future career paths in more detail.

The CDT DIS' successful Industry Group Projects, which give our first years the opportunity to apply their data science and machine learning skills in non-academic environments, has also been expanded to students on the MSc in Scientific and Data Intensive Computing for the first time, giving them a unique insight into how they can apply the skills they have been learning.

These projects have also been opened to Jordanian MSc students working with the CDT through the Newton Fund project.

Perhaps most significantly, staff from the CDT have been involved in a successful bid to expand research activities in data intensive science. The new Centre for Data Intensive Science and Industry will open in late 2021, providing a unique space which will bring together a wide range of researchers in the field. The CDT team are delighted to have the Centre's contributions recognised in this way and look forward to working closer with the MSc in Data Intensive Computing team and researchers across Physics and Astronomy in making it a success.



Sensitivity maps produced by a trained neural network for different input atmospheric features.

Left: The sensitivity maps for gaseous parameters, superimposed by their respective contribution function. Right: Sensitivity Maps for physical planetary parameters.

This plot shows that the model learns to recognise key molecular features as important features for its predictions, and that the model picks up degeneracies among physical parameters.

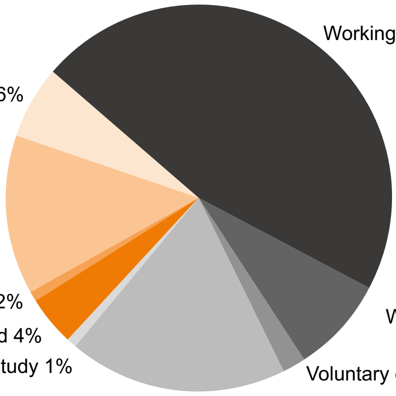
Career Profile

Graduate Destinations

Total number of graduates: 240

Response rate: 59%

Average salary:
UG £40,111 (employment)
PGT £29,911 (employment)



The data is for the 2018/19 graduating cohort, for all students.

.

Life has a better imagination… Stan Zochowski

This journey started as I did my undergraduate degree in physics at McMaster University, Hamilton, Canada, where I had summer jobs with the neutron scattering group – the bug bit. From there I went down the road as a Massey College Fellow to the University of Toronto. At Toronto I received my M.Sc. (Ultrasonic study of CrMn) and my Ph.D. (Magnetic Phase Diagrams of Nd and NdPr) as a student of Professor Eric Fawcett.

From the University of Toronto, I moved to Birkbeck College, London, where I held postdoctoral positions in the physics and chemistry departments. This was to be for a year, but thirty-odd years later I'm still here! I was appointed to a lectureship in physics at Birkbeck.

When the physics department closed, I came to the Condensed Matter and Material Physics group at UCL in 1997.

I started out looking at the magnetic phase diagrams of 4f-electron systems. Because of the spatial extent of the 4f distributions and their sensitivity to magnetic fields it was very efficient to map out their magnetic phase diagrams by measuring their length changes in changing conditions. To do this I built an automated dilatometric system that could measure very, very small length changes (comparable to measuring a hair at the top of Senate House). We also developed a lab to grow our own single crystals. Successful measurements were made across the rare-earths and some 5-f U systems.

When they closed the Physics Department at Birkbeck, there was a magnetic sputtering machine without a home. We found a home for it at Oxford where a group of us from various institutions used it to study uranium multilayers (unique because no one wanted to contaminate their equipment with uranium while that's exactly what we wanted to do). At the time we were the only ones doing this work. We mainly used x-ray, neutron, magnetisation and transport techniques. Unfortunately, this work eventually "sputtered" out.

My passion for the education and care of students began as a postgraduate, which led to my being appointed as Dean of Men at Victoria University in the University of Toronto. This interest in teaching and learning has continued unabated since. I have been a member of a number of College project boards and academic committees. At UCL I have had 20 years as departmental timetable (including the setting-up of the Nat Sci timetable). I spent ten years as Programme Tutor, six as Admissions Tutor (one as both, not recommended). I am now the Postgraduate (Research) Tutor. I have also taught at the Open University and NYU in London.

I have always tried different things in teaching, such as enhanced and asynchronous blended learning – long before we needed to use these techniques in response to the COVID-19 crisis. My teaching and tutoring have always been passable. Indeed, my tutorial notes for a Quantum Mechanics course were rated in the top ten by "Quantum Mechanics for Dummies" – hmmm?

And so here I am, a long-suffering Arsenal fan – now Prof Stan.

Observatory News

Student research at the UCL Observatory

The UCL Observatory has provided since 1929 both training and research resources for undergraduate students in the physics and astronomy department. Continuously updating and modernizing its facilities through the decades, the Observatory provides a range of on-site and remote access to both classical and modern telescopes as well as its own dedicated computing facilities which allow operation of on-site telescopes as well as submission to a robotic telescope network in both hemispheres.

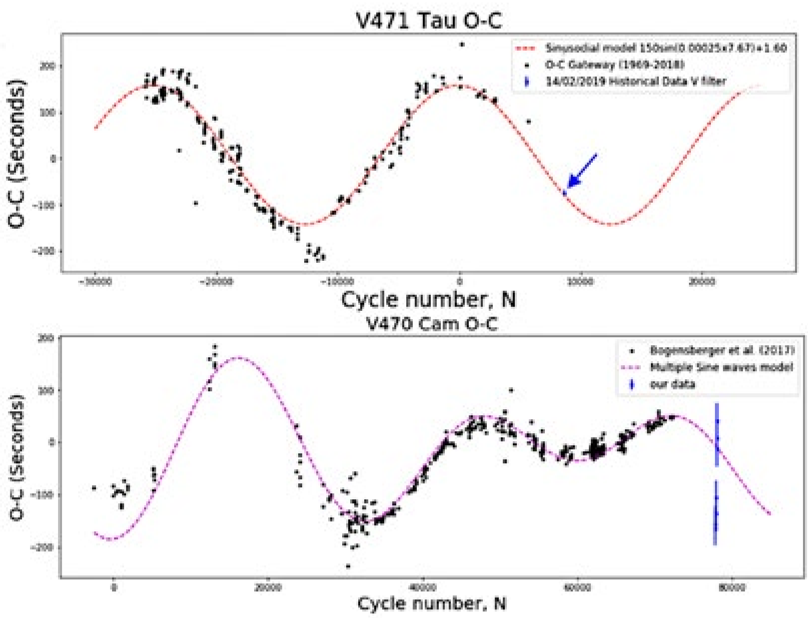
At the UCL Observatory we reconcile the training in experimental techniques with hands-off remote operation and complement both with all the data science skills which current astronomers and astrophysicists make use of.

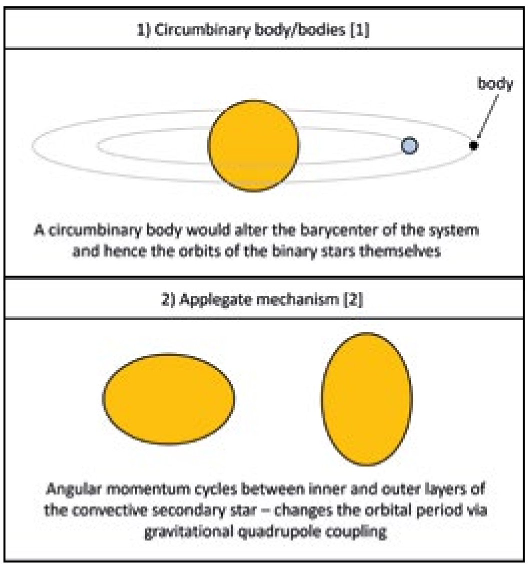
Research in solar system objects, exoplanets, variable stars and galaxies

In the years spent at the UCL Observatory, students experience a range of research topics which are integrated in all our modules. These include, planet observations, asteroid monitoring, exoplanet transit ephemeris (observations and refinement of), variable star measurements as well as photometric observations of other galaxies and galaxy clusters. At the end of the 3rd year, groups of students join efforts with academic mentors of the astrophysics group to tackle ongoing research questions through direct observations and archive data. Here below are two examples of topics from this year’s 3rd year group projects.

Eclipse timing variations in post common envelope binaries

Students used observatory data to extend the baseline of eclipse timing variations known to occur in evolved (post-main sequence) binaries. These newly gathered observations were combined with published, historical records to distinguish potential causes such as a third body (e.g. a planet), or changes in angular momentum caused by dynamic magnetic activity (Applegate mechanism).





Project students:
Hamza Afzal, Roman Aubry, Jaya Chand, Zac Hale.

Project supervisor:
Prof. Jay Farihi

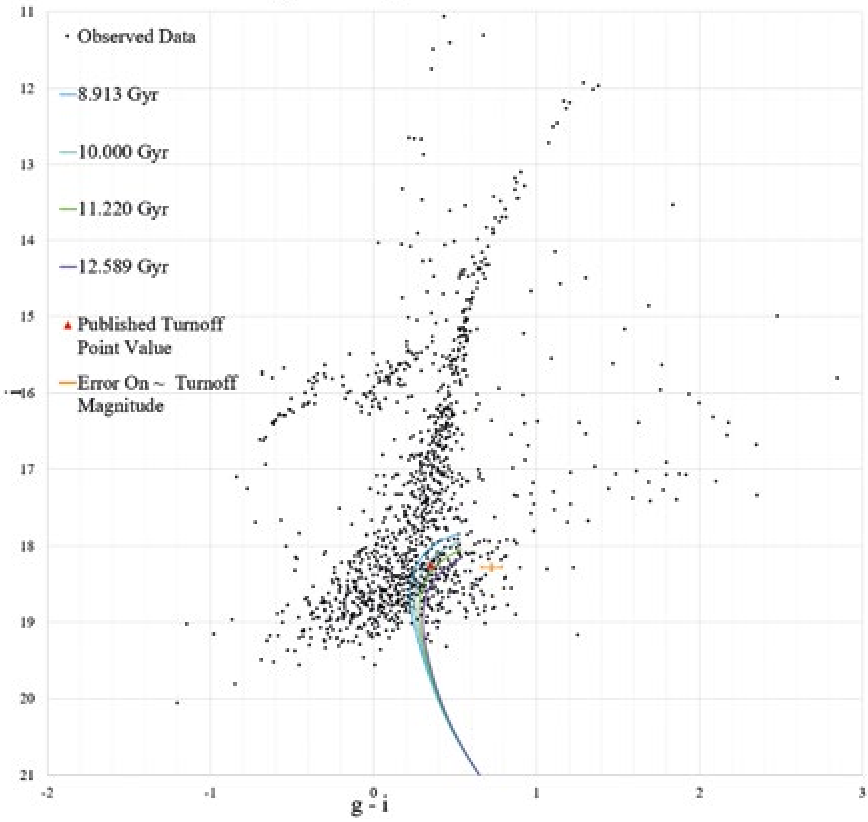
Using globular clusters (GC) to determine the age of the universe

Students used UCLO and Telescope Live images of globular clusters (GCs) to measure the brightness and colours of their stars to provide a lower limit to the age of the universe.

GCs lie in the peripheral regions of galaxies and analyses of their stellar populations strongly suggests they formed in a single event a long time ago.

By locating the turn-off point on the so-called 'main sequence' of the stellar population where the hydrogen in their stellar cores is exhausted.

NGC 5272 colour-magnitude diagram with theoretical isochrones



So-called HR diagram of stars in NGC52. The model isochrones are coloured and indicate an age of 10–12 billion years whi must be a lower limit to that of the univer.

ESO (European Southern Observatory) image of the NGC 5139 Omega Centauri cluster. The students acquired many similar images to perform photometry on a crowded field of stars which in the central parts of the cluster represented a major challenge.

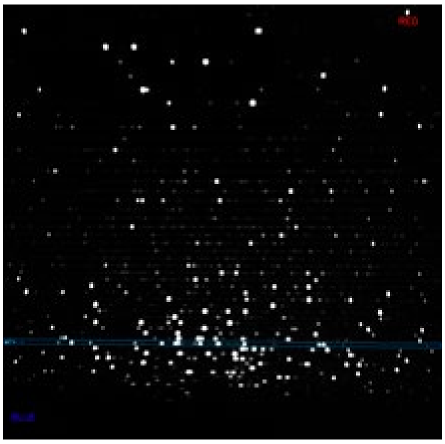
Image: www.eso.org/public/images/eso0844a/
Credit: ESO

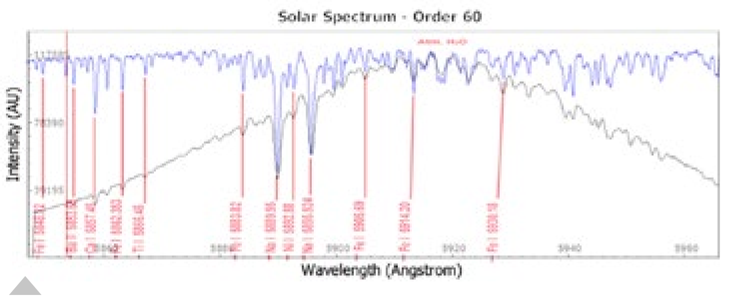
Project students:
Shreya Desai, Hashem Polad, Nikita Reid, Qingyang Wang
Project supervisor:
Prof. Richard Ellis

The new upcoming facilities

A stitched set of 2 millisecond frames of the new CMOS camera on the Perren telescope

A new echelle high-resolution spectrograph has been acquired by the Observatory and in the next year will be fully characterized and installed on the 80cm Perren telescope. Preliminary tests have been conducted in the lab with Ar-Th calibration lamps showing the expected high resolving power (~2×10^4). Students will be able to use the spectrometer to perform spectra of stellar objects and other astronomical bodies.



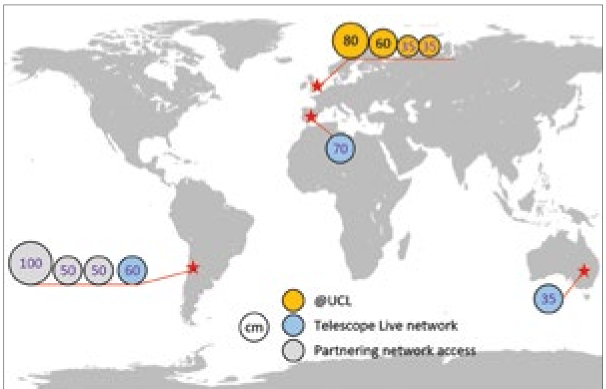


Flechaas++ measurement of the solar spectrum (black) and reference solar spectrum (blue). Source: www.astrophoto.at/sol-2014-10-31.html

A new fast CMOS camera (Andor-Marana) has been acquired (after a period of testing on-loan). This new imaging facility allows for rapid imaging with negligible readout time of the image frames. This will allow students to acquire rapid sequence images of targets which show fast transients as well as improve on the overall photometry signals as all time can be spent on integrating the light of the target rather than reading out the frames.

As part of a few tests performed with the device (on loan), a raster-scan of a section of the moon was taken (at 2 millisecond exposures) shown above.

This will be used to observe fast asteroid occultations, improve on the exoplanet transit timing and other fast astronomical transient events.



'Size' map of all telescopes accessible by UCLO students

The Observatory throughout the pandemic

With the lockdowns taking place, physical presence at the Observatory has been intermittent for students and in all cases with COVID-safe measures in place. At the same time, technical and observing staff have been working both remotely, generating online content for students and the general public, but also on site, preparing for the new exciting upgrades which will take place in the Summer of 2021. No reduction in teaching and research activities have occurred thanks to the robotic operation of our telescopes and our partnership with Telescope Live.

By Giorgio Savini, Director of UCLO

Centre for Space Exochemistry Data (CSED)

The Centre for Space Exochemistry Data (**www.ucl.ac.uk/space-exochemistry-data**) grew out of the Physics and Astronomy Department at UCL in November 2018, with key contributors from other departments in the Faculty of Mathematical and Physical Sciences (Computer Science, MSSL). Now in its third year, the centre is based in the Harwell Science Campus (Figure 1) and aims to bridge the gap between astrophysics, space engineering, computer science, machine learning and industry.

The centre is based within the Harwell Space Cluster, a strategic location that facilitates intersections with public organisations, and leading private companies from the space and digital sectors and start-ups. "Within walking distance to the European Space Agency (ESA), the STFC's RAL-Space, and the Satellite Applications Catapult, CSED has become an integrated part of this dynamic and collaborative environment", explains Emma Dunford, CSED Manager. "Of course, the Covid-19 pandemic has upended our modus operandi but we are pleased to say that operations have continued, and the centre has continued to grow".

Prof. Jonathan Tennyson, chair of CSED board and Head of ExoMol program said: "We have published over 250 papers in high-impact journals since the start, including the article with the highest altimetric score among physical sciences in 2019. The centre is involved in many activities, from providing a database of molecular laboratory spectra through sophisticated atmospheric radiative transport to machine learning-based techniques to analyse exoplanetary data to leading multinational space missions dedicated to the observations of planets in the galaxy". Three successful start-ups (QuanteMol, Blue Skies Space Ltd, SpaceFlux Ltd) have been created for the commercial exploitation of some of the activities supported by the centre.

In November 2020, the ESA Ariel Space Mission was formally adopted with a scheduled launch in 2029 (Figure 2). "Ariel will be the first dedicated space telescope to measure the chemical composition of ~1000 planets in the Milky Way" says Prof. Giovanna Tinetti, CSED Director and Ariel Principal Investigator. "Planets will be studied both as individual objects and as members of a population.

Figure 1
Aerial view of the Harwell Science and Innovation Campus, in Oxfordshire.
© UKRI_STFC

Proper exploitation of the new data will require swift turn-around times and big-data infrastructures, as the tools developed at CSED". Today the Ariel consortium include the contribution of 500 scientists and engineers, from 16 ESA countries, NASA and JAXA. "Work has now begun to prepare hardware manufacture: the payload for Ariel will be amongst the first to be assembled and tested at the STFC RAL Space National Satellite Test Facility, also in the Harwell Campus, in the second half of the decade", explains Paul Eccleston, Ariel Project Manager and CSED board member.

CSED members are also actively working at the construction of BSSL-Twinkle satellite and NASA-National Science Foundation EXCITE balloon experiment, both expected in 2024.

The centre is hosting many AI related activities, coordinated by Dr. Ingo Waldmann, CSED Deputy Director and PI of ExoAI program. "We have a very strong connection with ESA and Catapult, having collaborated on projects ranging from rogue ship detection with industry to classifying all of ESA's giant archive and understanding the geological histories of Mars and Venus in collaboration with the Natural History Museum. The Ariel Data Challenges 2019 and 2021, that we organised in collaboration with UK Space Agency and the European Conference on Machine Learning (ECML-PKDD), have been a global success, with 100+ teams from academia and industry competing for the first prize".

Dr. Ahmed Al-Refaie, Head of Numerical Methods at CSED said, “as part of our ongoing commitment to open science, CSED has launched an initiative to publish its research software open source. Large software frameworks such as the TauREx3 exoplanet modelling suite are already publicly available to the community: we had ~5,500 downloads of TauRex already, an average of 200+ downloads/month! We are also in the process of curating a directory of open-source software on the CSED website”.

CSED, in collaboration with DiRAC, will have access to 360 Nvidia A100 GPUs with 450 PFLOPs of computational power in August. “Combining this power with our cutting-edge Alfnoor code, we aim to simulate trillions of exoplanets in the most extensive population study in the field”, explained Dr. Al-Refaie (Figure 3). “The ExoMol database contains extensive line lists for 80 molecules, 190 isotopologues. Most of its trillion transitions have been produced using DiRAC resources”, added Prof. Sergey Yurchenko, Head of Spectroscopy at CSED.

Many CSED members are also very active in promoting educational and citizen-science activities. Dr. Angelos Tsiaras and Anastasia Kokori have created the very successful ExoClock project in collaboration with professional and amateur astronomers. “Currently, the ExoClock network includes 280 international participants”, says Anastasia “and it is still growing!”. ExoClock has collaborated with the UCL ORBYTS programme on a few occasions, with high-school students helping to analyse the data provided by ExoClock telescopes.

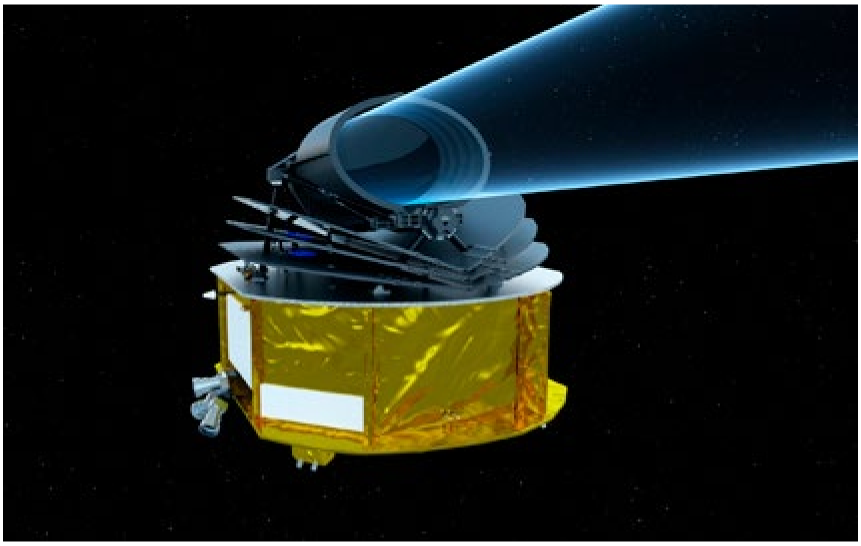


Figure 2
Artist’s impression of Ariel.
Credit: ESA/STFC RAL Space/UCL/UK Space Agency/ ATG Medialab

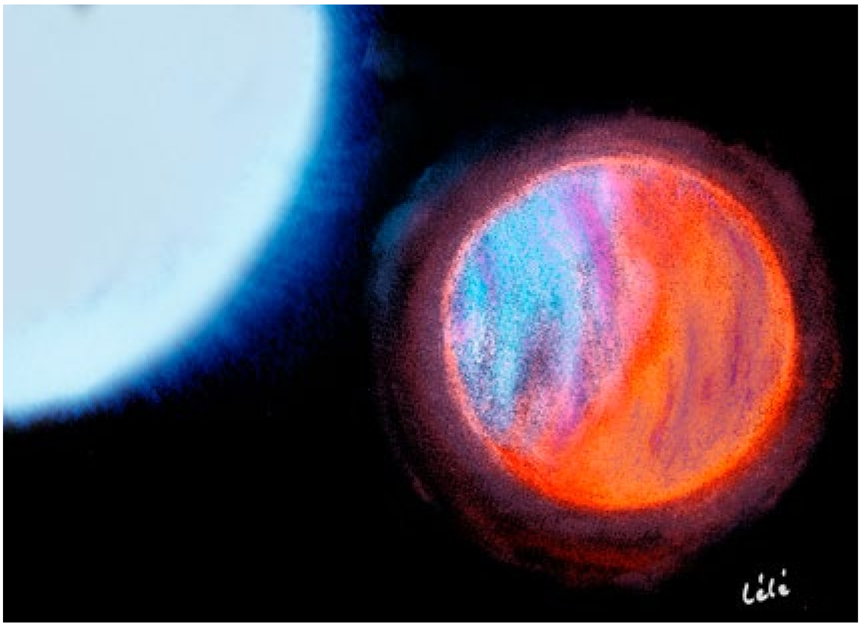


Figure 3
Artist impression of an exoplanet by CSED Artist in Residence Léa Changeat.

