Imperial College London

Faculty of Natural Sciences Research Showcase 2019

Wednesday 25 September

Information Booklet

Sir Alexander Fleming Building
Lecture Theatre G34, Concourse
Level 1 and SAF B120-122
Imperial College London
Exhibition Road
SW7 2AZ London, UK

Contents

Welcome to Imperial College London

A warm welcome to the Faculty of Natural Sciences annual Research Showcase.

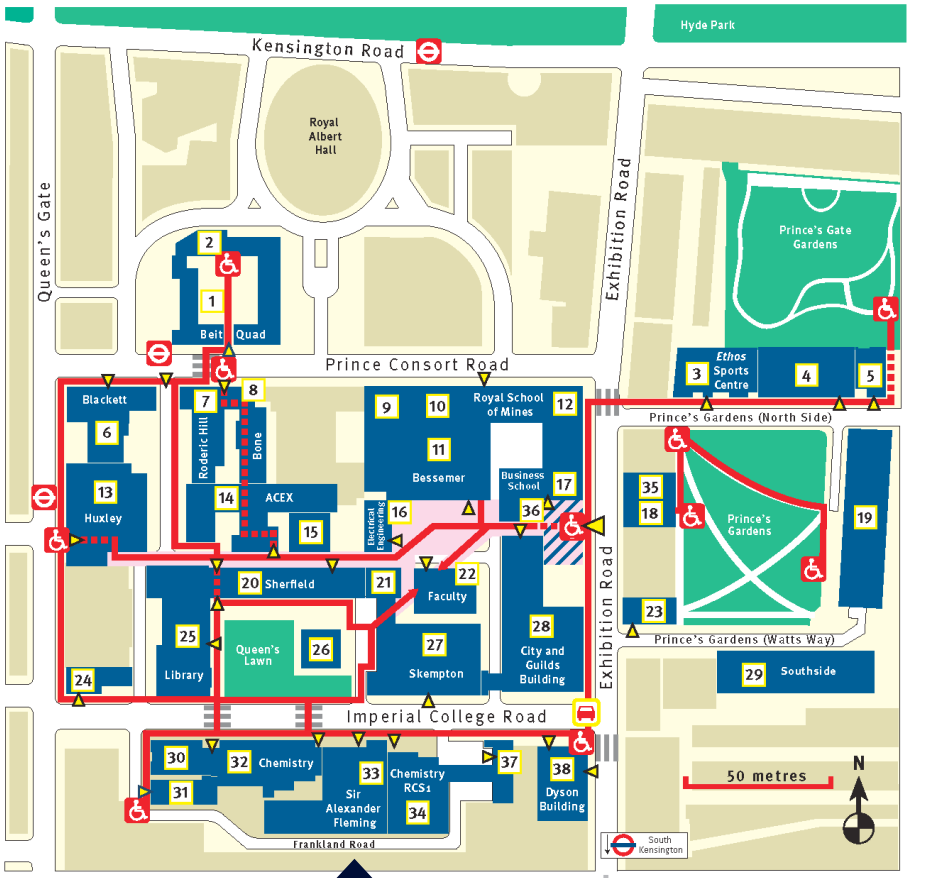
As my term as Dean of the Faculty of Natural Sciences draws to its conclusion, I look back with immense pride at the achievements of our staff and students over the past 5 years.

As in previous years, our flagship event will showcase the scientific excellence that our Faculty has to offer: from fundamental science underpinning discoveries in the infinitesimally small and infinitely big, to our most applied and innovative research. It provides a wonderful opportunity for all our guests and Faculty members to engage in stimulating discussions through a series of talks and posters by our members of staff, fellows and prize-winning post-graduate students.

The breadth and collegial nature of our Faculty enables us to work collaboratively to address tomorrow's biggest scientific challenges. Our panel discussion today led by the Centre for Environmental Policy on the topic of "The Plastic Challenge: Sustainable Interventions for a Healthy Planet" provides an example of how multidisciplinary research can tackle today's environmental challenges.

It has been my honour to lead a Faculty that is brave, creative and innovative, this event will be true display of the inspirational work of our colleagues.