Headline Research

Exploring Giant Magnetospheres: Jupiter and Saturn

The giant planet Jupiter has now been visited by several robotic space missions – the latest being NASA's Juno, orbiting Jupiter at present. The planetary plasmas group at UCL Physics and Astronomy have developed expertise, over the past decade, in building mathematical models of the magnetic fields surrounding rapidly rotating planets, such as Jupiter and Saturn. The space environments of these planets, known as magnetospheres, extend over many millions of kilometres from their parent planet. The magnetic fields observed by spacecraft in these regions consist of the internal field – produced by currents flowing deep within the parent planet – and an external field due to a vast disk of plasma, or 'plasma sheet', which is a central feature of Jupiter's and Saturn's magnetosphere. Our UCL magnetodisc model of these regions was co-developed by Professors Nicholas Achilleos and Patrick Guio (now at University of Tromso, Norway) in collaboration with Dr. Chris Arridge (now at University of Lancaster).

At Jupiter, the principal source of plasma from the plasmasheet is sulphur/oxygen compounds emitted by the volcanoes on the surface of Jupiter's moon, Io. These molecules become ionized, forming a plasma. Io adds of the order 500 kg/s of plasma to the Jovian magnetosphere and this material has to go somewhere – it cannot build up indefinitely at Io's orbit. The plasma diffuses radially outward forming the vast plasma sheet. At distances further than a few planetary radii, centrifugal force on the plasma dwarfs gravity.

All of these properties of the Jovian system have consequences for how the size of its magnetosphere responds to changes in the physical conditions of the solar wind upstream from the magnetospheric boundary – known as the magnetopause. In Figure 1 we show theoretical predictions from our Jovian magnetodisc model regarding

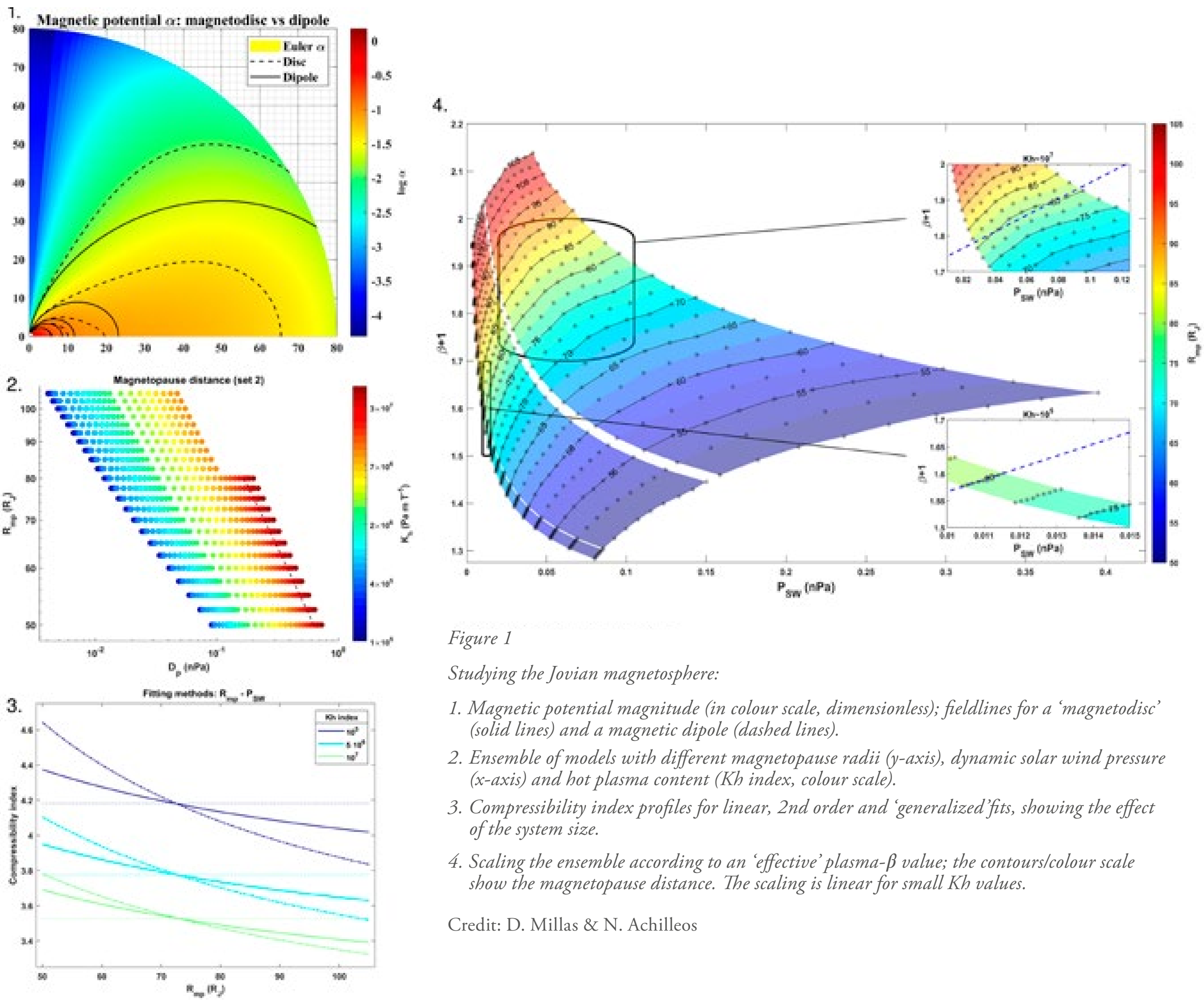


Figure 1

Studying the Jovian magnetosphere:

1. *Magnetic potential magnitude (in colour scale, dimensionless); fieldlines for a 'magnetodisc' (solid lines) and a magnetic dipole (dashed lines).*
2. *Ensemble of models with different magnetopause radii (y-axis), dynamic solar wind pressure (x-axis) and hot plasma content (Kh index, colour scale).*
3. *Compressibility index profiles for linear, 2nd order and 'generalized' fits, showing the effect of the system size.*
4. *Scaling the ensemble according to an 'effective' plasma-β value; the contours/colour scale show the magnetopause distance. The scaling is linear for small Kh values.*

Credit: D. Millas & N. Achilleos

the distance from Jupiter to its subsolar magnetopause (known as the standoff distance). The Figure shows how this distance changes according to two important parameters: (i) The dynamic pressure of the upstream solar wind – a denser, faster solar wind squeezes Jupiter's magnetopause to smaller size; and (ii) The level of inflatory pressure exerted from inside the magnetopause by the energetic particles in the magnetosphere. We have successfully compared our model predictions for Saturn to the observed spatial distribution of magnetopause locations from the Cassini spacecraft (Figures 2 and 3, Flavien Hardy), and are now conducting a parallel study for the Jovian system, led by Dimitrios Millas.

Dr. William Dunn provides us with cross-departmental expertise (MSSL/P&A) on the auroral emissions of giant planets, particularly in the X-ray and UV wavebands. These spectacular displays of light are a diagnostic of the physics underpinning the coupling between planetary atmospheres and magnetospheres.

Regarding Saturn's magnetosphere, we have been conducting studies, led by Matthew Cheng (graduate student of the CDT), which have focussed on developing data analysis techniques for automating the detection of features in spacecraft magnetic data. Figure 4 shows an example of one type of feature of interest – the observed 'dips' or sharp decreases in magnetic field strength observed by Cassini just outside Saturn's magnetopause. These are signs of collapsing 'magnetic bottles' containing trapped charged particles, known as mirror mode structures. Because there are so many of them, pattern recognition techniques would

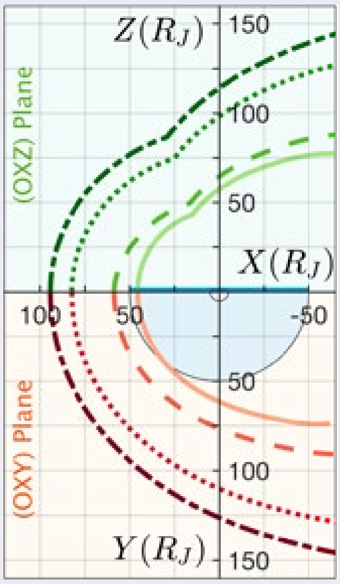


Figure 2
Pressure-balance solutions for Jupiter's magnetopause along the noon-midnight (upper panel) and equatorial (lower panel) planes for different interior contributions: a vacuum dipole field (solid curves), an additional current disk field (dashed) and the added effect of interior plasma (dotted).
Credit: F. Hardy, N. Achilleos, P. Guio

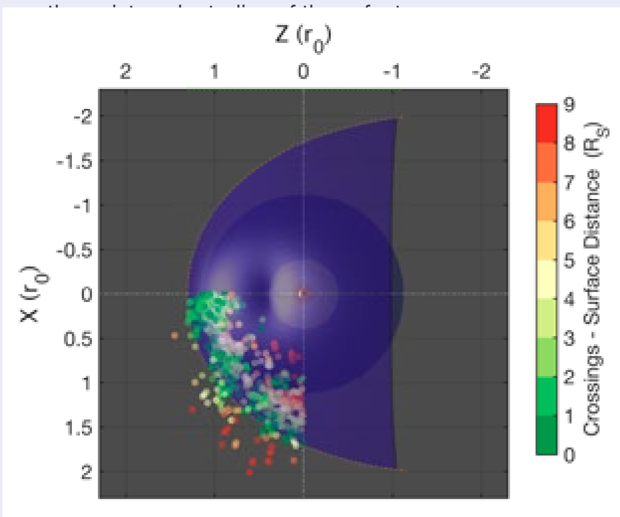


Figure 3
Equatorial view of a pressure-balance solution for Saturn's magnetopause (in blue), along with scaled boundary crossings of the Cassini spacecraft.
Credit: F. Hardy, N. Achilleos, G. Patrick

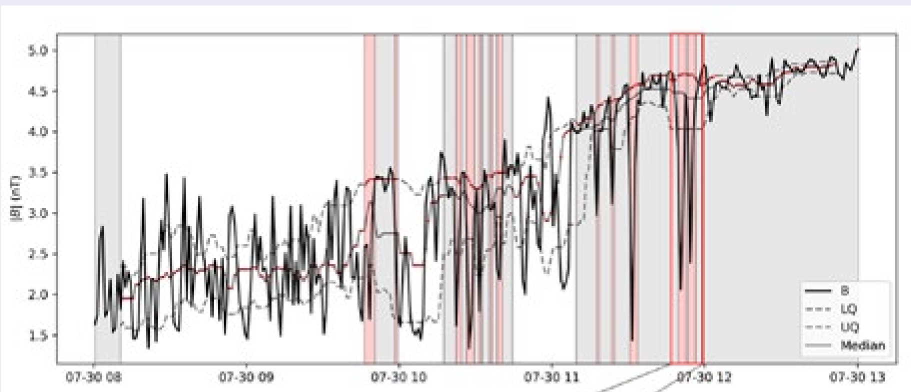
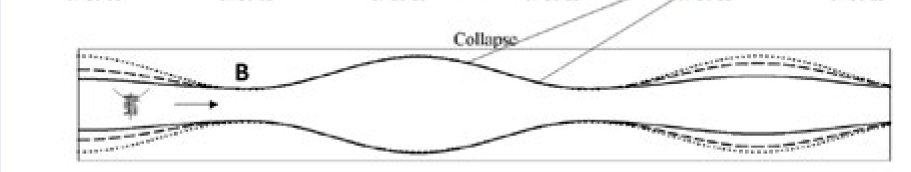


Figure 4
Magnetic field data measured by Cassini between 2005-07-30 08:00:00 and 2005-07-30 13:00:00, showing mirror mode structures in Saturn's magnetosheath. Plasma near the magnetopause (MP) and on the flanks typically have lower plasma β. This is less favourable for the mirror instability; $\frac{T_\perp}{T_\parallel} > 1 + \frac{1}{\beta_\perp}$ which prefers high β and anistropic plasma. On approach to the MP (right), we observe relatively uniform field with significant dips. As individual magnetic bottles collapse, the bottles that have not yet collapsed are observed as dips in the magnetic field. Red shaded areas correspond to 'dips'.



A schematic showing the relaxation of mirror mode structures. The dotted, dashed and solid lines depict the time evolution of the collapsee of such magnetic 'bubbles'. The field progressively becomes more uniform in space with individual bubbles decaying stochastically. Adapted from Joy *et al* 2006

Teaching

Teaching Report

This academic year has been a wild ride for the teaching-focused academics in the department. This was the first time that students had met these members of staff under their new titles. The old ‘Teaching Fellow’ system has now been replaced with one that aligns itself more with traditional academic staff with the new titles of; Associate Lecturer (Teaching), Lecturer (Teaching), Associate Professor (Teaching) and Professor (Teaching). In addition, the teaching academics are now or will soon be in significant teaching administrative roles within the Department. This includes the two Programme Tutors, the Teaching Laboratory Director, and the Director of Teaching. In addition, the current number of teaching academics within the Department now stands at ten.

Covid 19 was a significant challenge for student focused staff. Major work was undertaken during the 2020 summer period to get to grips with the issues it caused. This ranged from module to College level. The level of effort was astounding and had to take place in an environment that could change daily as we identified what needed to be done. This was particularly the case in the Teaching Laboratory context as face-to-face contact was either extremely restricted or effectively impossible due to student numbers, laboratory space and social distancing.

However, with those undertaking more lecture-based modules, the laboratory and Observatory activities had to devise new delivery methods that were strongly grounded in the growing best practice within UCL and in the growing literature. This also included interaction with other universities with equivalent problems due to Covid-19.

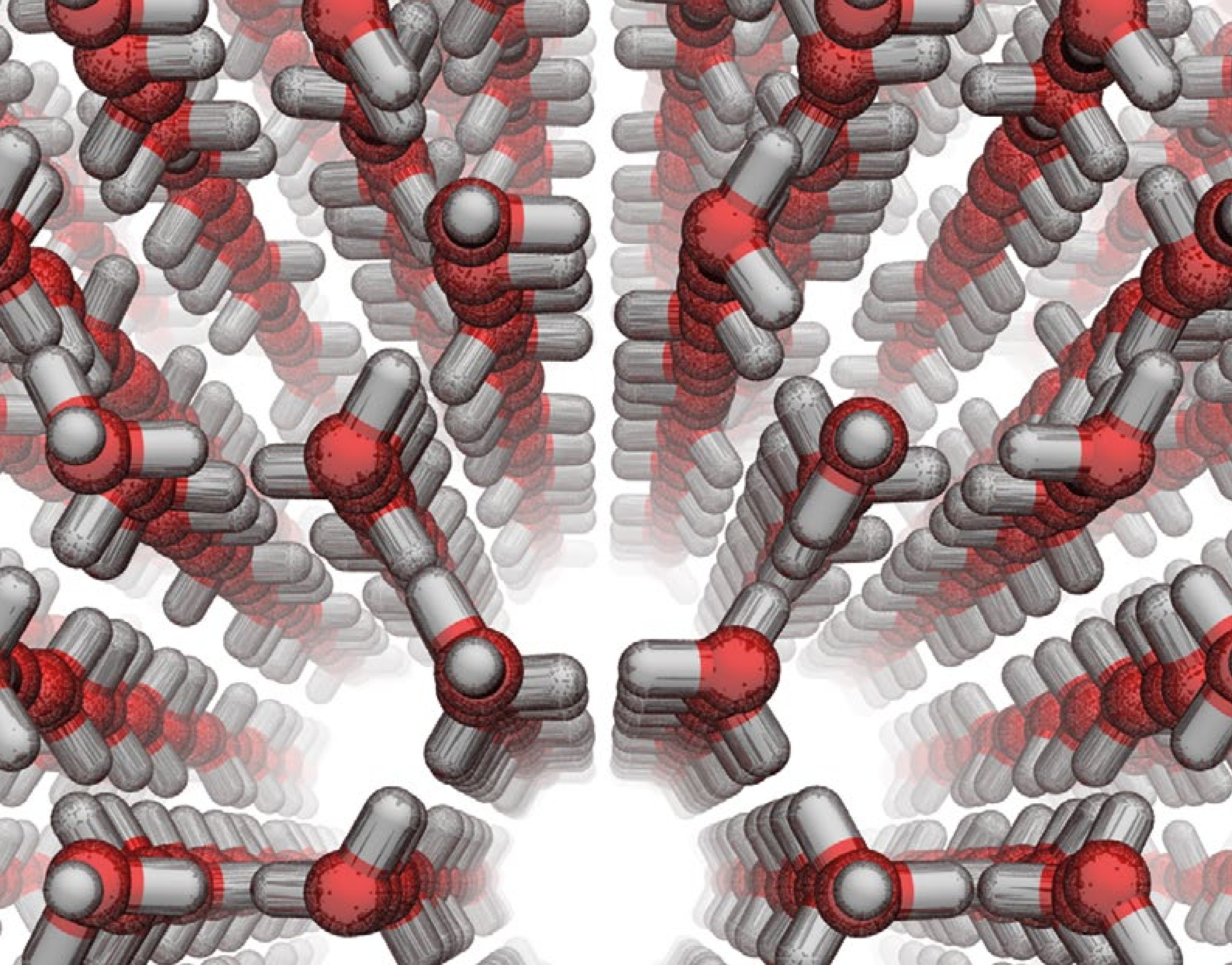
It was important for us to learn new teaching, delivery and assessment methods using both synchronous and asynchronous delivery modes. There were occasions where the delivery, particularly for Term 2, had to be pivoted to take into account the change in Covid-19 attendance expectations.

The teaching team really did work wonders this year and they have time now, this summer, to re-work our module delivery to the up-and-coming Covid-19 challenges as hoped for the approaching new academic year. However, hope is not a strategy and so staff are preparing a range of alternative delivery and assessment methods to deal with an uncertain future.

We have learned a great deal as a result of the Covid-19 crisis and it seems that we have encompassed new teaching styles and techniques that we will continue to build on in the future. Every Covid-cloud has a thin silver lining!

Paul Bartlett
Professor (Teaching)

Jasvir Bhamrah
Lecturer (Teaching)



Academic Showcase

A Sample of Staff Accolades

Department Teaching Prize

The Physics and Astronomy Departmental Teaching Prize for 2019–20 has been awarded to the entire Physics & Astronomy education team of academic, postgraduate, postdoctoral, technical, and professional services staff.

In recognition of the numerous members of our Department who have worked so tirelessly, and with such dedication, to ensure that our students receive the best possible education that we can offer under such challenging circumstances.

This award reflects our view that it is the collective team spirit and dedication of our Department as whole that has got us through the last 10 months, and which will continue to serve our students so well as we move forward. And for this we are extremely grateful. Thank you deeply.

Technician of the Year Award

The Physics and Astronomy Departmental Technician of the Year Award for 2019–20 has been awarded to the entire technical team.

The fantastic technical support provided by our department technicians and IT specialists help to ensure that our students receive the best possible education that we can offer under such challenging circumstances, and that we can continue to provide the best quality support to facilitate research and teaching at the highest level.

We would like to extend our heartfelt appreciation and gratitude for your diligence and dedication.

This award reflects our view that it is the collective team spirit and dedication of our department as whole that has got us through the last ten months.

UCLO:
Michael Pearson, Thomas Schlichter, Shana Sullivan

Gower Street:
Derek Attree, Bernard Bristoll, Gordon Crone, John Deacon, John Dumper, Edd Edmondson, Fabian Garza, Connor Godden, Tony Hoare, Fahad Ihsan, Rafid Jawad, Erdem Motuk, Mark Sterling, Derek Thomas, Kelvin Vine, Matthew Warren

LCN – CMMP support:
Andrew Gormanly, Sejal Patel, Fab Sidoli

Eddington Medal

Awarded to **Hiranya Peiris**

Professor of Astrophysics Hiranya Peiris has been awarded the 2021 Eddington Medal for her ground-breaking exploration of the origins of the Universe. Meanwhile, a collaboration that gave the world the first image of a black hole, involving Dr Ziri Younsi (UCL Mullard Space Science Laboratory), has been recognised with the 2021 Group Achievement Award.

The citation for the Eddington Medal described how Professor Peiris had helped shift cosmology, the branch of astronomy that studies the origin and evolution of the universe, “from a speculative area to a data-driven subject, and created new links between cosmology and high energy physics”.

Max Born Medal and Prize

Awarded to **Hiranya Peiris**

Professor Hiranya Peiris has been awarded the Max Born Medal and Prize 2021 for her outstanding contributions to the field of cosmology. The annual prize is given jointly by the Institute of Physics (IOP) and the German Physical Society (DPG) for outstanding contributions to physics.

The citation noted that Professor Peiris, whose research has helped to further our understanding of the Universe, had created new interdisciplinary connections between cosmology and high-energy physics.

Michael Faraday Medal and Prize

Awarded to **Richard Ellis**

Professor Richard Ellis has been awarded the Institute of Physics Michael Faraday Gold Medal and Prize for outstanding and sustained contributions in experimental physics. acknowledging his lifelong work in astrophysics. He has pioneered work in faint object astronomy, often with instruments he funded and constructed, and has opened up the early universe to direct observation. He is unparalleled in his achievements and leadership in exploring previously uncharted eras of cosmic history.