Professor Tom Welton, Dean of the Faculty of Natural Sciences



Sir Alexander Fleming Building (SAF)

Main walkway
Main entrance
Accessible route
Buildings where wheelchair access is not possible at this time
South Kensington Underground
Bus stops
Building entrances
Vehicle entrance

1	Beit Quadrangle
2	Imperial College Union
3	*Ethos* Sports Centre
4	Prince's Gdns, North Side
5	Weeks Hall
6	Blackett Laboratory
7	Roderic Hill Building
8	Bone Building
9	Royal School of Mines
10	Aston Webb
11	Bessemer Building
12	Goldsmiths Building
13	Huxley Building
14	ACE Extension
15	William Penney Laboratory
16	Electrical Engineering
17	Business School
18	53 Prince's Gate
19	Eastside
20	Sherfield Building Student Hub Conference Office
21	Grantham Institute – Climate Change and the Environment
22	Faculty Building
23	58 Prince's Gate
24	170 Queen's Gate
25	Central Library
26	Queen's Tower
27	Skempton Building
28	City and Guilds Building
29	Southside
30	Sir Ernst Chain Building – Wolfson Laboratories
31	Flowers Building
32	Chemistry Building
33	Sir Alexander Fleming Building
34	Chemistry RCS1
35	52 Prince's Gate
36	Alumni Visitor Centre
37	Observatory Building
38	Dyson Building of Design Engineering

Research Showcase programme

Locations

Talks: G34 LT, Sir Alexander Fleming building (SAF), South Kensington Campus

Coffee receptions: Level 1 concourse of the SAF building

Poster sessions: B120-121 of the SAF building (in front of G34)

Lunch and drinks/canapes reception: Level 1 concourse of the SAF building

Expert panel session: B122 of the SAF building

Schedule

09:30	*Welcome coffee*
10:00–11:20	**Session 1: Department of Chemistry**
	Coffee break
11:40–13:00	**Session 2: Department of Mathematics & the Centre for Environmental Policy**
13:00–14:00	*Poster session & lunch*
14:00–15:20	**Session 3: Department of Physics**
	Coffee break
15:40 – 17:00	**Session 4 – Department of Life Sciences**
	Refreshments / Wine & beer break
17:15–17:45	**Expert panel session**
17:45	**Poster session & prizes awarded** - *join us for drinks & canapes*

Symposium schedule

Welcome coffee from 9:30am on the level 1 concourse of the Sir Alexander Fleming building

Session 1: Department of Chemistry

10:00 - Professor Matt Fuchter | Using the combination of light and small molecules to reversibly control biology

10:20 - Dr Agniezca Brandt-Talbot | The role of molecular design in developing strong sustainable carbon fibres from lignin

10:35 - Francesca Vianello | Computational characterization of protein interaction sites: from small ligand pockets to large domain interfaces

10:50 - Daniele Antermite | Catalytic Functionalisation of 'Inert' Carbon-Hydrogen Bonds in Heterocycles to Provide a Faster Route to New Medicines

11:05 - Tom Hopper | Probing ultrafast energy losses in Perovskite materials for solar energy conversion

Coffee break

Session 2: Department of Mathematics and Centre for Environmental Policy

11:40 - Professor Emma McCoy | The Dangers of Observational Data

12:00 - Dr Alex Sing-Lam Tse | Some non-standard stochastic control problems and their economic applications

12:15 - Thiago Kanashiro | Deepening vulnerabilities and inequalities: A Political economy analysis of the impacts of austerity for the Amazonian family farmer

12:30 - Tarik Altuncu | How graphs and machine learning can help us cluster documents according to their content in an unsupervised manner

12:45 - Paul Mannix | Understanding the dynamics of subsurface oceans in icy moons

Lunch and Poster session 1

Session 3 – Department of Physics

14:00 - Professor Lesley Cohen | Antiferromagnets for Spintronics

14:20 - Dr Paula Alvarez Cartelle | Searching for New Physics at the Large Hadron Collider

14:35 - Sinead O'Brien | An investigation into how humans and machine systems understand and summarize technical knowledge

14:50 - Felix Kress | Rare particle decays; A path to explore Physics beyond the Standard Model?

15:05 - Stav Zalel | Grains of Spacetime: the Causal Set approach to Quantum Gravity

Coffee break

Session 4 – Department of Life Sciences

15:40 - Professor Robert Endres | Where physics meets biology: insights from data-driven modelling

16:00 - Dr Andrew Hammond | Gene drives for genetic control of the malaria mosquito

16:15 - Cian Duggan | Investigating the plant innate immune system to generate disease resistant crops

16:30 - Sophie Howard | The Pseudomonas aeruginosa type VI secretion system: a gun loaded with toxins

16:45 - Ralf Wenz | Zebrafish - a window into the evolution of intestinal neuro-immunology

Refreshments / Wine & beer break

Abstracts of the talks

Session 1: Department of Chemistry

Professor Matt Fuchter | Using the combination of light and small molecules to reversibly control biology

Photoswitchable compounds, which can be reversibly switched between two structural isomers by light, continue to attract significant attention for a wide array of applications that capitalise on the high temporal and spatial precision of using light as a stimulus. The recently established field of photopharmacology uses photoswitchable ligands that are selective for a specific cellular target, such as a receptor or an enzyme, and are employed as therapeutic entities. These ligands undergo a change in shape, flexibility, or electronic properties upon irradiation with light that leads to a change in the affinity for their cellular target; therefore, they exhibit a light-dependent therapeutic activity.