Professor Ellis is also an accomplished mentor of young researchers and a visionary who has championed the case for many international astronomical facilities, including the James Webb Space Telescope shortly to be launched.

David Tabor Medal and Prize

Awarded to **Alex Shluger**

Professor Alex Shluger has been awarded the David Tabor Medal and Prize for his seminal and wide-ranging contributions to surface and nanoscale physics. He has developed new theoretical models of atomic force microscopy (AFM), a type of scanning probe that allows the properties of a material to be explored at nanoscale.

Professor Shluger has also developed atomic-scale models of defects at the surfaces and interfaces of insulators and how these interfaces are modified by electronic excitation and carrier injection.

Galileo Galilei Award

The Galileo Galilei Award 2020 has been awarded to **Simon Jolly, Hywel Owen, Marco Schippers, Carsten Welsch** for their paper: **Technical challenges for FLASH proton therapy** in *Physica Medica (EJMP)*.

Physics World Breakthrough of the Year finalists

A team headed up by **Joao Seco** at the German Cancer Research Centre (DKFZ) and **Simon Jolly** of UCL High Energy Physics is among the finalists in the Physics World Breakthrough of the Year prize.

The research combined work from a team at UCL led by Associate Professor Simon Jolly and his PhD student **Laurent Kelleter** – who had been working on a detector for efficient quality assurance in proton and ion beam therapy, with a team from DKFZ led by Professor Joao Seco with PhD student **Lennart Volz**, who had been working on image guidance in ion beam therapy by means of proton and helium ion imaging.

Science and Technology Facilities Council (STFC)

Professor Jon Butterworth who has been appointed to STFC Council, to formally begin 1 April 2021. His research focusses on measurements at high-energy colliders – and related software and phenomenology – probing the predictions of the Standard Model, and possible physics beyond it. He was awarded the Chadwick medal and prize of the Institute of Physics in 2013 for his pioneering experimental and phenomenological work in high energy particle physics, especially in the understanding of hadronic jets.

NEON Widening Access Initiative (Outreach) Award

Dr Mark Fuller, UCL Department of Physics and Astronomy and **Dr William Dunn**, Mullard Space Science Laboratory (MSSL) win a national NEON Widening Access Initiative (Outreach) Award for the ORBYTS initiative.

BEAMS Professional Services Awards

Lee Bebbington has won the runner up prize in the BEAMS Professional Services Award in the ‘Maintaining a sustainable estate to meet our aspirations’ category. Lee has provided the department outstanding service over the last year and we are very proud of his achievements.

Andy Gormanly has won the runner up prize in the BEAMS Professional Services Award in the ‘Delivering excellent systems and processes in support of UCL’s vision’ category. A well deserved recognition for his support and hard work throughout the pandemic.

George Darwin Lecture Award

Professor Ofer Lahav was awarded the Royal Astronomical Society annual George Darwin Lecture. The George Darwin Lecture is given annually by an authoritative and engaging speaker on a suitable topic in astronomy (including astrochemistry, astrobiology, astroparticle physics, etc). Professor Lahav delivered his lecture titled Darkness Visible: AI in Cosmological Experiments on 9 October 2020.

All Souls College, University of Oxford

Professor Ofer Lahav, Perren Professor of Astronomy, UCL, was a Visiting Fellow at All Souls College for the Hilary (virtual) and Trinity (in person) Terms 2021.

MAPS Faculty Education Awards

The Education Support Team won the Excellence in the MAPS Faculty Education ‘Team Awards’ category’. Helen Copeland and Ryan Edmonds were highly commended in the ‘Support Staff’ category.

Breakthrough results on the origins of the first generations of stars in the Universe more than 13 billion years ago.

Lead author Dr Nicolas Laporte (University of Cambridge), who started the project while at UCL, Co-author Dr Romain Meyer (UCL Physics & Astronomy and the Max Planck Institute for Astronomy in Heidelberg, Germany) and Co-author Professor Richard Ellis (UCL Physics & Astronomy). The UK-led research team examined six of the most distant galaxies currently known, whose light has taken most of the universe’s lifetime to reach us. They found that the distance of these galaxies away from Earth corresponded to a “look back” time of more than 13 billion years ago, when the universe was only 550 million years old.

Cosmic dawn, when stars formed for the first time, occurred 250 million to 350 million years after the beginning of the universe, according to a new study led by researchers at UCL and the University of Cambridge.

The study, published in the Monthly Notices of the Royal Astronomical Society, suggests that the NASA James Webb Space Telescope (JWST), scheduled to launch in November, will be sensitive enough to observe the birth of galaxies directly.

The UCL press release can be found here:
www.ucl.ac.uk/news/2021/jun/cosmic-dawn-occurred-250-350-million-years-after-big-bang

Research Degrees

September 2019 – December 2020

Adeoluwa A. Ajibade
Electron Transport through Ringed Organic Molecules Hosting Magnetic Atoms
(Prof A. Fisher)

Anas A. Almuqhim
Development of levitated electromechanics of nanodiamond in a Paul trap
(Prof P. Barker)

Holly M. Andrews
A radio census of the young massive stellar cluster Westerlund 1
(Prof R. Prinja)

Padraic H. D. Calpin
Exploring quantum computation through the lens of classical simulation
(Prof D. Browne)

Medbh A. Campbell
Measuring Neutrino Oscillations in the NOvA and CHIPS Detectors
(Prof J. Thomas)

Giuseppe Carnicella
Organic Materials for Photonics: Properties and Applications
(Prof F. Cacialli)

Ashwin K. Chopra
Construction and commissioning of the tracker for the SuperNEMO demonstrator module and unfolding the $2\nu\beta\beta$ spectrum of 100Mo from the NEMO-3 experiment
(Prof D. Waters)

Elliot Christou
Quantum fluctuations and criticality of interacting Dirac fermions
(Dr F. Kruger)

Philip A. Coles
Theoretical rotational-vibrational spectroscopy of XY3-type molecules of industrial relevance
(Prof J. Tennyson)

Giuliana Cosentino
Physical and chemical processes in cloud-cloud collisions: star formartion on the making
(Prof S. Viti)

Giovanni F. Cotella
Innovative organic electroluminescent devices: diarylethenes as light-responsive switches and emissive graphene quantum dots
(Prof F. Cacialli)

Thomas R. Durrant
Supercell electrostatics of charged defects in periodic density functional theory
(Prof A. Shluger)

Billy N. Edwards
Spectroscopy of Planetary Systems with Space-based Telescopes
(Prof G. Tinetti)

Simone Famiani
Synthesis and characterisation of iron-based nanoparticles for magnetic hyperthermia
(Prof T. Nguyen)

Daniel Gradeci
Physical modelling of epithelia: reverse engineering cell competition in silico
(Prof G. Charras)

Andrew J. Hallam
Tensor network descriptions of quantum entanglement in path integrals, thermalisation and machine learning
(Prof A. Green)

Niall Jeffrey
Cosmology with dark matter maps
(Dr F. Abdalla)

William D. Jennings
The emulation game: modelling and machine learning for the Epoch of Reionization
(Dr F. Abdalla)

Xiuyun Jiang
Computational Studies of Electron Transfer in Multi-Heme Proteins
(Prof J. Blumberger)

Harry Johnston
The alignments and clustering of galaxies in wide-area photometric galaxy surveys
(Dr B. Joachimi)

Venkata S. C. Kuppili
X-ray far-field ptychotomography at I13-1 diamond light source
(Dr P. Thibault)

Elijah Lator
Superconductivity in layered transition metal (di) chalcogenides: iron selenide and niobium diselenide
(Prof C. Howard)

Wei Liu
Exploring B-L gauge models at the LHC and beyond
(Prof F. Deppisch)

Luisa Lucie-Smith
Insights into cosmological structure formation with machine learning
(Prof H. Peiris)

Alexandre A. Morgan
Coupling Rydberg atoms to superconducting microwave circuits
(Prof S. Hogan)

James G. Morley-Wilkinson
Evolution of entanglement structure in open quantum systems
(Prof S. Bose)

Krishna Naidoo
Capturing the Cosmic Web for Cosmology
(Prof O. Lahav)

Ricky S. Nathvani
Ad Lucem: Quantum Electrodynamic Parton Distribution Functions
(Prof R. Thorne)

Valentina Notararigo
Quantum optical signatures of coherent vibronic dynamics in bio-inspired light harvesting systems
(Prof A. Olaya-Castro)

James C. O'Sullivan
Coupling superconducting resonators to bismuth donor spins in silicon for quantum memory applications
(Prof J. Morton)

James E. Palmer
Rydberg-Atom Interferometry
(Prof S Hogan)

Jack T. L. Poulton
A density functional theory study on the properties of dopants in silicon nanostructures
(Prof D Bowler)

Susan E. Pyne
Higher-order statistics of weak gravitational lensing
(Prof B Joachimi)

Sofia Qvarfort
Quantum metrology with optomechanical systems in the nonlinear regime
(Prof S Bose)

Alexandros G. Rapidis
Novel organic semiconductors for light-emitting diodes
(Prof F. Cacialli)

Martin P. Rey
Genetically modified galaxies: performing controlled experiments in cosmological galaxy formation simulations
(Prof A. Pontzen)

Tom Rivlin
Ultracold atom-atom scattering with R-matrix methods
(Prof J. Tennyson)

Guido W. Roberts-Borsani
Galactic-scale outflows in galaxies of the local Universe
(Prof A. Saintonge)

Amal Vaidya
Measuring jet substructure in topologies containing W, top and light jets with the ATLAS detector
(Prof M. Campanelli)

Michael J. G. Vasmer
Fault-tolerant quantum computing with three-dimensional surface codes
(Prof D. Browne)

Mitchell C. Watts
Production and characterisation of phosphorene nanoribbons.
(Prof N. Skipper)

Thomas G. Wilson
On the formation, evolution, and destruction of minor planetary bodies
(Prof J. Rawlings)

David P. Yallup
Constraining new physics with fiducial measurements at the LHC
(Prof N Konstantinidis)

Marie-Christine A. Zdora
X-ray phase-contrast imaging using near-field speckles
(Dr P. Thibault)

Portrait of…

Kay Nakum

When did you first start at UCL? Tell us some more about it.

I began my role in the department in January 2008. Prior to that I worked for ISD for three weeks in December. I very quickly figured out that coding in Linux was not the line of work for me, so I resumed my search for alternative jobs within the college. Whilst in ISD, I was based on the first floor of the KLB, and often used to walk along the Astrophysics corridor (on the ground floor) on my way in/out of the building; I was mesmerised by the beautiful images on the wall and, as luck would have it, the following weekend I discovered that there was a vacancy for an administrator for that very group! I was interviewed by (then) Departmental manager – Ms Hilary Wigmore and Profs. Ofer Lahav and Jonathan Rawlings in room E1 (Physics building). Following the more conventional questions, my favourite one asked was, "How would you redecorate this room?" At that particular time, E1 was rather cluttered yet sombre and somewhat lacking, and having recently moved into our own home and spending nearly a year getting the décor just right, I was happy to elaborate – needless to say the interview lasted a little longer than expected!

Educational background?

I completed a BSc in Multimedia Technology at the University of Hertfordshire, and then worked in the Department of Electronic Engineering at Queen Mary's for a couple of years.

What is your role and what does it involve?

I was promoted to Astro Group Manager last summer, and my primary role is to be responsible for the day to day management of the group. I work in close collaboration with the Head of Group, Prof. Giovanna Tinetti, and others, to support the work of about 60 academic staff and postdocs and 50 PhD students. I oversee a vast range of duties, including the website, finance, infrastructure, event management and publicity. I facilitate strategic plans that underpin the research and teaching for the group and I act as a focus for enquires and dissemination of information. It is a busy role, in a fast-paced environment but extremely enjoyable and satisfying.

What do you most enjoy about your work?

Without a doubt, the variation on a daily basis is second to none, there is never a dull day – the extensive range of activity definitely keeps me on my toes! Secondly, the research that my colleagues conduct is awe-inspiring and I feel very privileged to assist them from a managerial perspective. Last but by no means least: my colleagues themselves – who come from a diverse range of backgrounds, are all a pleasure to work with, especially my 'office-buddies': we are known to have a good natter and cover everything from travelling to food, current affairs to children, and yet more food!

What project has been the most challenging?

A memorable work challenge to date has been overseeing the relocation of the group to 132 Hampstead Road in 2014, followed by the return to campus (albeit spread across 3 different locations) in 2017. The temporary, open-plan site was not fit for purpose: the kitchen area was practically on top of the working area, the sound baffle panels were too high and too small to distort any sort of noise and the meeting pods had no ceilings! To put it nicely, it was an adventure like no other, but with a lot of patience, determination and effort we got through it!

Managing the group and keeping everyone connected throughout the pandemic has been another immense and unexpected task. I never imagined that the world would come to a halt and that, like millions of others, I would have to juggle, for a long time, home-schooling my children with work. At the beginning of the pandemic, there were periods which were difficult and stressful for the whole household, however, we eventually settled into a schedule that was manageable. Challenges also came with new pandemic-related tasks and procedures to learn and prioritise, such as integrating new ways to connect and meet virtually with colleagues and host events, and in supporting others in working from home. However, with an alternative outlook, a new approach to time management, and renewed motivation and dedication, especially once the kids were finally back at school (!) and the amazing support and flexibility from the department and my line managers, managing the group from home has now become an enjoyable and successful norm.

What are you working on at the moment?

At the moment I am busy with the logistics of campus reopening. Many Astro colleagues are wanting to work from the office so I am knee-deep in emails making sure the relevant courses have been completed so that I can devise a rota that conforms to the UCL guidelines and the Government roadmap. In conjunction, I am looking into desk and office (re)allocations, which at times can be complex, and I am engaged in managing summer internships and placements. I am also dedicating a portion of my time and energy to sprucing up our website before the new academic year commences. In addition, during this unconventional year, where the group budget allocation has not been consumed by the usual travel, seminars, food and drink, I am engrossed in managing the Astro Small Grants scheme where money has been allocated to some amazing initiatives, working closely with the successful candidates, UCL Finance and external organisations.

Most motivational quote? Most inspirational moment in life?

Most motivational quote is a very simple one, but something I truly believe in: “Wherever you go, go with all your heart.”
– Confucius.

Most inspirational moment in life, was when I had my children, nothing can compare.

What is your favorite album, film and novel?

No single favourite album but many 90’s cheesy songs resonate well.

I have two favourite films, very different from each other: The Shawshank Redemption and Slumdog Millionaire.

This is really very tough… Shantaram (Gregory David Roberts), A Little Life (Hanya Yanagihara) and A Thousand Splendid Suns (Khaled Hosseini) are three books I would be very happy re-reading umpteen times. I also adore books for children – a few of my favourites: Supermarket Zoo (Caryl Hart) is more of a picture book and makes me giggle every time (my kids and I love it so much that we are on our third copy!) and novels by Onjali Rauf for older kids, especially The Boy at the Back of the Class and The Star Outside My Window.

What is your favorite joke (pre-watershed)?

I am pathologically incapable of remembering either jokes or card game rules, but here is one I heard from my kids yesterday: Why do we never tell jokes about pizza? They’re too cheesy.

Who would be your dream dinner guests? What would be on the menu?

My dream dinner guests would be my grandparents, Princess Diana, Nelson Mandela, Anne Frank, Marilyn Monroe and the Brontë sisters, all of whom are no more. Back to the living: in no particular order, I would include the Obama family, Hilary Clinton, David Attenborough, Dalai Lama, Romesh Ranganathan,
Oprah Winfrey and Priyanka Chopra-Jonas.

I would be extremely happy to play chef and serve a primarily Indo-Chinese fusion affair.

To commence: manchow soup, garlic chill paneer, and gobi 65.

To continue: veg manchurian, chinese bhel, schezwan vegetable curry and triple fried rice.

To conclude: (a twist on the Indian classics) rice kheer with chocolate and mandarin, and a mango shrikhand with pistachio crumble.

Refreshments: Two types of lassi: 1st - mango and lime, 2nd – rose and coconut (laced with rum for the non-teetotallers) as well as cardamom masala chai and of course jal jeera - would love to hear their feedback!

What advice would you give your younger self?

Keep playing, laughing and having fun, don’t get too serious, life is short.

What would it surprise people to know about you?

I could spend a few hours happily wandering around a supermarket, learning about new ingredients and drifting from aisle to aisle conjuring new recipes. In addition, upon meeting me for the first time, many think I am quiet and reticent, but my friends and family would whole-heartedly disagree!

What is your favorite place?

There are three: my kitchen, a good bookshop and a remote island surround by warm tropical waters with a cocktail or two.

Giovanna Tinneti writes:

I have known Kay since 2007, when I first joined UCL. Throughout the years, I have always admired her enthusiasm and energies, with which she accomplishes daily multiple tasks for the management and wellbeing of the group. As Manager of a group of over one hundred people, including staff, students and research fellows, there is never a dull moment for her! Even more remarkably, she does all this work always with a smile and a good word for everybody.

During the past year, in my new role as Head of Group, I have had the chance to work more closely with Kay. Remote working during a global pandemic has been a challenging experience for the group and the college. More than ever I have appreciated Kay’s competence and resourcefulness in trying to find solutions to difficult and sometimes sensitive issues. This brief note is therefore an opportunity for me to thank Kay, at a personal level and also on behalf of the Astro group, for her invaluable work every day, every week, every year. Her positive attitude and resilience are an inspiration to all of us.

In Memoriam

Bill Somerville

After a long illness that kept him away from UCL for the last couple of years, our beloved Bill Somerville died on January 22nd.

Bill leaves a wonderful UCL legacy that spans more than six decades. He welcomed to UCL many undergraduates that would become the successful scientists still around us today.

After his retirement, Bill became a major pillar of the very successful Diploma 2-year evening course in Astronomy (today a certificate), which along 20 years is contributing to our society by enriching the lives of hundreds of mature students, some of them embarking in post graduate courses and most of them becoming proud fellows of the Royal Astronomical Society.

Furthermore, Bill founded the Diploma Club which welcomes all Diploma/Certificate alumni to monthly lectures, and other activities.

I had the privilege of being part of this all, even sharing an office with him. On the third Thursday of every month, Bill would arrive carrying 2 or 3 bags full of nibbles and wine for the E3/7 receptions that followed the lectures in the Harrie Massey LT.

When Bill's health deteriorated, I took over the management of the Diploma Club and this kept me in touch with him and his lovely wife Jackie. I did a few home deliveries of documents and personal items from his UCL desk. I always found him with his typical sense of humour.

Bill's thanksgiving on-line service took place on February 20th. It was a lovely ceremony conducted by Rev Dr Simon Woodman with more than 100 links to the call.

Here is a selection of shared stories and anecdotes:

'Bill was always good at having the right thing to say on difficult occasions.

He knew how to say things to make people smile. Sometimes it could be hard to know whether he was joking. His accent was a mystery, many thought that he was Welsh.'

'Brought up in Glasgow, then moved to Belfast, always interested in science, he got his first degree on physics and maths at Queens University. He moved to London where he completed his PhD at UCL, which became his academic home for the rest of his life. In the words of David Williams, UCL:

'Bill and I knew each other for more than 60 years. We met at Queens University, Belfast. My respect for his knowledge developed into close friendship. We met again at UCL, where I found that Bill was regarded by his departmental colleagues with enormous respect for his inspirational teaching and for the care and attention he gave to his students.'

The service gave us at UCL, new perspectives of Bill's rich life. From his passion for hill walking, to being an avid reader and displaying meticulous leading skills in Scottish country dancing.

But that was not all. In 1985 the BBC-Open University produced one of their science TV programmes called Violent Galaxies, which Bill narrated superbly. This vintage programme was recorded on VHS tape by James Dow, one of our earliest Diploma alumnus, who kindly made it available to us and can now be found here:

www.youtube.com/watch?v=dWz3zpPDP4g

A brief selection was screened at the service.

Some testimonies:

‘That’s really sad news. He was a gentleman, a fantastic lecturer and so supportive of his undergraduates.’

Richard Ellis

‘Sorry to hear of Bill’s death - he was a backbone of UCL astronomy for many years and continued to contribute for years after his retirement.’

Mike Barlow

‘Sad news, my condolences. I recall Bill’s contribution to running the highly successful Diploma Club.’

Ofer Lahav

‘So dreadfully sorry to hear about this - he was, as Richard said, a gentleman and a great educator. I’m sure his life will be deservedly commemorated.’

Nick Achilleos

Bill was a very caring teacher, always having time for students. His unique sense of humour (you had to get used to) and his beautiful Scottish accent will be sadly missed.’

Ian Furniss

‘Bill interviewed me for my undergrad place at UCL. I’m not the first, and won’t be the last, to say he was a fine man and a stalwart of the group.’

Ian Howarth

‘Very sorry to hear that Bill has left us - as you say he was a gentleman, and a gentleman, always fun to be around and it was clear he cared about his students. He was a big influence on me, as I’m sure he was on many of us. Bon voyage Bill’.

Keith Mason

‘The UCL Diploma was a life changing event for me. Previously I was demotivated with my life and my career [at 20 years old], but after the Diploma course I realised what I can do in Astronomy. I am deeply indebted to Bill for accepting me on to the course at that critical time.’

Umut Yildiz

‘I knew Bill for more than 25 years, from back in the 1990s when he lectured me as an undergraduate, to being a valued colleague on the Diploma/Certificate in Astronomy more recently. He was a lovely, very kind man, always in possession of a humorous observation and with a twinkle in his eye. I’m very glad I was able to share an office with him over the last few years.’

Adam Burnley

‘Bill Somerville changed my life. Someone told me about the UCL Astronomy Diploma, and I thought that it would be perfect for me. And surely it was! After completing it, I was so inspired that I went on to study for a part-time MSc in Astronomy at Sussex University. Bill made all of this (and so much more) possible. He gave me a gateway to our beautiful universe. Thank you, Bill’.

Isabelle Doyle

‘ When I think of Bill, I remember his beautiful voice with that soft Scottish accent, and the twinkle in his eye… A scholar and a true gentlemen, who touched so many people in a well lived life. I found this quote from Einstein, which I thought was quite appropriate:

“Now he has departed from the strange world.... That means nothing. People like us, who believe in physics, know that the distinction between past, present, and future is only a stubbornly persistent illusion.”

Hilary Martin

We were honoured to welcome Jackie Somerville to our special Diploma Club on-line Lecture that took place on March 4th about the technology and science behind the OU TV programme on Violent Galaxies mentioned above. The speakers were Richard Ellis and Mat Page. The video recording of this historical lecture is available here: **www.youtube.com/watch?v=fI12rnYHgvw**

Francisco Diego

In Memoriam

Dr William A Towlson (1933 to 2020)

Bill Towlson began his association with UCL in 1951 as a Physics undergraduate. He went on to study for his PhD in 1954 and a few years later achieved that goal. He left UCL for a few years to work in the electronics industry at the relatively newly formed company called Elliott Automation, a firm set up in 1957 and there he was able to gain a lot of experience in electronics and servo control systems which would stand him in good stead for his future career. (EA was absorbed by GEC finally.)

In the early to mid 60s he returned to UCL Physics Department where his first major task was involvement in the systems design of the Heavy Liquid Bubble Chamber, which was a collaboration between Rutherford High Energy Lab and UCL. It was being built in Oxfordshire at the National Institute for Research in Nuclear Studies (NIRNS now RAL). The bubble chamber was the detector used to study the decay products produced after accelerated protons hit a special target. The protons came from NIMROD a particle accelerator at RHEL.

Bill worked on this as part of the embryonic UCL Engineering Design Group, the rest of the group being Harry Tomlinson, Tom Venis, Bob Catch and Fred Want.

I met Bill in 1969/70, the first year of my PhD in the Infrared Group. The EDG was working on the production of the first of many balloon borne platforms, the 40cm Far Infrared telescope system which was used to collect data for my PhD. All platforms were designed to be controlled from the ground while they were at 100,000ft or higher, hanging from a Helium gas filled balloon of 1 million cubic feet volume or larger. That was the start of my long association with him and the EDG. Together the two groups went on many trips to Palestine in Texas USA to fly the super-fluid liquid helium cooled IR detectors and instruments. We also got to balloon launch sites in New Mexico, Australia and Argentina.

I recently counted up the number of flights of the 40cm and 60cm telescope systems. 20 for the 40cm with a 75% success of data collection and 15 for the 60cm with a success rate of 81.3%. There were also flights of a UV spectrometer and later a UV telescope with a cross dispersed Echelle system, both of which Bill was instrumental (pun intended) in designing and producing. We did have some mishaps with balloons and platforms but the success of the platforms was principally down to Bill's ability and the two groups working well together. They were soon to became one Group.

After the Ballooning ended in 1987 due to lack of funding, Bill moved onto ground based IR instrumentation. A Cooled Grating Spectrometer #3 was designed by him for use on the United Kingdom InfraRed Telescope on Mauna Kea in Hawaii. He also applied his talents to the Fabry Perot Interferometers and Interchange Wheel System which were part of the Long Wavelength Spectrometer for the Infrared Space Observatory, an ESA space mission which used super-fluid liquid helium (~2 Kelvin) to provide the cooling for the instruments and telescope mirrors. Both the FPIs and the IWS were spectacular successes, operating in those cryogenic conditions and allowing the LWS to collect data. Anything Bill had a hand in producing worked well. I can't think of any instrument that didn't.

The Group was always busy and Bill was nearly always at the centre. He helped lots of Postgrads, Postdocs, Staff and visiting scientist from abroad who 'passed' through the IR group. His abilities were also used by the Department in the undergraduate labs. Bill would produce demonstration instruments with left over 'bits' from our research group and then, when satisfied, have copies made so the UGs could use them in Lab sessions. I can think of two in particular: for Lab 2, 'Measurement of the band gap in semiconductor silicon or germanium' and for Lab 3 'Measurement of the splitting of spectral lines of Mercury by a magnetic field. (The Zeeman effect)'.

It wasn't all work though. Friday lunchtimes were something used to mark the almost completion of the week. A group of 4 or 5 of us would go out for a meal, onto Tottenham Court Road or just a short walk from it. Italian, German, Greek or Indian restaurants were visited, whichever the group decided was the menu for that day. Sometimes, even humble fish and chips. It was our 'catching up' time.

Bill loved rock climbing and hiking in the UK or abroad. Mike Esten and he were of the same era and both loved those pastimes. Along with Sid Corrigan they might all go off to enjoy a weekend climbing or hiking somewhere. Mike recently told me of one of Bill's early publications. It was 'A climbing guide to the main features of UCL' and contained 12 to15 routes that could be taken. It was produced with the help of others with the same passion. The routes had to be climbed on a misty/foggy night so the College Beadles didn't catch them.

When Bill fully retired in 1998, he had taken early retirement about 10 years before, there was a 'hole' in the department which was never really filled.

He and his wife Pamela moved up to Mellington in Powys where there are lots of countryside hikes and climbs. He would occasionally come down to visit London, letting me know beforehand and nearly always on a Friday so we could go out to lunch. He would be on his way to the theatre or meeting up with his daughter Anna. Bill T was a quiet unflappable person, he had a 'fun side' and was very dependable. I knew him for a long time and I shall miss him but I'm glad we have shared times together. I have lots of memories and photos of him from our Ballooning and ISO days.

I heard from Anna and Mike Esten that in July of this year Bill had been taken into hospital. After he beat that first illness he was released to a care home but finally he was taken back to the hospital. Further problems had arisen and the dementia didn't help. Anna said he recognised her when she visited him but during the last hospital stay he deteriorated, slipping into a coma and slowly passed away. He died on Saturday 12th December in the early hours.

He is survived by Pamela his wife, daughter Anna and sons Ivan and Brian.

Ian Furniss

P.S. My thanks go to Dr Mike Esten for helping fill in the 'early bits' I wasn't sure about.

Headline Research

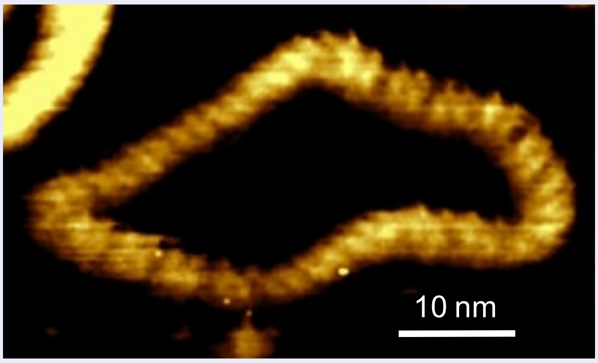
Dancing DNA

In cells in our body, two metres of DNA fit into each cell nucleus, with a size of the order of a micrometre. DNA has therefore evolved to exist in twisted and coiled forms: Loopy DNA is everywhere in the genome, forming twisted structures. However, these twisted structures are hard to resolve.

To investigate the looping of DNA, Dr Alice Pyne (present address: University of Sheffield) and collaborators have used a combination of atomic force microscopy, which feels the nanoscale contours of a biomolecule, and atomic-scale computational simulations. Focussing on small "packets" of genetic information called DNA minicircles, they resolved the dynamic behaviour – 'dancing' – of twisted DNA and verified how the twisted state of the DNA affected the binding of molecules that regulate gene expression.

These results are a milestone in high-resolution DNA imaging as pioneered in Prof. Bart Hoogenboom's laboratory and provide an indication of how non-canonical forms of DNA structure can determine how genetic information is processed in our body.

The results have been published in Pyne, Noy, et al., Nature Communications (2021), **https://doi.org/10.1038/s41467-021-21243-y.**



Atomic force microscopy image of a DNA minicircle. The bands along the loop represent the two strands of the DNA double helix twisting around each other.

In Memoriam

Hannelore Emmi Saraph (née Schulz) (1936–2020)

Hannelore was born in Berlin on 1936 August 3rd, her father running a tailor's shop and the family living in the flat above it. Difficult and at times traumatic experiences must have defined Hannelore's childhood, particularly during bombing raids carried out by the Royal Air Force, with the United States and Soviet Union also participating in the later stages of the Second World War. And although evacuated to stay with grandparents in a rural setting, Hannelore must have worried about the safety of her parents who remained in Berlin to continue operating the business. In order to spare Hannelore and her mother from the worst of the trauma experienced by the civilian population of Berlin in 1945, her father evacuated them to a German North Sea island which later fell under British control.

After the war, Hannelore and her mother returned to Berlin and the family gradually and secretly transferred their moveable possessions into a new and, as it turned out, temporary residence in what was to become West Berlin. The family was fortunate to find themselves in West Berlin when the Berlin Wall was built in 1961 August. Shortly afterwards, the family decided to relocate to London. Once in London, Hannelore's father needed to visit West Berlin on several occasions to sort out financial and pension arrangements; he died around 1966, on the last of these expeditions. As we recall, Hannelore's mother died in London in 1993.

Hannelore's education was fragmented; from 1942–1958 she attended various schools and finally the Technische Universität Berlin (TUB), first coming to London in the late fifties with a view to improving her use of English. Having completed three years of a TUB physics degree, she enquired about continuing her studies at the University of London. She got referred to University College London (UCL) Physics Department and was sent to see the late Professor M.J. Seaton FRS. Mike Seaton had some grant money and gave her a temporary job as a computer programmer.

In the early sixties, Hannelore's family took the big decision to move permanently from Berlin to London. Once settled in London, Hannelore wanted to develop her career. It was a shock to find that the University of London was unwilling to take any account of previous university studies in Berlin. Not only that, the University of London would not accept any of Hannelore's German school qualifications. Representations were made on Hannelore's behalf by the UCL Department of Physics, but to no avail. Hannelore therefore ended up doing O-level and A-level examinations, followed by an external physics degree at Birkbeck College, which was awarded by the University of London in 1969. Although by 1969 Hannelore had been doing research in UCL for several years, she enrolled in that year as a doctoral research student, supervised by Mike Seaton; the University of London awarded the PhD Degree in 1971 for a thesis entitled 'Electron Collisions with Complex Ions'.

By 1971 Hannelore was a highly valued member of the Department of Physics, which was to merge in 1972 with the Department of Astronomy to form the Department of Physics and Astronomy. With the appointment of the late Professor R. Wilson FRS to the Perren Chair, following the 1972 retirement of Professor C.W. Allen, UCL became involved in ultraviolet astronomy through the launch of the International Ultraviolet Explorer Satellite in 1978; this was to provide an exciting new opportunity to apply the results of atomic physics calculations to the interpretation of ultraviolet astronomical spectra.

There was therefore an obvious demand for research workers having Hannelore's skills in computational atomic physics and her post-doctoral role was to continue as Mike Seaton's research assistant, eventually joining the permanent staff at the UCL Department of Physics and Astronomy. Hannelore became internationally recognised as an atomic physicist in her own right, collaborating with colleagues in France and in the seventies holding a Visiting Fellowship at the Joint Institute for Laboratory Astrophysics (Boulder, Colorado, USA).

After Professor Seaton's retirement in 1988 and until her own retirement in 2001, Hannelore became involved in undergraduate teaching; with Dr. Gillian Peach, she was responsible for giving classes in computing and programming skills. Throughout her employment at UCL, and on into her retirement, Hannelore was an active researcher in atomic physics, publishing some sixty papers in the period between 1961 and 2009.

Until 1992, stellar envelope opacity calculations were based on photoexcitation and photoionisation data calculated for many elements and their ionisation stages with necessarily rudimentary methods. By 1982 it had become clear that better estimates of the metal (all elements except hydrogen and helium) contribution to stellar envelope opacities were urgently needed. Professor Seaton accordingly initiated the Opacity Project (OP) in which Hannelore became involved, along with most of his former research students and post-doctoral research assistants. The large-scale data production for OP work was made possible through the R-matrix implementation of the close-coupling equations; the collaboration therefore involved the late Professor P.G. Burke FRS (Queen's University Belfast) and Professor K.T. Taylor MRIA (Royal Holloway College), the latter getting to know Hannelore particularly well through this work. Following the success of the Opacity Project, it was recognised that the team involved could usefully work on electron collision data; for this reason in 1993 the late Dr. D.G. Hummer (then a visitor at the Munich university observatory) formed the Iron Project, in which Hannelore proceeded to make an important contribution.

Hannelore had many activities outside UCL; in particular she became a property owner and provided rented accommodation in London and took on the usual responsibilities of a landlady. Following German reunification, Hannelore claimed ownership of much of the family property left behind in what had been East Berlin. The process proved to be quite complicated and it took sometime to legally establish Hannelore's claim to her childhood home. Once in possession, many urgent repairs had to be arranged after more than forty years of neglect. After retirement, Hannelore gave German classes in London and was able to satisfy her life-long desire to travel and see the world. Hannelore died on 2020 October 1st at Homerton Hospital, London; she was pre-deceased by her son Hans, who experienced a fatal car accident in 1990.

Gillian Peach
Tony Lynas-Gray
Ken Taylor
Jonathan Tennyson

Staff News

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

Professor Keith Hamilton (HEP)
Professor of Theoretical Physics

Professor Benjamin Joachimi (Astro)
Professor of Astrophysics

Professor Stan Zochowski (CMMP)
Professor of Physics

Professor Pavlo Zubko (CMMP/ LCN)
Professor of Physics

Promotion to Professorial Research Fellow

Professor David Brooks (Astro)
Professorial Research Fellow

Promotion to Associate Professor

Dr Arijeet Pal (CMMP)
Associate Professor

Promotion to Associate Professor (Teaching)

Dr Steve Fossey
Associate Professor (Teaching)

Microwave spectroscopy of the positronium fine structure

In the basement of the physics building you can find the positronium spectroscopy laboratory (PSL). Here a team of researchers led by Professor David Cassidy seek to perform precision spectroscopic measurements of the matter-antimatter atomic system positronium, with the aim of testing quantum electrodynamics (QED) theory to the highest precision possible, and perhaps even catching a glimpse of some new physics that is not currently included in the Standard Model.

Positronium (chemical symbol Ps) is a hydrogen-like atom composed of a positron bound to an electron. It is metastable, and left alone will self-annihilate (that is, spontaneously turn into gamma radiation) in less than a microsecond. If, however, one uses lasers to put Ps atoms into excited states they may live for longer. The reason why it is of interest to study this simple atomic system is that the positron and the electron are both fundamental particles, with no internal structure. This means that Ps is, to a very high degree, described by QED. Hydrogen, by contrast, contains a proton, and the proton structure is not well understood because it is determined by the strong nuclear force. This results in some uncertainty in the hydrogen structure arising from incomplete knowledge of the proton charge distribution. These uncertainties are only apparent because of the extremely high precision with which hydrogen has been studied, and positronium spectroscopy has a long way to go before it can probe these regimes.

In the PSL work is being performed to try and bridge this gap. Specifically, the Ps fine structure is being probed via microwave spectroscopy in the first new experiments of this kind for more than 25 years. The structure being probed consists of the small energy differences between substates in the $n = 2$ manifold, where n refers to the principal quantum number (see FIG. 1).

By driving transitions between these states using microwave radiation it is possible to induce large changes in the Ps decay rate [1], which can then be observed via the time spectrum of subsequent annihilation radiation. The energy levels of Ps have been calculated to an estimated theoretical uncertainty of 80 kHz, and the new measurements have obtained an uncertainty of approximately 600 kHz.

Surprisingly, researchers found that one transition (the $2\,^3S_1$ to $2\,^3P_0$ interval) disagreed with theory by more than four standard deviations [2]. Given that Ps is so well described by theory this result is difficult to understand, and remains unresolved [3]. Work continues in the PSL to resolve this discrepancy.

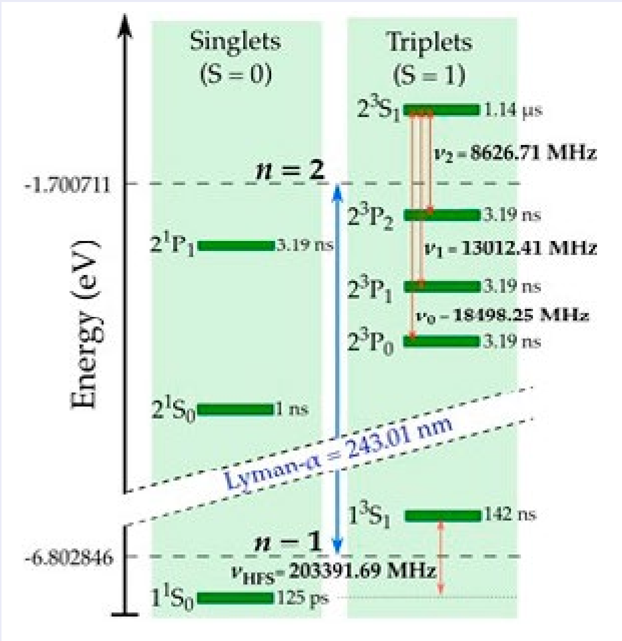
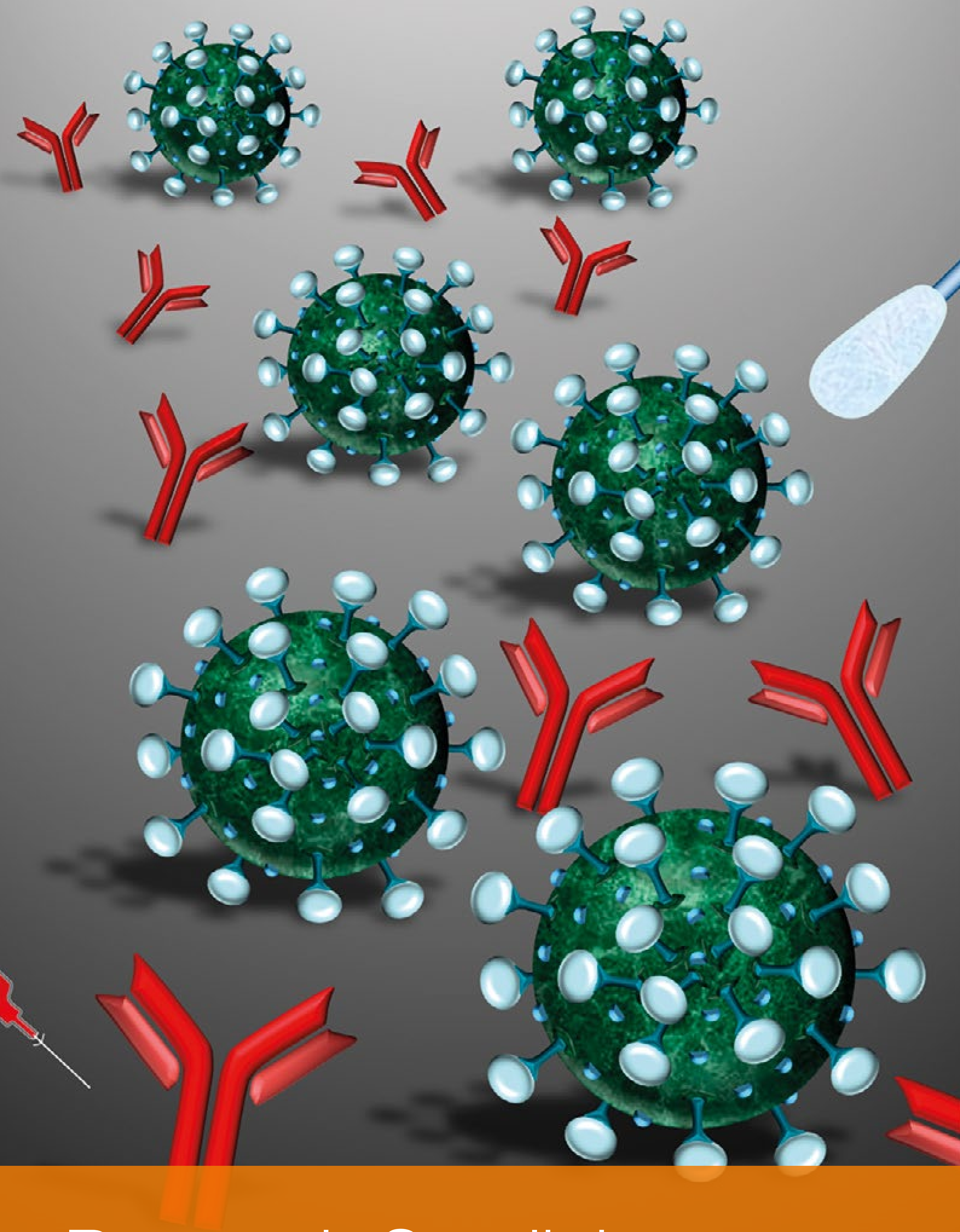


FIG. 1. Energy level diagram of the n = 1 and 2 levels in positronium. The energies of Bohr levels are indicted by the dashed horizontal lines as well as the calculated transition frequencies between various sublevels. Radiative or annihilation lifetimes for all levels are also indicated, according to the primary decay mode.

[1] Controlling Positronium Annihilation with Electric Fields, A. M. Alonso, B. S. Cooper, A. Deller, S. D. Hogan, and D. B. Cassidy, Phys. Rev. Lett. 115, 183401 (2015).

[2] Precision Microwave Spectroscopy of the Positronium n = 2 Fine Structure, L. Gurung, T. J. Babij, S. D. Hogan, and D. B. Cassidy, Phys. Rev. Lett. 125, 073002 (2020).

[3] Observation of asymmetric line shapes in precision microwave spectroscopy of the positronium $2\,^3S_1 \rightarrow 2\,^3P_J$ (J = 1,2) fine-structure intervals, L. Gurung, T. J. Babij, J. Pérez-Ríos, S. D. Hogan, and D. B. Cassidy, Phys. Rev. A 103, 042805 (2021)



Research Spotlight

Condenced Matter and Material Physics (CMMP)

The Condensed Matter and Materials Physics (CMMP) has twenty-one permanent academic staff who research the physics and materials science of solids, liquids and other condensed matter states. Key research themes in the group include materials modelling, many body theory, neutron and X-ray scattering and materials discovery.

This year CMMP welcomed Dr. Edina Rosta who has been appointed as Associate Professor in Computational Materials Physics. Dr. Rosta was previously a Reader at King's College London and her research interests are in atomistic modelling, particularly directed towards molecular kinetics calculations of phosphate enzyme catalysis. We also welcome Dr. Robin Perry, who has joined the group as Associate Professor, having previously held a position at UCL's Institute of Materials Discovery. Dr. Perry's work focuses on crystal growth for neutron and X-ray scattering experiments and he runs a well-equipped laboratory on the Harwell campus dedicated to this purpose.

Congratulations to Professor Alexander Shluger, who was awarded the 2020 David Tabor Medal and Prize of the Institute of Physics "*for the development of new theoretical models of defects at the surfaces and interfaces of insulators and mechanisms of imaging and manipulation of surface atoms and molecules using atomic force microscopy (AFM)*".

Research successes in the group have been highlighted by a number of papers in high impact journals, including *Science, Nature Materials, Nature Catalysis and PNAS.*

Recent appointees Dr. Roger Johnson and Dr. Edina Rosta have been notably successful in this regard. Dr. Johnson co-discovered the first known case of helical ordering of electric dipoles in a bulk material and published the work in *Science* (see highlights).

Dr. Rosta and her group at UCL and King's College, working with Cambridge Scientists, published a paper in *Nature Catalysis* that describes a study of electrocatalysts for selective CO_2 conversion in the production of renewable fuels. Here a nickel complex is introduced as a CO_2 reduction electrocatalyst between gold electrodes. The system was then studied by Raman scattering techniques, bolstered by density functional theory calculations. The combination of spectroscopic and numerical modelling techniques sets a template for studying and understanding oxidation and reduction reactions in few-molecule systems.

A paper published in *Nature Materials* by Dr. Pavlo Zuvko and his group, along with colleagues from France, Ireland and Czech Republic, has described how, in some superlattices composed of layers of ferroelectric lead titanate ($PbTiO_3$) separated by thin spacers of metallic or insulating oxides, the electric dipoles form an unusual pattern of nanoscale domains that order in three dimensions to create a 'domain supercrystal'.

Under the influence of applied electric field, small displacements of the boundaries between the different domains give rise to large changes in the net electric polarization. The complex domain patterns in the ferroelectric layers are accompanied by very strong distortions of the crystalline lattice that, in turn, set up a periodic modulation with very large local curvatures in the metallic or insulating spacers. This curvature can be tuned

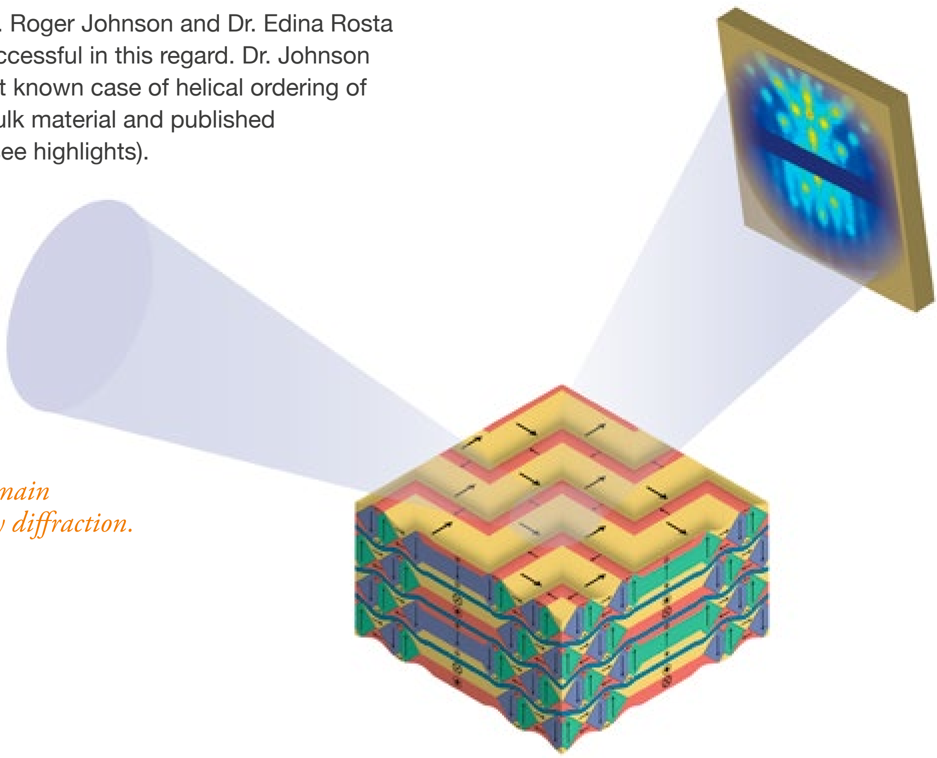


Figure 1
Investigating the domain supercrystal by X-ray diffraction.

by application of electric fields and its periodicity can be engineered on demand by adjusting the thicknesses of the ferroelectric layers. This makes such superlattices an ideal system for exploring curvature-induced properties in a variety of insulating, conducting and magnetic materials.

> “CMMP has also received considerable attention in many media outlets.”

Profs. Des McMorrow, Ian Robinson and their groups, were part of an international team led by Brookhaven National Laboratory (USA) who published a paper in PNAS (Proceedings of the National Academy of Sciences), reporting the ultrafast behaviour of a particular class of magnetic material, known as a “gapped antiferromagnet”. The broader motivation of the work relates to the exponential growth in data processing, which has largely been driven by shrinking electronic circuits to ever smaller size, making continued progress dependent on exploiting new physical phenomena. A promising avenue is the manipulation of quantum spins in magnetic materials, but possibilities are limited by a lack of knowledge of how magnets behave on ultrafast (trillionth of a second) timescales. In the gapped antiferromagnet system studied, atomic spins are locked in an alternating up-down arrangement that takes a considerable amount of energy to disrupt. The researchers fired a laser at a crystal of strontium iridate ($Sr_3Ir_2O_7$) and tracked how the spins deviated from their antiferromagnetic arrangement using very short and intense x-ray pulses.

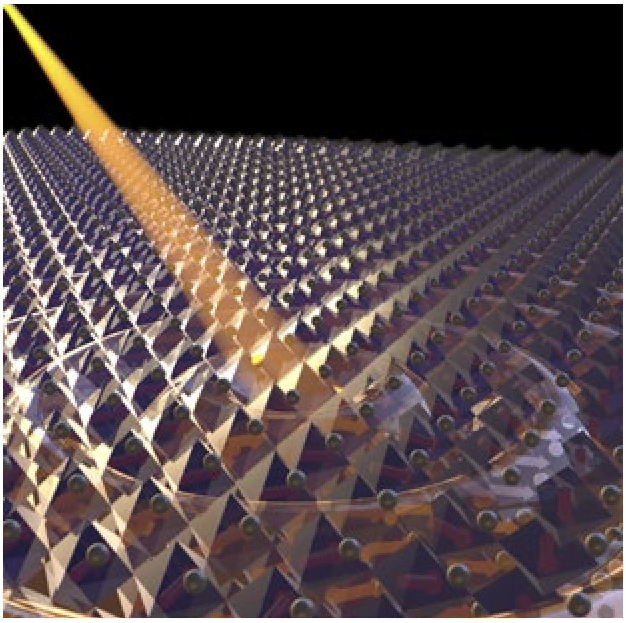


Figure 2
A laser shone at a magnetic crystal disrupts the magnetic order, which can be tracked on ultrafast timescales by x-ray diffraction.

They discovered that the laser causes the spins to start strongly fluctuating in a fraction of as picosecond, destroying the magnetic properties, and taking a much longer time scale for equilibrium to be re-established. Such insights may have important implications for the design of new magnetic technologies.

CMMP research has also received considerable attention in many media outlets. Pride of place in this regard must go to the CMMP’s Prof. Franco Cacialli and his group who have published a paper in the Journal of Advanced Electronic Materials that concerns organic light-emitting diodes: devices that are used, for example, in computer, TV and smartphone displays. Their paper describes a new and easy method of transferring a green light emitting diode on to virtually any kind of surface. This potentially includes tattooing the skin to potentially create “skin-wearable” sensors for biomedical and sporting applications, for example. The extensive media and public interest in this work is hardly surprising.

Finally, CMMP researchers have published many excellent papers in important specialised journals like the APS’s Physical Review series and the Institute of Physics journals. A good example is work by Dr. Carla Perez Martinez, along with collaborators from Oxford University, who published a paper in Journal of Physics: Condensed Matter that describes the use of electric fields to control adhesion between two surfaces (see highlights).

References

Demelza Wright, Qianqi Lin, Dénes Berta, Tamás Földes, Andreas Wagner, Jack Griffiths, Charlie Readman, Edina Rosta, Erwin Reisner & Jeremy J. Baumberg. Mechanistic study of an immobilized molecular electrocatalyst by in situ gap-plasmon-assisted spectro-electrochemistry, Nature Catalysis 4, 157 (2021).

Marios Hadjimichael, Yaqi Li, Edoardo Zatterin, Gilbert A. Chahine, Michele Conroy, Kalani Moore, Eoghan N. O’ Connell, Petr Ondrejkovic, Pavel Marton, Jiri Hlinka, Ursel Bangert, Steven Leake & Pavlo Zubko. Metal–ferroelectric supercrystals with periodically curved metallic layers, Nature Materials 20, 495 (2021).

Daniel G. Mazzone, Derek Meyers, Yue Cao, James G. Vale, Cameron D. Dashwood, Youguo Shi, Andrew J. A. James, Neil J. Robinson, Jiaqi Lin, Vivek Thampy, Yoshikazu Tanaka, Allan S. Johnson, Hu Miao, Ruitang Wang, Tadesse A. Assefa, Jungho Kim, Diego Casa, Roman Mankowsky, Diling Zhu, Roberto Alonso-Mori, Sanghoon Song, Hasan Yavas, Tetsuo Katayama, Makina Yabashi, Yuya Kubota, Shigeki Owada, Jian Liu, Junji Yang, Robert M. Konik, Ian K. Robinson, John P. Hill, Desmond F. McMorrow, Michael Först, Simon Wall, Xuerong Liu & Mark P. M. Dean. Laser-induced transient magnons in $Sr_3Ir_2O_7$ throughout the Brillouin zone, PNAS 118 e2103696118 (2021).

Jonathan Barsotti, Alexandros G. Rapidis, Ikue Hirata, Francesco Greco, Franco Cacialli & Virgilio Mattoli. Ultrathin, Ultra-Conformable, and Free-Standing Tattooable Organic Light-Emitting Diodes, Advanced Electronic Materials 2001145 (2021).

Astrophysics

A 3D journey through 11 billion years

A five-year mission to create an unprecedented 3D map of the universe using the Dark Energy Spectroscopic Instrument (DESI), designed and built in part by Prof. Ofer Lahav, Prof. David Brooks and Prof. Peter Doel at UCL, has formally started in May 2021.

DESI will capture and study light from tens of millions of galaxies and other distant objects with the aim of unravelling the mysteries of 'dark energy', which is believed to be driving the accelerating expansion of the universe.

The instrument, based at Kitt Peak National Observatory (Figure 1) near Tucson, Arizona, in the United States, contains 5,000 fibre-optic 'eyes', each of which can image a galaxy in just 20 minutes. In a four-month trial run, DESI captured four million spectra – more than the combined output of all previous spectroscopic surveys.

Figure 1
Kitt Peak National Observatory telescopes: the Mayall 4-m telescope on the right.

Professor Ofer Lahav, chair of the DESI UK consortium of seven universities, said: "This survey will go deeper into space and the history of the Universe than we have ever achieved before, and follows years of efforts of building DESI by the international collaboration, including by UCL and Durham's instrumentation teams. "DESI is a revolution in astronomy, collecting spectra from 5,000 galaxies every 20 minutes. It will lead to unprecedented observations that will help us characterise the mysterious nature of dark energy."

> "Spectra collected by DESI reveal important information such as the chemical composition of objects…"

DESI will measure 10 times more galaxy spectra than ever obtained. Instead of two-dimensional imaging of galaxies, quasars, and other distant objects, the instrument will become 'a time machine' placing those objects on a timeline that reaches as far back as 11 billion years ago. Spectra collected by DESI reveal important information such as the chemical composition of objects being observed as well as information about their relative distance and velocity. As the universe expands, galaxies move away from each other, and their light is shifted to longer, redder wavelengths. The more distant the galaxy, the greater its 'redshift.' By measuring galaxy redshifts, DESI researchers will create a 3D map of the universe. The detailed distribution of galaxies in the map is expected to yield new insights on the influence and nature of dark energy.

DESI is mounted on a four-metre telescope whose top end is replaced with DESI's optical corrector, built by a team including UCL physicists (Figure 2). This corrector, which houses six lenses, the largest 1.1m across, reflects light on to the fibre-optic "eyes" that move independently to capture light from individual galaxies. It also expands the telescope's viewing window by about 16 times. The captured light is then split into bands of colour by spectrographs to map the movements of the galaxies relative to Earth, revealing the expansion history of the universe.

> "As DESI collects data during its five-year survey, UCL astronomers will be analysing it to reveal the secrets of the universe"

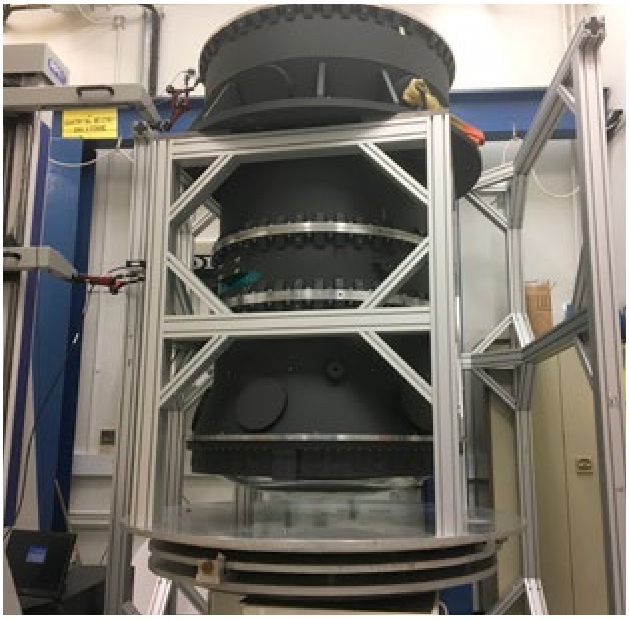


Figure 2
The Dark Energy Spectroscopic Instrument's (DESI) wide field optical corrector which has been fully assembled and tested at UCL and was shipped to the Mayall telescope at Kitt Peak Observatory in Arizona. The corrector contains six lenses, the largest of which is 1.2m is diameter, and the whole assembly stands over 2.1m tall and weighs 2.4 tonnes. The lenses were installed and aligned at UCL to a precision of a few 10s of micrometres.

In addition, our colleagues, Professor David Brooks and Professor Peter Doel helped design, assemble and build the optical corrector at UCL.

Professor Doel said:

"The design, assembly and testing of the large multiple lens system that is the DESI optical corrector was a major undertaking of UCL's Optical Science Laboratory. To provide the sharpest of images, each of the six lenses were aligned to an extremely high accuracy – less than half of a hair's thickness. This precision is maintained as the telescope moves to image the night sky. We're very happy with its excellent performance during the trial runs of the instrument. It's exciting that the full survey is starting and I look forward to all the science discoveries the new data will reveal."

As DESI collects data during its five-year survey, UCL astronomers will be analysing it to reveal the secrets of the universe. UCL astrophysicist, Professor Amelie Saintonge said:

"After years of planning and discussing the science that DESI will make possible, it is very exciting to see the data pour in and start working on better understanding how galaxies grow and how they relate to the dark matter and dark energy framework of the Universe."

DESI is a collaboration involving hundreds of scientists around the world. In the UK it receives funding from the Science and Technology Facilities Council (STFC). Its primary funder is the US Department of Energy's Office of Science. Other UK institutions involved include the universities of Durham, Portsmouth, Edinburgh, St Andrews, Cambridge and Warwick.

High Energy Physics (HEP)

High energy physics (HEP) is about looking at extremely small sizes, or equivalently, at extremely high energies. Its aim is to explore the underlying nature and foundations of the entire physical universe, as well as the forces and laws that govern its development.

As one of the largest particle physics groups in the country our research at UCL HEP covers a wide range of areas, from theoretical physics and exploring the world's highest energy proton-proton collisions at the Large Hadron Collider (LHC), to unlocking the mysteries of neutrinos, searching for illusive dark matter, exploring new physics with precision muon studies and many more. In addition to fundamental physics research we are involved in a number of interdisciplinary and knowledge exchange projects (see the research highlight "Mixed Ion Beam Radiotherapy") and are active in promoting particle physics in schools and among the general public.

The last year has been one of the most exciting in particle physics for some time. A critical result, with considerable UCL leadership, has confirmed that the muon's magnetic dipole moment does not exactly agree with very precise Standard Model calculations (see the research highlight "Anomalous Muon Magnetic Dipole Moment"). Other flavour physics experiments (those which explore the heavier quarks and leptons than those found in ordinary matter) have also found hints of non-Standard Model behaviour. Taken together, we have tantalising (but not yet conclusive) signs of new forces or particles at work.

Work during the ongoing pandemic has continued to be a challenge. However, it's truly impressive how much progress our key projects have been able to make despite the travel and other restrictions. While some of these new ways of working may be here to stay permanently, we're also very much looking forward to spending more time in the department and the labs around the work where we conduct our research. We are also very excited to welcome Dr. Sarah Malik into the group, bringing with her a Royal Society University Research Fellowship. You can read more about her research programme in Quantum Computing for HEP below.

Here we provide a few highlights from 2020–21. More information on the UCL HEP group activities can be found at:
http://www.hep.ucl.ac.uk/research.shtml

ATLAS

ATLAS and the Large Hadron Collider (LHC) have been intensifying efforts to prepare for the restart of data taking in Spring 2022, after a three-year shutdown. One of the main upgrades of the ATLAS detector will be the installation of a new Time-of-Flight system for the Atlas Forward Proton (AFP) detector (see Figure 1). The system will be located in the LHC tunnel, approximately 200 meters either side of the ATLAS interaction point. The detector measures protons that, after a soft interaction that has left them intact, have subsequently deviated out of the LHC beam line. Prof. Mario Campanelli is Deputy Project Leader of the AFP project and UCL is heavily involved in the commissioning and data quality monitoring of the AFP system, which will allow us to observe and study, for the first time, this new class of events and search for new physics in a phase space that has so far been inaccessible.

"One of the main upgrades of the ATLAS detector will be the installation of a new Time-of-Flight system…"

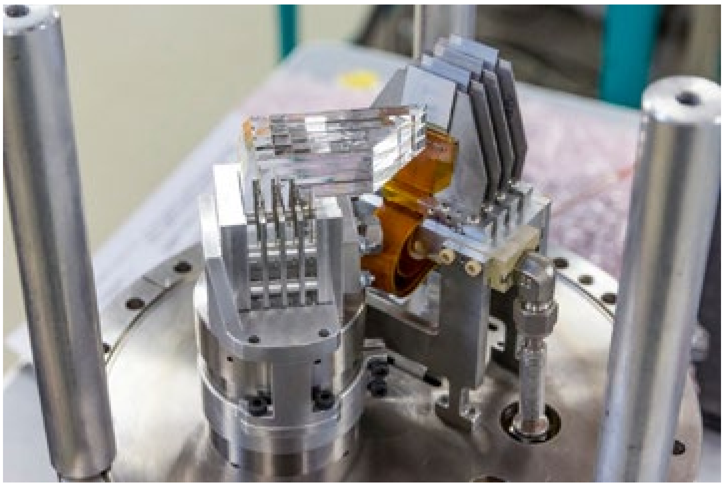


Figure 1
A forward proton detector for the ATLAS experiment.

ATLAS reached a major milestone of 1000 physics results published by June 2021, a testament to the huge wealth and diversity of its physics programme. The UCL ATLAS team has had a leading role in many of those publications. The next LHC running period, Run 3 (2022–25), will more than double the number of events for data analysis and will be another major step forward in the exploration of the energy frontier. An example of a UCL-led analysis that will benefit enormously from the increased statistics is the study of the H→bb-bar process, in particular the topology where the Higgs boson is produced with extremely large transverse momentum, which is a process that is very sensitive to physics beyond the Standard Model. The first result probing such extreme topologies, was published by ATLAS recently with the full Run 2 dataset (Figure 2 shows an example data event with a candidate Higgs boson transverse momentum over 1 TeV). In addition to collecting more data, one of the most significant challenges when selecting H→bb-bar events is in efficiently and accurately reconstructing the trajectories (tracks) of the charged particles produced in the Higgs boson decays. This is vital not just for the H→bb-bar analysis, but for the entire physics programme of ATLAS, and the UCL team has been leading an international effort to significantly enhance these algorithms, which, together with the large increase in data in Run 3, will significantly enhance our sensitivity to new physics.

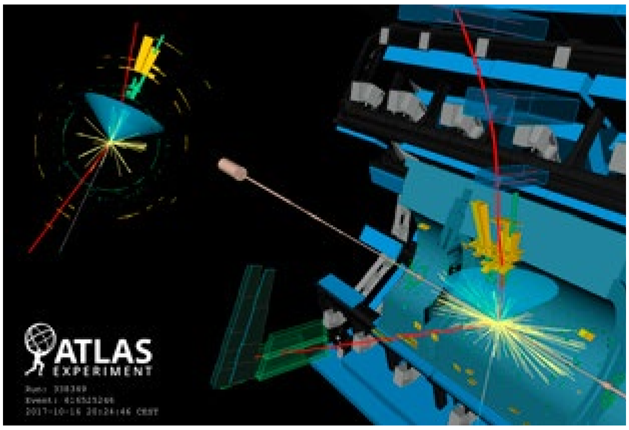


Figure 2
An event display of a candidate high-transverse momentumHiggs decaying to a pair of b-quarks.

"In the past year we have made significant contributions to neutrino oscillation experiments…"

Neutrinos & Dark Matter

The group has a long-standing tradition of initiating and leading international experiments exploring new physics with neutrinos and searching for dark matter. In the past year we have made significant contributions to neutrino oscillation experiments (NOvA, DUNE, CHIPS) and neutrinoless double beta decay experiments (SuperNEMO, LEGEND). Both SuperNEMO and LEGEND are gearing-up to take their first data, and UCL is also playing an important role in establishing LEGEND as a leading-candidate for a next-generation so-called 'tonne-scale' experiment with high discovery sensitivity.

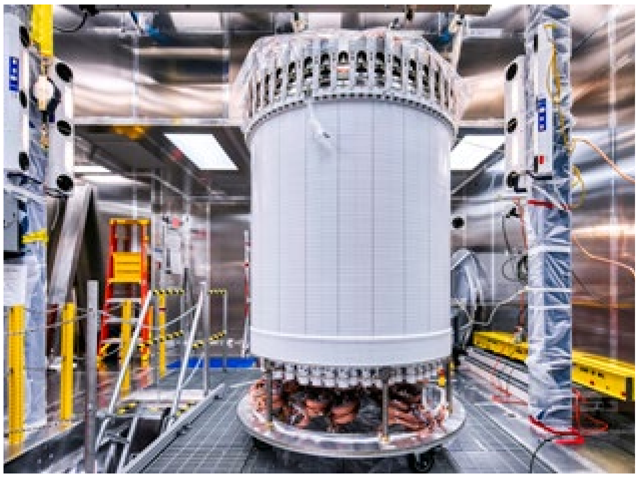


Figure 3
The completed LUX-ZEPLIN Time Projection Chamber in the surface assembly lab at SURF in South Dakota, US.

The 5-year project to construct the LUX-ZEPLIN (LZ) Dark Matter Experiment was successfully completed with the installation of the detector 1.5 km under the Earth's surface at the Sanford Underground Research Facility, S. Dakota, USA (see Figure 3). LZ is now being commissioned ready for first data taking later this year and the most sensitive direct search for galactic Dark Matter ever performed.

Quantum Computing for HEP

The goal of this project is to study the potential role of quantum computers in tackling some of the most challenging problems in high energy physics. In the first of a series of papers we have used quantum computers to simulate the complexity of high energy particle collisions, such as the ones seen at the Large Hadron Collider (LHC). We exploit the equivalence of q-bits and spinors to calculate the hard interaction using helicity amplitudes and design an algorithm that simulates the parton shower process (see Figure 4). This is a first step towards a quantum computing algorithm to model the full collision event at the LHC and a demonstration of using quantum computers to model an intrinsically quantum system.

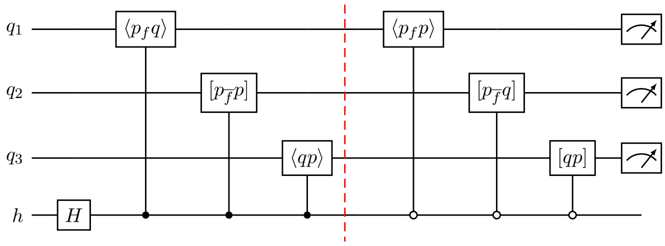


Figure 4 A quantum circuit representing the splitting of a gluon into a quark-antiquark pair.

Theory

The UCL group is the centre for work on one of the very small number of global fits for parton distribution functions. All processes at hadron colliders, in particular the Large Hadron Collider at CERN, rely on the description of the protons in terms of its constituent quarks, antiquarks and gluons, generically known as partons. The structure of the proton is described in terms of parton distribution functions, PDFs, which describe how many of each of the partons carry a fraction ("x") of the proton's total momentum. Moreover, these fractions change as a function of the energy scale of a proton collision, as higher energy collisions probe more deeply inside the proton. The PDFs are obtained by comparing theoretical predictions using the theory of strong interactions, Quantum Chromodynamics (QCD) to a very wide variety of data from different experiments, and maximising the likelihood of the fit quality. This is a very large ongoing project, and major updates only take place a couple of times a decade. The MSHT group at UCL provided the first major update since 2014 with the MSHT2020 PDFs, which now use a very large amount of LHC data and calculations to next-to-next-to leading perturbative order in QCD (Figure 5). These provide the PDFs with a precision and accuracy of a couple of percent over a very wide range of x, and are the most up-to-date and complete set of parton distributions currently available. As such they will play a vital role in developments at the LHC, both in increasing our understanding of the Standard Model and in searches for new Physics.

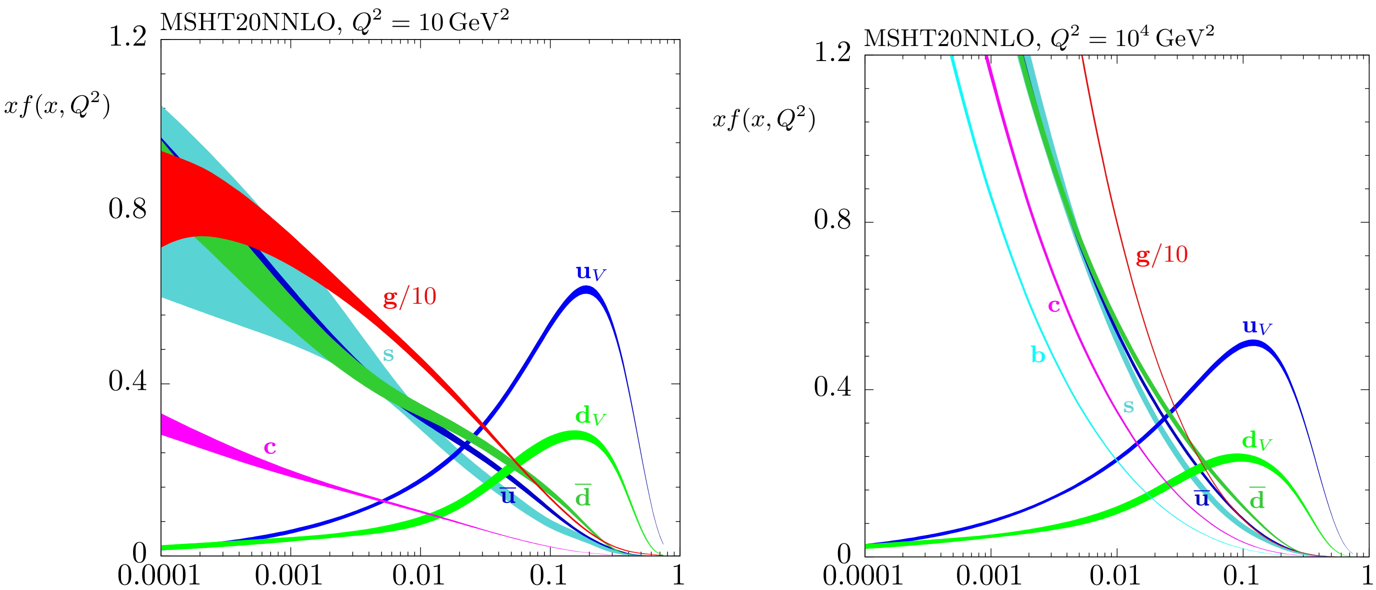


Figure 5
The latest parton density functions for different quark flavours and gluons inside the proton, at low momentum transfer (left) and high momentum transfer (right).

Atomic, Molecular, Optical and Positron Physics (AMOPP)

The research activities in the Atomic Molecular Optical and Positron Physics (AMOPP) group cover a wide range of topics, from precision spectroscopy of perhaps the simplest atom – positronium – to studies involving microcavity polaritons – quasi particles composed of a photon bound to a quantum-well exciton – biomolecules, trapped nanoparticles, and superconducting circuits.

Over the last year the Covid-19 pandemic significantly impacted everyone in the group. Activities in our laboratories ceased for several months in late spring 2020, and our staff, research fellows, and PhD students began working from home. By mid summer 2020 some laboratory activities restarted. Nevertheless, throughout the 2020/21 academic year working from home remained the default mode of operation. However, even under these extremely challenging circumstances, an exceptional range of world-class research has been carried out in the group.

In the area of low-energy tests of fundamental physics Prof David Cassidy's group reported the most precise measurements every made of the fine-structure in the $n = 2$ excited state of positronium (see research highlight). This work represents an experimental test of bound-state quantum electrodynamics, and offers opportunities to search for beyond-Standard-Model physics. Profs Peter Barker, Sougato Bose and Alessio Serafini led studies of new approaches to detecting time-dependent gravitational accelerations including gravitational waves (Figure 1), and investigating entanglement induced by effects of quantum gravity using levitated nanoparticles.

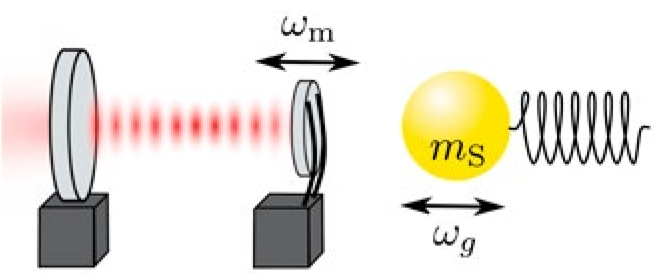


Figure 1

The time-dependent gravitational acceleration of the end mirror of a Fabry-Pérot cavity caused by the presence of an oscillating test mass. From S. Qvarfort, A. D. K. Plato, D. E. Bruschi, F. Schneiter, D. Braun, A. Serafini and D. Rätzel, Phys. Rev. Research 3, 013159 (2021).

Prof Stephen Hogan, together with collaborators in the HEP group, and in Cambridge, Swansea and NPL started a new large-scale project funded jointly by the STFC and EPSRC to exploit AMO physics techniques – including magnetic confinement of cold tritium atoms and Rydberg-atom magnetometry – to measure the neutrino mass.

> "…under these extremely challenging circumstances, an exceptional range of world-class research has been carried out in the group."

Work in the group on theoretical quantum optics and quantum information processing over the last year led to a proof by Prof Sougato Bose and colleagues that optimal quantum spatial search can be achieved in 1D spin chains. This has important implications for the implementation of efficient quantum algorithms using spin chains. Prof Dan Browne led work on the numerical optimisation of quantum computing systems comprising limited numbers of qubits with comparatively high gate error rates – as encountered in currently operational quantum processors; and studies of the use of a cellular automaton for error correction in quantum codes. Prof Alessio Serafini and his group investigated entanglement in hydrogenic systems bound by attractive $1/r$ potentials. Prof Marzena Szymańska's group reported new studies of vortex dynamics in 2D, non-equilibrium many-body systems. This work is relevant to understanding driven-dissipative mocrocavity polaritons, and synchronisation and frequency stability in networks of coupled oscillators, including, e.g., optomechanical oscillators. Prof Szymańska and her group also investigated spontaneous nucleation of topological defects by the Kibble-Zurek mechanism in systems of exciton-polaritons in microcavities, and approaches to the realisation of polariton parametric oscillators upon dynamic control of these exciton-polaritons using acoustic waves. They also reported studies of symmetry breaking in Floquet time crystals, the development of a tensor-network algorithm to describe the dynamics in two-dimensional quantum lattice models (Figure 2), and work on critical slowing down of the time it takes an engineered superconducting circuit to reach equilibrium as a signature of bistability in a dissipative first-order phase transition.

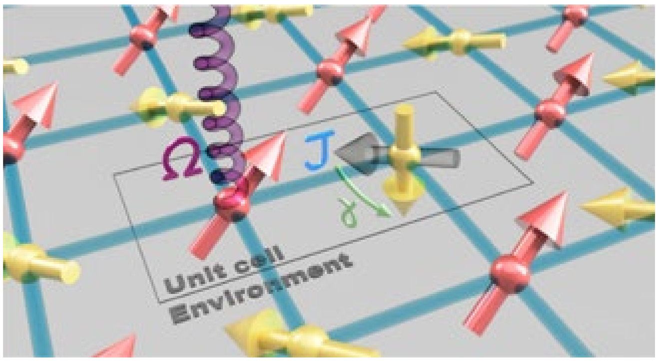


Figure 2
Open quantum lattice model of interacting spins. From C. Mc Keever and M. H. Szymańska, Phys. Rev. X, 11, 021035 (2021).

Experimental work involving cold atoms and molecules, quantum interfaces and quantum sensing is performed in the groups of Prof Stephen Hogan and Prof Ferruccio Renzoni. Recent work in Prof Hogan's group on the development of hybrid interfaces between gas-phase Rydberg atoms and superconducting microwave circuits led to the use of helium Rydberg atoms as microscopic probes of the spectral characteristics of a single co-planar waveguide resonator mode. Prof Renzoni's group reported new studies of approaches to focussing low-frequency oscillating magnetic fields for applications in imaging by magnetic induction tomography, contactless power transmission and underwater communication. They also demonstrated electromagnetic induction imaging with an unshielded portable scanning radio-frequency atomic magnetometer (Figure 3) which has applications in security screening and medical imaging.

Work on cavity optomechanics with levitated anoparticles has opened a range of new opportunities for low-energy tests of fundamental physics as discussed above. In the broader context of this research area Prof Peter Barker's group demonstrated levitation of nanoparticles in tailored optical potentials generated using light with a broad spectral width. Prof Tania Monteiro led theoretical studies of two-dimensional levitated nanoparticle cooling by coherent light scattering. And Prof Alessio Serafini worked on studies of optical coherent feedback in cooling, quantum squeezing, entanglement, and optical-to-mechanical state transfer in cavity optomechanics.

Theoretical studies of atoms and molecules in strong and short-wavelength laser fields carried out in the last year included work in Prof Agapi Emmanouilidou's group on multiphoton absorption on attosecond timescales in the extreme ultraviolet region of the electromagnetic spectrum that leads to multiple ionisation of gas-phase atoms, ionisation dynamics of N_2 and CO in pulses of light generated in X-ray free-electron lasers, and differences in the effects of magnetic fields on nonsequential double ionisation of atoms and of small molecules. Prof Carla Figueira de Morrison Faria and her group obtained new insights into holographic interference patterns between different electron trajectories upon ionisation of atoms in

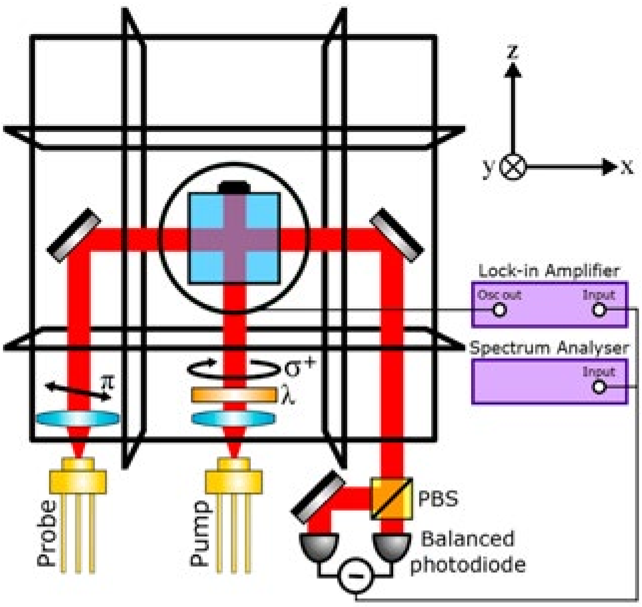


Figure 3
Schematic diagram of apparatus developed for electromagnetic induction imaging with a scanning radio frequency atomic magnetometer. From C. Deans, Y. Cohen, H. Yao, B. Maddox, A. Vigilante and F. Renzoni, Appl. Phys. Lett., 119, 014001 (2021).

strong laser fields. They investigated contributions from the orbital angular momentum of photoelectrons produced in strong-field ionisation to vortex interference features observed when an atom is subjected to a sequence of strong counter-rotating circularly polarised laser fields separated by a time delay. They also introduced a method to determine the parity of atomic or molecular orbitals using photoelectron holography, and developed a new analytical approach to calculating wavepacket dynamics in double well potentials.

> "Dr Isabel Llorente-Garcia used single-molecule super-resolution imaging to study binding of the HIV virus to host-cell receptors at the nanoscale."

In the area of theoretical molecular physics and spectroscopy Prof Jonathan Tennyson led work on a range of new calculations of effects of electron scattering from small molecules including BF, BF_2, BeH, CO, H_2, N_2, N_2^+, NO, PF_3, and SF_6. This included, e.g., studies of electron impact ionisation, dissociative excitation and dissociative electron attachment. Together with Prof Sergey Yurchenko and colleagues he also published new high-precision spectral line lists calculated for molecules of interest in the characterisation of exoplanet and other hot atmospheres, including, e.g., CaOH, KOH, NaOH and NO. These calculated spectral line lists are widely used by the astronomy community to identify molecules present in exoplanet atmospheres. This type of interdisciplinary collaboration resulted, in this last year, in the discovery of new carbon and nitrogen bearing molecules in the atmosphere of a gaseous giant exoplanet. Prof Yurchenko and his team also investigated spectroscopic properties of molecules that arise from effects of non-local thermodynamic equilibrium. They set out a robust methodology for modelling spectra of polyatomic molecules produced in reactive or dissociative environments, e.g., exoplanet atmospheres, under these conditions. In addition to this, Profs Yurchenko and Tennyson and their colleagues identified previously unexplored contributions of electric quadrupole and magnetic dipole transitions in infrared spectra of H_2O and CO_2, and developed a new spectroscopic model to describe the low-lying electronic states of NO.

Research activities in optical biophysics in the AMOPP group connect with the BioP group. In this last year Prof Angus Bain and colleagues reported new studies of fluorescent molecules that can be used to optically probe biophysical environments.

Dr Isabel Llorente-Garcia used single-molecule super-resolution imaging to study binding of the HIV virus to host-cell receptors at the nanoscale. Prof Alexandra Olaya-Castro led theoretical work on spontaneous synchronisation dynamics of vibrations that assist energy transfer in biomolecules. She and her group also proposed a new scheme to monitor the way in which quantum systems lose their quantum mechanical features as classical behaviour emerges. The classical behaviour that emerges in this way when a quantum system decoheres as a result of interactions with its environment, is sometimes referred to as being a consequence of Quantum Darwinism.

This year's Carey Foster Prize 'for outstanding postgraduate physics research in AMOPP' was awarded jointly to Dr Alexandre Morgan and Dr Sofia Qvarfort for their theses on 'Coupling Rydberg atoms to superconducting microwave circuits', and 'Quantum metrology with optomechanical systems in the nonlinear regime', respectively.

Many of the staff, research fellows and PhD students in the AMOPP group made major contributions to the organisation of virtual seminar series and virtual workshops on various topics in AMO physics over the last year. These online events were particularly important for knowledge transfer during the Covid-19 pandemic. They included, e.g., the 'UniKORN Seminars' of BORN the British Optomechanical Research Network, the 'Quantum Battles in Attoscience' virtual workshop, the 'AttoFridays' seminar series, 'Frontiers of Ultrafast Science' seminars, and a seminar series on 'Quantum Information, Gravity and Experiment'. These events, many of which occurred on a weekly basis, regularly attracted large and diverse international audiences. The efforts made by members of our local AMOPP research community, to bring together our international communities in these difficult times, are a great credit to our group and our department.

Biological Physics (BioP)

The Biological Physics group focuses on solving key intellectual and practical problems in the physics of biological systems and the underlying properties of soft matter, from molecular to cellular length scales, by using experimental, computational and theoretical methods. It overlaps with the cross-faculty UCL Institute for the Physics of Living Systems (IPLS), which promotes interdisciplinary approaches that combine physics and biology to understand fundamental properties of living systems. Several of its activities focus on membranes and their role in defining and compartmentalising living matter, as described below.

The cell membrane: tough but soft

If someone would ask you to draw a cell — the unit of life on Earth — you would likely first draw a basic circular shape that represents the cell membrane. Indeed, the cell is defined by its membrane that separates it from its environment. The cell membrane is a thin layer of lipid molecules that protects the bustling biochemical life occurring on the cell interior. In complex cells, like ours, it also defines numerous inner cellular compartments. Cell membranes have unique physical properties — they are self-assembled and resilient, but still fluid and soft.

Shape of my membrane

Virtually all essential cellular processes require reshaping, cutting, and resealing of cell membranes. For instance, cell division — the basic condition for the existence of life — requires deforming and cutting the membrane that envelops the cell. The cell membrane also needs to be reshaped for the cell to take in nutrients from the environment and expel waste. Pathogens, such as viruses, also need to breach this outer layer to infect the cell. Analogously, the delivery of therapeutic materials to diseased cells requires transport across the membrane barrier.

Bend me and pinch me

Remodelling of cell membranes is at its heart a physical process that requires precise mechanical work executed at the nanoscale. A wide array of protein molecules have evolved to bend, cut, and seal soft membranes. These proteins adhere to the membrane, spontaneously combine into higher-order structures, called assemblies, which then jointly bend and remodel the attached membrane surface. These protein assembly processes are often driven far from thermodynamic equilibrium, through the consumption of energy-rich molecules, which ensures that protein assembly is timely and reversible. Pathogens also often exploit these protein assemblies to penetrate the cell. It is important to understand the physical principles behind membrane remodelling, both to understand the basic rules of life, but also to prevent the uptake of undesired species and to deliver therapeutics to cells.

Simulate me

Membrane reshaping includes many complex interconnected effects that are difficult — or even impossible — to separate from one another in experiment. Even if we did have experimental techniques to observe protein assembly and membrane remodelling in complete detail, we might still not understand how and why they occur, and which physical forces control them. This is, however, possible to investigate in computer simulations.

While not amenable to detailed molecular simulation, membrane remodelling is perfectly suitable for treatment via computer models rooted in statistical mechanics and soft matter physics. Such “coarse-grained” computer simulations represent protein and membrane molecules only by their key physical and chemical properties — usually encoded in their shapes and effective interactions. These models can reach experimental scales and have a unique ability to capture the complexity at the nanoscale. The Saric lab develops custom-made coarse-grained models to investigate the physical principles of how membrane remodelling structures function and provide design guidelines for membrane crossing vehicles.

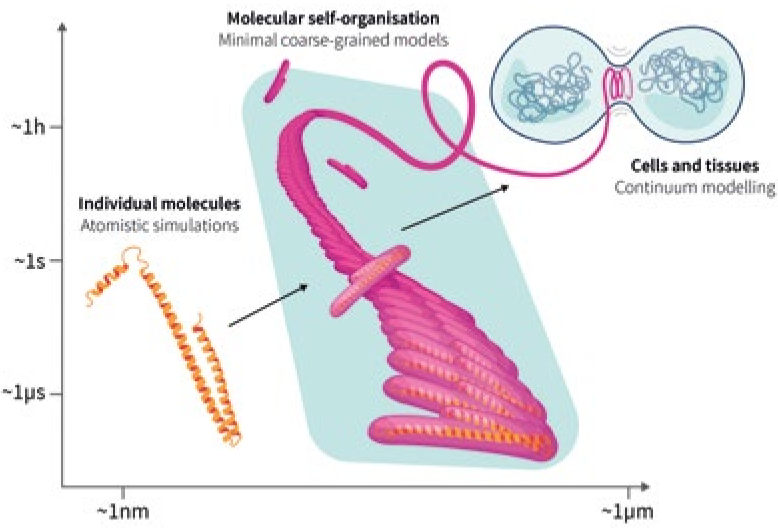


Figure 1 Computational modelling covers various scales involved in the emergence of life. The Saric lab develops minimal coarse-grained models that bridge molecular and continuum scales.

Elastic and shapeshifting

One particular protein — called ESCRT — self-assembles into spiral and helical nanoscale filaments and is able to deform cell membranes into a wide variety of shapes, including upward and downward tubes and cones, which can cut membrane surfaces into tubes and sphere. This filament is highly evolutionary conserved and is required for many important cell processes, from virus release to cell division. How this nanoscale filament works remained a mystery for decades.

Collaborating with the experimental teams of Buzz Baum (UCL LMCB/LMB Cambridge) and Aurelién Roux (University of Geneva), the Saric group developed the first computer model for membrane reshaping and cutting by ESCRT filaments. They showed that the filament acts as an active elastic shapeshifting material — by changing its own shape through a sequence of geometrical transformations, the filament changes the shape of the membrane it is attached to.

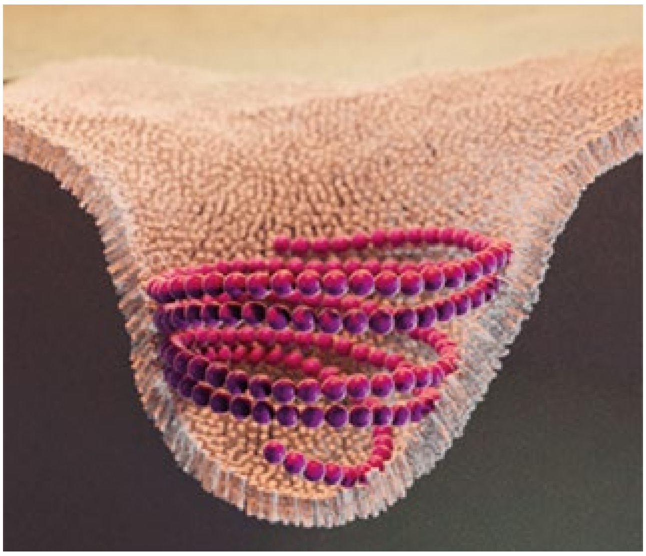


Figure 2 Snapshot from our simulations showing active elastic ESCRT filament deforming initially flat membrane.

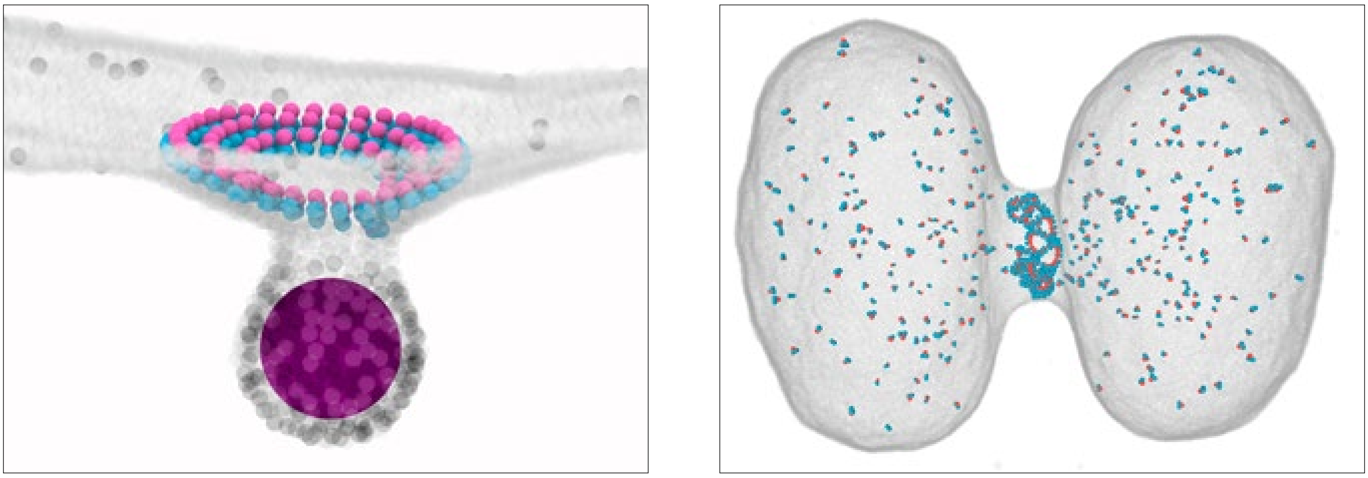


Figure 3 Our model for ESCRT filament cutting the cell membrane to release cargo (left) and to divide the cell into two (right).

One becomes two

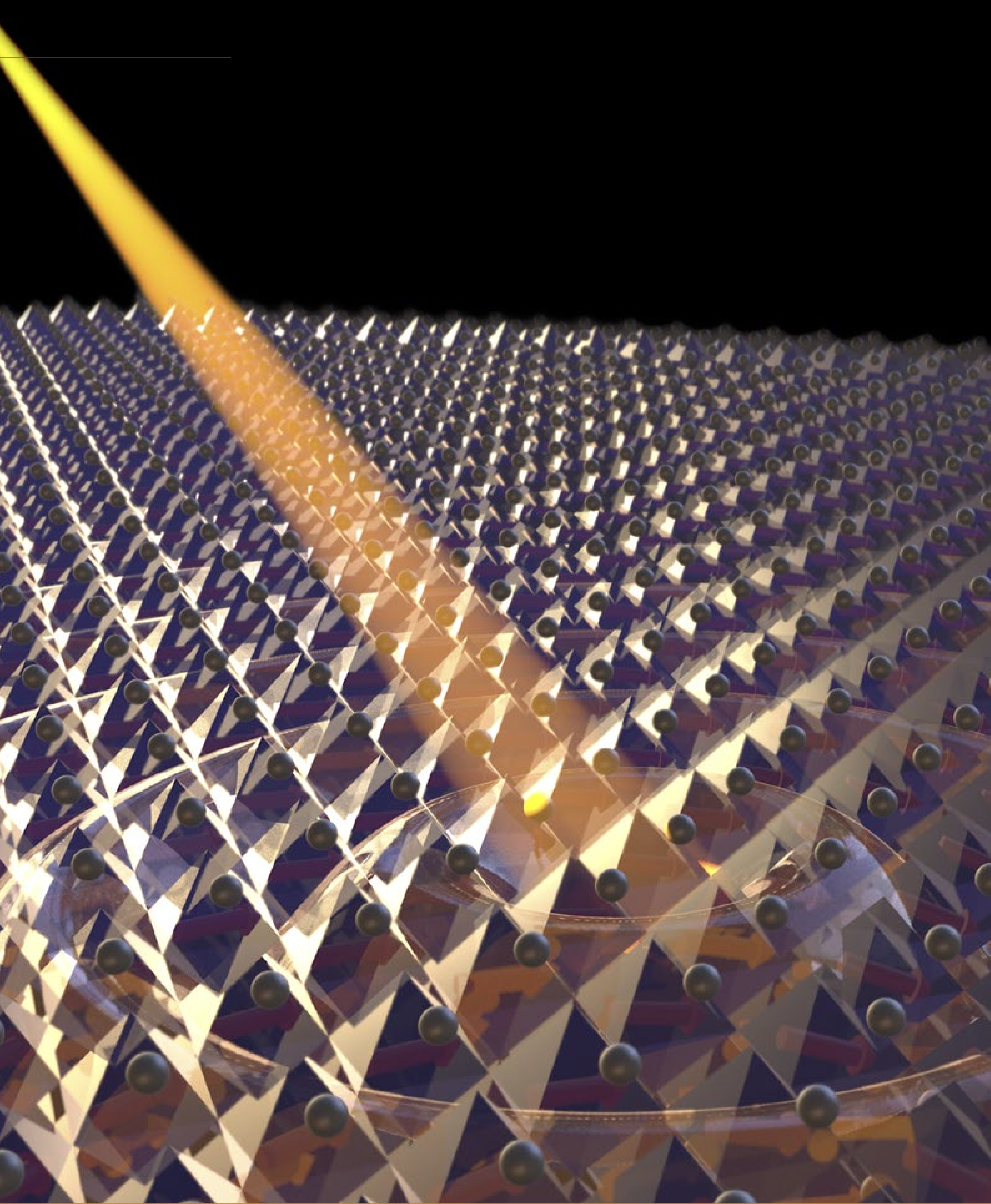
ESCRT filaments are also crucial for snipping the bridge between the two daughter cells during cell division. Together with the Baum team, the Saric group revisited to evolutionary origins of this process— they investigated cell division in evolutionary "old" unicellular organisms called archaea. They developed the first computer model for cell division of archaea and identified a new mechanism for cell division, by super-coiling of an elastic coil. Remarkably, a simple physical model, based on beads and springs and simple interactions, can recover a process as complex as cell division. The model provided quantitative matching with live cell imaging data, which opens a new avenue for placing sot matter simulations in the context of a living cell.

Powered by:

UCL PhD student Lena Harker-Kirschneck, PDRAs Anne Hafner and Xiuyun Sharon Jiang, ERC Starting Grant "NEPA", Royal Society University Research Fellowship, Volkswagen Foundation 'Life' grant, BBSRC programme LIDO.

Read more:

- L. Harker-Kirschneck et al., bioRxiv 10.1101/2021.03.23.436559 (2021).
- J. Forster et al. Phys Rev Lett, 125, 228101 (2020).
- G. T. Risa et al., Science, 369, 6504 (2020).
- A.-K. Pfitzner et al., Cell 182, 1140 (2020).
- L. Harker-Kirschneck et al., BMC Biology 17, 1-8 (2019).

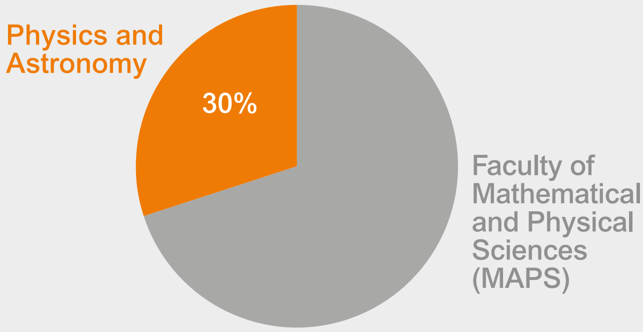


Research Statistics

Research Statistics

Active Grants and Contracts

In the last financial year (Aug 2019 – Jul 2020), the MAPS faculty as a whole yielded £37,561 with the Department of Physics and Astronomy contributing £11,343 (30%) of the total research income for the MAPS faculty.



Astrophysics (Astro)

EPN-2024-RI, (European Commission), PI: Prof Nick Achilleos, £47,400

Predicting the upper atmospheric response to extremes of space weather forcing, (NERC), PI: Dr Anasuya Aruliah, £49,225

SNDUST: Supernova Dust: Production and Survival Rates, (European Commission), PI Prof Michael Barlow, £2,133,028

Solar System Consolidated Grant 2019-22, (STFC), PI: Prof Nick Achilleos; £457,240

The origin of cosmic dust in galaxies, (STFC), PI: Dr Ilse De Looze, £512,669

Early star-forming galaxies and cosmic reionisation, (European Commission), PI: Prof Richard Ellis, £2,068,100

UCL Astrophysics PATT Travel Grant 2020–22, (STFC), PI: Prof Jay Farihi, £37,279

Towards new physics from next-generation cosmological data, (Royal Society), PI: Dr Stephen Feeney, £572,894

New cosmology measurements with voids in next-generation galaxy surveys, (STFC), PI: Dr Andreu Font Ribera, £527,837

F/SHIP DR Andreu Font-Ribera: Precision cosmology at high redshift with the Lyman-alpha forest, (STFC), PI: Dr Andreu Font Ribera, £491,529

DiRAC-3 Operations 2019-2022 – UCL, (STFC), PI: Dr Clare Jenner, £912,851

DiRAC 2.5y Bridging Funding – UCL, (STFC), PI: Dr Clare Jenner, £156,599

Euclid UK SGS Bridging Grant- UCL, UK Space Agency); PI: Dr Benjamin Joachimi, £315,115

Newton Fund for capacity building in data intensive science in the Middle-East, (STFC), Prof Ofer Lahav, £303,213

Quantum Simulators for Fundamental Physics Version A, (STFC), PI: Prof Hiranya Peiris, £602,976

Understanding the diversity of galaxy morphology in the era of large spectroscopic surveys, (European Commission), PI: Prof Andrew Pontzen, £1,392,984

Towards new physics from next-generation cosmological data, (STFC), PI: Prof Andrew Pontzen, £519,699

Consolidating leadership in a new approach to galaxy formation (Royal Society), PI: Prof Andrew Pontzen, £215,701

Understanding the Hubble sequence, (Royal Society), PI: Prof Andrew Pontzen, £356,434

UKRI COVID 19 Grant Extension Allocation, (UK Research and Innovation (UKRI)), PI: Dr Benjamin Joachimi, £75,033

UKRI COVID 19 Grant Extension Allocation, (UK Research and Innovation (UKRI)), PI: Dr Clare Jenner, £35,567

UCL Astrophysics Consolidated Grant 2021–2024, (STFC), PI: Prof Amelie Saintonge, £780,047

Cold gas as a probe of galaxy evolution: the dust connection, (Royal Society), PI: Prof Amelie Saintonge, £220,671

Cold gas as a probe of galaxy evolution, (Royal Society), PI: Prof Amelie Saintonge, £352,853

Cold gas as a probe of galaxy evolution: multi-phase outflows at high resolution, (Royal Society), PI: Prof Amelie Saintonge, £106,838

Dynamics of the Milky Way with Gaia, (Royal Society), PI: Dr Jason Sanders, £459,428

Dynamics of the Milky Way with Gaia, (Royal Society), PI: Dr Jason Sanders, £459,428

Development of Large Anti-Reflection Coated Lenses for Passive (Sub)Millimeter-Wave Science Instruments, (European Space Agency), PI: Prof Giorgio Savini, £44,423

PRISTINE design: a space mission to measure high accuracy deviations from the uniform black-body spectrum, (Royal Society), PI: Prof Giorgio Savini, £11,700

Distributed Pipelines for Networks of Robotic Telescopes, (Konica Minolta Business Solutions Europe GMBH), PI: Prof Giorgio Savini, £36,000

ESA M4 Mission ARIEL Post Adoption, (STFC), PI: Prof Giovanna Tinetti, £55,405

ESA M4 mission ARIEL Post adoption, (STFC), PI: Prof Giovanna Tinetti, £61,910

ARIEL Science Advisory Team UK Activities, (STFC), PI: Prof Giovanna Tinetti, £87,309

ARIEL space mission Phase B, (UK Space Agency), PI: Prof Giovanna Tinetti, £214,993

Exoplanet Atmosphere New Emission Transmission Spectra Analysis, (European Commission), PI: Prof Giovanna Tinetti, £181,963

AstroChemical Origins, (European Commission), PI: Prof Serena Viti, £450,516

The Interstellar Medium and Star Formation in Extreme Galactic Environments, (Royal Society), PI: Prof Serena Viti, £12,000

UCL Astrophysics Consolidated Grant 2018-2021, (STFC), PI: Prof Serena Viti, £15,632

UCL Astrophysics Consolidated Grant 2018-2021, (STFC), PI: Prof Ofer Lahav, £460,325

UCL Astrophysics Consolidated Grant 2018-2021, (STFC), PI: Prof Andrew Pontzen £129,713

UCL Astrophysics Consolidated Grant 2018-2021, (STFC), PI: Prof Jay Farihi, £332,067

UCL Astrophysics Consolidated Grant 2018-2021, (STFC), PI: Prof Sergey Yurchenko, £371,077

ExoAI: Deciphering super-Earths using Artificial Intelligence, (European Commission), PI: Dr Ingo Waldmann, £1,258,528

Using switches to control clusters and data flows, (Mellanox Technologies LTD), PI: Dr Jeremy Yates, £48,136

Computer vision and machine learning for pattern recognition in LHC data, (Lenovo Technology (UTD KINGDOM)), PI: Dr Jeremy Yates, £48,500

S/SHIP De Ceuster: Accelerated 3D general purpose radiative transfer codes, (INTEL Corporation UK LTD) PI: Dr Jeremy Yates, £27,144

Atomic, Molecular, Optical and Positron Physics (AMOPP)

New approaches to studying redox metabolism using time-resolved NAD(P)H fluorescence and anisotropy, (BBSRC), PI: Prof Angus Bain, £296,382

Laser refrigeration on the nanoscale: From nanocryostats to quantum optomechanics, (EPSRC), PI: Prof Peter Barker, £729,667

Testing the Large-Scale Limit for Future Quantum Technologies, (European Commission), PI: Prof Peter Barker, £415,197

Quantum Code Design and Architecture, (EPSRC), PI: Prof Dan Browne, £246,719

Production of positronium atoms, ions, and molecules, (EPSRC), PI: Prof David Cassidy, £853,721

Control and Spectroscopy of Excited States of Positronium, (EPSRC), PI: Prof David Cassidy, £802,355

Exotic forms of matter in molecules driven by Free-Electron Lasers, (Leverhulme Trust), PI: Prof Agapi Emmanouilidou, £180,939

Semi Classical Models for Ultra Fast Multi Electron Phenomena in intense Electro Magnetic Laser Fields, (EPSRC), PI: Prof Agapi Emmanouilidou, £336,665

AQuA DIP: Advanced Quantum Approaches to Double Ionisation Processes, (EPSRC), Prof Carla Figueira De Morisson Faria, £388,202

CATMOLCHIP: cold atmospheric molecules on a chip, (European Commission), PI: Prof Stephen Hogan, £1,720,983

Optomechanical sensors: rapid prototyping for navigation and quantum technologies, (Royal Academy of Engineering), PI: Dr Ying Lia Li, £198,855

Quantum Computing and Simulation Hub, (EPSRC), PI: Prof Dan Browne, £252,643

Prosperity Partnership in Quantum Software for Modeling and Simulation, (EPSRC), PI: Prof Dan Browne, £308,579

Revealing unambiguous signatures of quantum coherence in photosynthetic complexes on a photonic chip, (Gordon and Betty Moore Foundation), PI: Prof Alexandra Olaya-Castro, £1,024,321

Quantum information applied to fundamental physics, (EPSRC), Prof Jonathan Oppenheim, £623,081

Lead Princeton Uni: It from Qubit: Quantum Fields, Gravity and Information, (Simons Foundation), PI: Prof Jonathan Oppenheim, £473,651

Non-Ergodic Quantum Manipulation, (EPSRC), PI: Professor Sougato Bose, £570,713

UKRI COVID 19 Grant Extension Allocation, (UK Research and Innovation (UKRI)), PI: Prof Angus Bain, £9,399

UKRI COVID 19 Grant Extension Allocation, (UK Research and Innovation (UKRI)), PI: Prof Jonathan Tennyson, £20,452

UKRI COVID 19 Grant Extension Allocation, (UK Research and Innovation (UKRI)), PI: Prof Gaetana Laricchia, £18,931

UKRI COVID 19 Grant Extension Allocation, (UK Research and Innovation (UKRI)), PI: Prof David Cassidy, £35,000

UKRI COVID 19 Grant Extension Allocation, (UK Research and Innovation (UKRI)), PI: Prof Angus Bain, £24,637

UKRI COVID 19 Grant Extension Allocation, (UK Research and Innovation (UKRI)), PI: Prof Marzena Szymanska, £40,000

Novel sensors for the detection of explosives, (Defence Science and Technology Laboratory), PI: Prof Ferruccio Renzoni, £9,270

Atomic magnetometers with ultracold atoms, (EPSRC), PI: Prof Ferruccio Renzoni, £67,665

Single-shot screening for security applications – Phase 2, (Defence Science and Technology Laboratory), PI: Prof Ferruccio Renzoni, £117,747

Atomic magnetometers for NMR and NQR sensing of illicit materials, (Defence Science and Technology Laboratory), PI: Prof Ferruccio Renzoni, £64,200

Vehicle Checkpoint with Atomic Magnetometers - Phase II, (Defence Science and Technology Laboratory), PI: Prof Ferruccio Renzoni, £223,676

Coherent Gamma Rays from BEC of 135mCs isomer, (Atomic Weapons Establishment), PI: Prof Ferruccio Renzoni, £29,612

Far from Equilibrium Quantum Simulators, (EPSRC), PI: Prof Marzena Szymanska, £ 850,350

Polariton lattices: a solid-state platform for quantum simulations of correlated and topological states, (EPSRC), PI: Prof Marzena Szymanska, £116,174

Quantum Simulations for Real Problems, (RAHKO LTD), PI: Prof Jonathan Tennyson, £24,575

Exploring complexity and scalability of Near-term Quantum Computing algorithms for Quantum Chemistry, (RAHKO LTD), PI: Prof Jonathan Tennyson, £33,000

ExoMolHD: Precision spectroscopic data for studies of exoplanets and other hot atmospheres, (European Commission), PI: Prof Jonathan Tennyson, £1,989,072

Electron initiated chemistry: dissociative attachment of small molecules (Royal Society), PI: Prof Jonathan Tennyson, £2,500

Detailed models of technological plasmas, (QUANTEMOL LTD), PI: Prof Jonathan Tennyson, £23,000

Short wavelength absorption by water vapour, (NERC), PI: Prof Jonathan Tennyson, £272,984

Electron impact vibrational excitation of molecules, (QUANTEMOL LTD), PI: Prof Jonathan Tennyson, £23,000

Towards quantum-based realisations of the pascal, (European Commission), PI: Prof Jonathan Tennyson, £56,000

UK Atomic, Molecular and Optical physics R-matrix consortium (UK AMOR), (EPSRC), PI: Prof Jonathan Tennyson, £326,139

Integrated software for electron-molecule collisions, (STFC), PI: Prof Jonathan Tennyson, £ 322,353

Quantum processes assisted with machine learning: application and development, (Moscow Witte University), PI: Prof Sergey Yurchenko, £132,277

Condensed Matter & Materials Physics (CMMP)

Advancing first principles computational modelling of electron transfer processes at molecule/electrode interfaces, (Pacific Northwest National Laboratory), PI: Prof Jochen Blumberger, £25,444

Softcharge: charge carrier transport in soft matter: from fundamentals to high-performance materials, (European Commission), PI: Prof Jochen Blumberger, £1,703,779

Centre for Advanced Materials For Integrated Energy Systems (CAM – IES), (EPSRC), PI: Prof Franco Cacialli, £83,733

Multifunctional Polymer Light-Emitting Diodes with Visible Light Communications (MARVEL), (EPSRC), PI: Prof Franco Cacialli, £372,355

F/SHIP Eberhardt: Nature Versus Nurture: The Effect of Stellar Irradiation On Atmospheric Evolution, (Royal Astronomical Society), PI: Dr Jo Barstow Eberhardt, £165,219

Domai Switching in Multifunctional Materials: Towards a Multiferroic Memory, (Royal Society), PI: Dr Roger Johnson, £155,256

Spin physics in Two-Dimensional Layered Ferromagnets, (EPSRC), PI: Prof Chris Howard, £36,755

Graphene Flagship Core Project 3, (European Commission), PI: Prof Chris Howard, £29,709

The Materials and Molecular Modelling Hub, (EPSRC), PI: Prof Angelos Michaelides, £4,510,208

TIER 2 Hub in Materials and Molecular Modelling, (EPSRC), PI: Prof Angelos Michaelides, £4,000,000

Correlated Non-Equilibrium Quantum Matter: Fundamentals and Applications to Nanoscale Systems, (European Commission), PI: Dr Arijeet Pal, £1,196,382

UKRI COVID 19 Grant Extension Allocation, (UK Research and Innovation (UKRI)), PI: Prof Alexander Shluger, £16,265

Dynamical Redesign of Biomolecular Networks, (European Commission), PI: Dr Edina Rosta, £775,054

TeraHertz Detection Enabled by Molecular Optomechanics, (European Commission), PI: Dr Edina Rosta, £185,902

Atomistic calculations of relevant point defects near the SiC/SiO2 interface, (Infineon Technologies Austria AG), PI: Prof Alexander Shluger, £45,000

Degradation and dielectric breakdown in modern HfON based devices, (Synopsys INC), PI: Prof Alexander Shluger, £36,000

Molecular dynamics simulation of interface structure of interface structure and interface diffusion phenomena for the Cu/TiW system, (Infineon Technologies Austria AG), PI: Prof Alexander Shluger, £40,000

Defect Functionalized Sustainable Energy Materials: From Design to Devices Application, (EPSRC), PI: Prof Alexander Shluger, £470,811

S/SHIP Jakobsen: Adsorption Self-Assembly, (University of Hamburg), PI: Prof Alexander Shluger, £32,000

S/SHIP: Atomistic Modeling 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

Uncovering hidden phases of metal-amine solutions: glasses to superconductors, (Leverhulme Trust), PI: Prof Neal Skipper, £210,857

Materials and Molecular Modelling High Performance (Hpc) Hub, (OCF PLC), PI: Miss Karen Stoneham, £140,000

Materials and Molecular Modelling Exascale Design and Development Working Group, (EPSRC), PI: Miss Karen Stoneham, £3,701

Surface and Interface Toolkit for the Materials Chemistry Community, (EPSRC), PI: Prof Alexander Shluger, £91,390

Materials for Neuromorphic Circuits, (European Commission), PI: Dr Pavlo Zubko, £219,210

FNR - Fundamentals of Negative Capacitance: Towards New Low Power Electronics, (EPSRC), PI: Dr Pavlo Zubko, £464,861

High Energy Physics (HEP)

Uncovering the Origin of Neutrino Masses through Direct Searches and Global Fits, (STFC), PI: Dr Matteo Agostini, £529,519

Towards leptonic CP violation with NOvA and T2K, (Royal Society), PI: Dr Chris Backhouse, £110,231

Maximizing NOvA physics potential with test beam measurements, (Royal Society), PI: Dr Chris Backhouse, £99,209

Unlocking neutrino mysteries with the nova and dune experiments, (Royal Society), PI: Dr Chris Backhouse, £508,256

SoftWare InFrastructure and Technology for High Energy Physics experiments, (STFC), PI: Prof Jonathan Butterworth, £106,374

MCnetITN3: Innovative Network for Monte Carlo Event Generators for LHC Physics, (European Commission), PI: Prof Jonathan Butterworth, £290,252

NEw WindowS on the universe and technological advancements from trilateral EU-US-Japan collaboration, (European Commission), PI: Dr Rebecca Chislett, £72,000

A proposal to extend the sensitivity to charged lepton flavour violation by 4 orders of magnitude, (STFC), PI: Dr Rebecca Chislett, £64,887

South-Eastern Particle Theory Alliance Sussex - RHUL - UCL 2020-2023 - UCL Node, (STFC), PI: Prof Frank Deppisch, £124,155

South-Eastern Particle Theory Alliance Sussex - RHUL - UCL 2017-2020, UCL NODE, (STFC), PI: Prof Frank Deppisch, £131,100

Widening the search for Dark Matter and Physics beyond the Standard Model with direct detection experiments, (STFC), PI: Dr Jim Dobson, £511,341

XENON FUTURES: R&D for a Global Rare Event Observatory - Phase 1, (STFC), PI: Prof Chamkaur Ghag, £117,773

UCL Experimental Particle Physics Consolidated Grant (2019-2022), (STFC), PI: Prof Chamkaur Ghag, £3,629,307

UCL Experimental Particle Physics Consolidated Grant (2019-2022), (STFC), PI: Prof Chamkaur Ghag, £76,149

UCL Experimental Particle Physics Consolidated Grant (2019-2022), (STFC), PI: Prof Chamkaur Ghag, £79,608

Spanning multi-TeV to GeV scales for collider discoveries and measurements, (European Commission), PI: Dr Keith Hamilton, £277,764

Mu3e: a proposal to extend the sensitivity to charged lepton flavour violation by 4 orders of magnitude, (STFC), Dr Gavin Hesketh, £4,536

Quality Assurance Range Calorimeter for Proton Beam Therapy, (STFC), PI: Dr Simon Jolly, £364,767

Developing Quality Assurance Tools for Proton Beam Therapy, (STFC), PI: Dr Simon Jolly, £304,453

F/SHIP Facini: searches for beyond the standard model physics with hadronic topologies, (STFC), PI: Dr Gabriel Facini, £489,070

ATLAS Phase-2 Upgrades – Construction project, (STFC), PI: Prof Nikolaos Konstantinidis, £970,302

DUNE Construction Grant, (STFC), PI: Prof Ryan Nichol, £350,947

UCL Experimental particle physics consolidated grant (2015-2019), (STFC), PI: Prof Ryan Nichol, £4,489,778

UCL Experimental particle physics consolidated grant (2015-2019), (STFC), PI: Prof Ryan Nichol, £241,999

UCL Experimental particle physics consolidated grant (2015-2019), (STFC), PI: Prof Ryan Nichol, £173,779

Support for Machine Learning Based Surrogate Models for Emulating the Extreme Scale Simulation of Tokamak plasma, (UK Atomic Energy Authority), PI: Prof Emily Nurse, £32,000

Searching for Dark Matter at the LHC, (Royal Society), PI: Prof Emily Nurse, £102,290

A novel technique to search for dark matter at the large hadron collinder, (Leverhulme Trust), PI: Prof Emily Nurse, £288,386

F/SHIP: Emily Nurse Higgs studies and a search for dark matter at the ATLAS experiment, (Royal Society), PI: Prof Emily Nurse, £274,703

Determination of Absolute Neutrino Mass Using Quantum Technologies, (STFC), PI: Prof Ruben Saakyan, £1,897,333

Enhancing H-bb: Exploring the Higgs Sector and Discovering New Physics, (Royal Society), PI: Dr Tim Scanlon, £199,796

Exploring the Higgs Sector and Probing for New Physics using H->bb, (Royal Society), PI: Dr Tim Scanlon, £331,215

Peering at Neutrino Oscillations with a Magnifier, (Royal Society), PI: Prof Jennifer Thomas, £1,126,535

CHROMIUM CHROMIUM, (European Commission), PI: Prof Jennifer Thomas, £2,146,848

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

Standard Model Phenomenology, (STFC), PI: Prof Robert Thorne, £366,312

Particle phenomenology, QCD and the standard model, (STFC), PI: Prof Robert Thorne, £435,388

LEGEND: Neutrinoless Double-Beta Decay and Germanium Detector Technology, (STFC), PI: Prof David Waters, £23,840

Advancement and Innovation for Detectors at Accelerators, (European Commission), PI: Prof Matthew Wing, £104,000

Production of high quality electron bunches in AWAKE Run 2, (STFC), PI: Prof Matthew Wing, £286,284

AWAKE: a proton-driven plasma wakefield acceleration experiment at CERN, (STFC), PI: Prof Matthew Wing, £378,915

Search for dark protons and investigation of QCD using novel accelerator scheme, (LEVERHULME TRUST), PI: Prof Matthew Wing, £318,272

Biophysics (BioP)

Several BioP grants are held through the London Centre for Nanotechnology (LCN).

New approaches to studying redox metabolism using time-resolved NAD(P)H fluorescence and anisotropy, (BBSRC), PI: Prof Angus Bain, £296,382

Advancing first principles computational modelling of electron transfer processes at molecule/electrode interfaces, (Pacific Northwest National Laboratory), PI: Prof Jochen Blumberger, £25,444

Softcharge: charge carrier transport in soft matter: from fundamentals to high-performance materials, (European Commission), PI: Prof Jochen Blumberger, £1,703,779

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

Physical determinants of cellular fitness for survival and proliferation, (Royal Society), PI: Dr Shiladitya Banerjee, £89,023

Physics of cytoskeletal organisation and cellular morphogenesis, (Royal Society), PI: Dr Shiladitya Banerjee, £323,858

Molecular Control of Cortical Homeostasis and Cell Polarization, (Human Frontier Science Program), PI: Dr Shiladitya Banerjee, £241,241

Real-time tracking stem cells in vivo using dual mode NIR-II fluorescence and magnetic resonance imaging, (Royal Society), PI: Prof Thanh Nguyen, £12,000

Nanoscale Magnetism of Novel Structures, (Air Force Office of Scientific Research), PI: Prof Thanh Nguyen, £110,345

UKRI COVID 19 Grant Extension Allocation, (UK Research and Innovation (UKRI)), PI: Prof Thanh Nguyen, £13,503

Revealing unambiguous signatures of quantum coherence in photosynthetic complexes on a photonic chip, (Gordon and Betty Moore Foundation), PI: Prof Alexandra Olaya-Castro, £1,024,321

UKRI COVID 19 Grant Extension Allocation, (UK Research and Innovation (UKRI)), PI: Prof Angus Bain, £9,399

UKRI COVID 19 Grant Extension Allocation, (UK Research and Innovation (UKRI)), PI: Prof Angus Bain, £24,637

The Evolution of Trafficking: from Archaea to Eukaryotes, (Volkswagen Stiftung), PI: Dr Andela Saric, £158,560

Non-Equilibrium Protein Assembly: from Building Blocks to Biological Machines, (European Commission), PI: Dr Andela Saric, £1,139,659

Physical mechanisms of membrane remodelling by active elastic filaments, (Royal Society), PI: Dr Andela Saric, £107,894

Rational design of cell-reshaping elements, (Royal Society), PI: Dr Andela Saric, £88,992

Physics of protein organisation beyond the cell's edge, (Royal Society), PI: Dr Andela Saric, £526,770

Amyloid aggregation: Inhibition of self-replication and membrane-mediated control, (Academy of Medical Sciences), PI: Dr Andela Saric, £99,304

Impact Acceleration Account - University College London 2017, (EPSRC), PI: Prof Thanh Nguyen, £31,663

Impact Acceleration Account – University College London 2017, (EPSRC) PI: Prof Thanh Nguyen, £49,999

Staff Snapshot

Staff Snapshot

Head of Department Professor R. K. Prinja

Deputy Head of Department Professor F. Renzoni

Astrophysics

Head of Group:
Professor G. Tinetti

Professors:
G. Savini, N. Achilleos, M. J. Barlow, A. P. Doel, R. Ellis, J.Farihi, B. Joachimi, O. Lahav, H. Peiris, A. Pontzen, R. K. Prinja, J.M.C. Rawlings, G. Tinetti, A. Saintonge, G. Tinetti, S. Viti, S. Yurchenko

Associate Professors:
F. Abdalla, A. L. Aruliah, I. Waldmann

Lecturers:
S. Feeney, M. Kama, J. Sanders

Professorial Research Fellow:
D. Brooks, P. Guio

Senior Research Fellows:
A. Al-Refaie, F. Diego, S. Nadathur, M. Tessenyi, A. Tsiaras, R. Wesson

Research Fellows:
C. Cadiou, Q. Changeat, C. Circosta, J. Davies, W. Dunn, B. Edwards, Y. Ito, N. Jeffrey, F. Kirchschlager, A. Loureiro, M. Marcha, D. Millas, N. Nikolaos, S.Pyne, M. Rocchetto, A. Saxena, F. Schmidt, S. Stopyra, A. Swan, M. Tang, N. Tessore, L. Whiteway, L. Whittaker

Marie Curie Early Stage Researchers:
R. O'Donoghue, M. Keil

Support Staff:
S. Boyle, J. Deacon, E. Dunford, E. Edmondson, J. Fabbri, S. Fossey, C. Jenner, A. Maguire, R. Martin, M. Pearson, K. Nakum, M. Rangrej, T. Schlichter, S. Sullivan, A. Williams

Atomic, Molecular, Optical and Positron Physics

Head of Group:
Professor S. Hogan

Professors:
A. Bain, P. Barker, S. Bose, D. Browne, D. Cassidy, A. Emmanouilidou, C. Figueira de Morisson Faria, S. Hogan, G. Laricchia, T. Monteiro, A. Olaya-Castro, J. Oppenheim, F. Renzoni, A. Serafini, M. Szymanska, J. Tennyson, S. Yurchenko

Lecturer:
I. Llorente Garcia

Research Fellowships:
Y.L. Li, L. Masanes, J. Palmer, S. Qvarfort, C Sparaciari

Research Fellows:
T. Babij, D. Bhattacharya, T. Blacker, A. Callison, B. Cooper, G. Dagvadorj, A. Ferrier, K. Gawlas, L. Lao, C. Nation, M. Pezzella, O. Polyansky, A. Pontin, A. Rahman, A. Svesko, D. Toniolo

Support Staff:
J. Dumper, F. Garza, C. Godden, F. R. Jawad, S. Thomas

Biological Physics

Heads of Group:
Professor B. Hoogenboom

Professors:
A. Bain (also AMOPP), J. Blumberger (also CMMP), G. Charras (Cell & Developmental Biology), B. Hoogenboom, P. Jones, T. Nguyen, A. Olaya-Castro (also AMOPP), I. Robinson (also CMMP)

Associate Professor:
I. Llorente Garcia (also AMOPP), A. Saric

Lecturer:
T. Michaels

Senior Research Fellows:
Zena Hadjivasiliou (Crick), M. Molodtsov (Crick)

Senior Research Associate:
T. Le

Research Fellows:
C. Bortolini, L. Chu, X. Jiang, I. Palaia, G. Pobegalov, T. Trakoolwilaiwan, X. Wu

Support Staff:
J. Gill-Thind

Condensed Matter and Materials Physics

Head of Group:
Professor S. T. Bramwell

Professors:
J. Blumberger, D. Bowler, S. Bramwell, F. Cacialli, A. Fisher, I. Ford, A. Green, C. Howard, D. McMorrow, A. Michaelides, I. Robinson, A. Shluger, N. Skipper, M. Szymanska, S. Zochowski

Associate Professors and Readers:
M. Buitelaar, F. Kruger, A. Pal, E. Rosta, P. Zubko, R. Perry

Lecturers:
R. Johnson, S. Schofield, C Perez Martinez

Research Fellowships:
A. Seel

Research Fellows:
M. Badaoui, R. Darkins, F. Faizi, T. Foldes, S. Gehrke, S. Ghosh, T. Greenland, R. Hafizi, L.Ishibe Veiga, A. James, Z, Koczor-Benda, K. Kwakwa, E. Parsons, J. Richter, L. Stojanovic, M. Szyniszewski, B. Villis, C. Yin

Marie Curie Trainee:
E. Stylianidis

Most Research staff are employed through the LCN

Support Staff:
A. Gormanly, J. Levin, D. Ottley, S. Patel, F. Sidoli, K. Stoneham, J. Walden

High Energy Physics

Head of Group:
Head of Group: Professor R. Saakyan (to 15 November 2020)
Head of Group: Professor D. Waters (from 16 November 2020)

Professors:
J. M. Butterworth, M. Campanelli, F. Deppisch, C. Ghag, K. Hamilton, N. Konstantinidis, R. Nichol, E. Nurse, R. Saakyan, J. A. Thomas, R. S. Thorne, D. Waters, M. Wing

Associate Professors:
G. Hesketh, S. Jolly, A. Korn, T. Scanlon

Lecturer:
R. Chislett

Principal and Senior Research Associates:
A. Basharina-Freshville, R. Flack, P. Sherwood, B. Waugh

Ernst Rutherford Fellows:
M. Agostini, J. Dobson

Royal Society University Research Fellows:
C. Backhouse, S. Malik

Research Fellows:
J. M. Carceller, J. Cesar, D. Cooke, T. Cridge, C. Gutschow, S. Jones, N. Kimura, A. Martyniuk, V. Monachello, C. Patrick, D. Phan, A. Sztuc, T. Fruth, J. M. Carceller Lopez, Y. Ma, D. Phan

Support Staff:
D. Attree, G. Crone, E. Edmondson, C. Godden, T. Hoare, E. Motuk, S. Thomas, M. Warren

Teaching

Director of Undergraduate Teaching:
Professor N. Skipper

Director of Postgraduate Studies:
S. Zochowski

Undergraduate Careers Officer:
J. Farihi

Professor (Teaching):
P. Barlett

Associate Professors (Teaching):
D. Armoogum, E. Ashgrove, S. Fossey,
L. Dash, N. Nicolaou

Associate Lecturer (Teaching):
S. Boyle

Lecturer (Teaching):
J. Bhamrah, F. Diego Quintana

Laboratories

Director of Laboratories:
P. Bartlett

Laboratory Superintendent:
D. Thomas

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

Experimental Development Officer:
K. Vine

The Workshop: High Precision Design and Fabrication Facility (HPDFF)

Physics, Chemical and Biochemical Engineering Facility
R. Saakyan

Admissions Tutors:
A. Aruliah (MSc), F. Diego (Astronomy Certificate),
J. Blumberger (Postgraduate Research),
P. Jones (Undergraduate)

Schools Liaison Officer:
C. Howard

Programme Tutors:
D. Armoogum (Physics and Astronomy), S. Fossey (MSc),
N. Nicolaou (Physics and Astronomy),
J. C. Rawlings (Astronomy Certificate), S. Zochowski (PhD)

UCL Observatory

Director:
G. Savini

Senior Observatory Technicians:
M. Pearson (Mechanical and site officer)
T. Schlichter (Computing and Instrumentation Officer)

Observatory Technician:
S. Sullivan

Professional Services

Departmental Manager:
L. Coletti Campbell

Deputy Departmental Manager:
L. King

Senior Staffing and Communications Officer:
B. Carboo

Senior Research Officer:
R. Martin

Senior Finance Officer:
K. Coleman

Education Support Team

Senior Postgraduate and Student Finance Administrator:
N. Waller

Senior Teaching and Learning Administrator:
S. Lovell

MSc Teaching and Learning Administrator:
S. Begum, S. McGrath

UG Teaching and Learning Administrators:
H. Copeland, R Edmonds, L. Medici

Postgraduate Research Teaching Administrator:
S. Samuels

Research Groups

Astrophysics Group Manager:
K. Nakum

AMOPP/HEP Research Groups & Goods Inwards Administrator:
S. Thomas

Biological Physics (BioP) Research Administration Officer:
J. Gill-Thind

Finance Officer and CMMP Research Group Administrator:
J. Levin

Centre Manager (Centre for Space Exoplanet Data):
E. Dunford

Thomas Young Centre (TYC) & Materials & Molecular Modelling (MMM) Hub Coordinator:
K. Stoneham

Project Manager and Scientific Officer (The Centre for Planetary Sciences):
J. Fabbri

Project Manager (Cosmoparticle Physics (CPP) Initiative) and Executive Assistant: A. Maguire

Project Manager (Euclid): M. Rangrej

Computing and IT

Computing and IT Manager: B. Waugh

Computing Administrator (HEP): T. Hoare

IT Systems Managers:
F. Garza (AMOPP & BioP), F. Ihsan (Teaching and Learning)

Safety Officer and Estates Manager:

L. Bebbington

Outreach and Public Engagement

Outreach Coordinator and Ogden Science Officer: M. Fuller

Science Centre Organiser: S. Kadifachi

Doctoral Training Centre

CDT Manager, CDT in Data Intensive Science (DIS):
M. Witcombe

Visiting Professors, Honorary Professors and Emeritus Staff:

A. Aylward, P. Beltrame, S. Bridle, R. Cohen, M. Coupland, I. Crawford, D. H. Davis, J. Drew, M. M. Dworetsky, M. Duff, D. Duffy, M. Ellerby, J. Ellis, M. Esten, I. Ferreras, J. L. Finney, F. Fernandez-Alonso, J. Fordham, I. Furniss, M. J. Gillan, A. H. Harker, C. Hirjibehedin, B. Hiley, C. Hilsum, P. Hobson, I. D. Howarth, J. W. Humberston, T. W. Jones, N. Kaiser, A. Kravtsov, M. Lancaster, B. R. Martin, G. Materlik, K. A. McEwen, J. McKenzie, A. Michaelides, D. J. Miller, S. Miller, D Moores, R. Maiolino, W. Newell, G. Peach, R. Radogna, A. Slosar, A. C. Smith, P. J. Storey, D. N. Tovee, C. Wilkin, D. A. Williams

UCL Department of Physics and Astronomy
Gower Street • London • WC1E 6BT
www.phys.ucl.ac.uk