This talk will give an overview of our recent discovery of a new class of photoswitch, the arylazopyrazoles, which offer quantitative photoswitching and high thermal stability of the Z isomer (half-lives of up to ~1000 days). It will describe our recent studies to elucidate the origin of the long thermal half-lives and excellent addressability of the arylazopyrazoles. Given the large tunability of their properties and the predictive nature of their performance, we believe the azoheteroaryl photoswitches to have huge potential in a wide range of optically addressable applications, including as photopharmacological agents. The talk will showcase one such application: The development of the first TRPA1 photoswitchable ligand, which allows for optical channel activation and deactivation in vivo.

Dr Agniezca Brandt-Talbot | The role of molecular design in developing strong sustainable carbon fibres from lignin

In order to decarbonise our economy we need to replace petroleum as a major fuel source but also as the key feedstock for the chemical industry. An abundant, renewable alternative is woody or lignocellulosic biomass.

Wood contains three major types of polymers, cellulose, hemicellulose and lignin. While many applications for cellulose and its building block glucose exist today, lignin is regarded as a low value co-product, and less than 1% of the lignin generated is currently isolated and transformed into products.

In this seminar, I will focus on the application of using lignin as a low-cost precursor for carbon fibres. Significant fuel savings can be achieved by replacing steel used in vehicles with carbon fibre reinforced composites. However, carbon fibres are currently too costly to be used at the mass scale. In addition, the precursors used for conventional carbon fibres are derived from the petroleum derived polyacrylonitrile (PAN) and pitch.

Transforming extracted lignin into carbon fibres has the potential to drastically cut the cost of carbon fibres by more than 75%, due to the low cost of isolated lignin and its high carbon content. However, the strength of such carbon fibres remains to be improved sufficiently in order to meet strength targets set out by the automotive industry. In my talk, I will argue that lignin needs to be designed on a molecular level to overcome these limitations. I will present results from research carried out in my group to produce and test novel lignins and spinning protocols.

Francesca Vianello | Computational characterization of protein interaction sites: from small ligand pockets to large domain interfaces
(Supervisors: Sophia N. Yaliraki {Chemistry}; Mauricio Barahona {Mathematics})

Protein-protein interactions (PPIs) are central to all regulatory processes in nature and are therefore considered crucial nodes in disease pathways and particularly attractive drug targets. However, the size and complexity of protein interfaces pose significant challenges to targeted drug discovery, as effective ligand design requires knowledge of the interactions at the atomistic and bond-specific level. Crucially, most experimental and computational approaches focus solely on the detection of potential protein interactions, stopping short of characterising their structural details.

We put forward the application of a theoretical methodology for the structural characterisation of PPI sites, based on the exploration of the edge space of a protein network constructed from the atomic coordinates and chemical interactions between atoms. This framework originated from the investigation of intra-protein allosteric communication[1] and is expanded here to the communication from an active site to inter-protein contact residues, allowing for the integration with drug discovery approaches. We also present the implementation of a complete in-silico mutational analysis of protein structures, which can be used in conjunction with our graph-theoretical approach. Doing so provides a coherent workflow for the identification of key bonds involved in PPIs and for their comparison with experimental results.

Here, we showcase how this approach can be used to describe different levels of allosteric complexity - from small ligand binding pockets to large protein-protein interfaces. The scalability of our procedure also allows for the analysis of multiple protein structures (such as an entire protein family) without unreasonable computational expenditure. The successful application of this methodology to known systems serves as a stepping stone towards de novo prediction of interaction sites from any given crystal structure. We expect our approach to be fully integrated into experimental workflows, significantly reducing the exploration space to be covered by chemical biology experiments and leading to faster, more effective drug discovery pipelines. The high specificity of our putative contact sites will also lead to equally specific small molecules design, allowing for the targeting of distinct complexes within general protein families.

1. Amor, B. R. C., Schaub, M. T., Yaliraki, S. N. & Barahona, M. Prediction of allosteric sites and mediating interactions through bond-to-bond propensities. Nat. Commun. 7, 1–30 (2016).

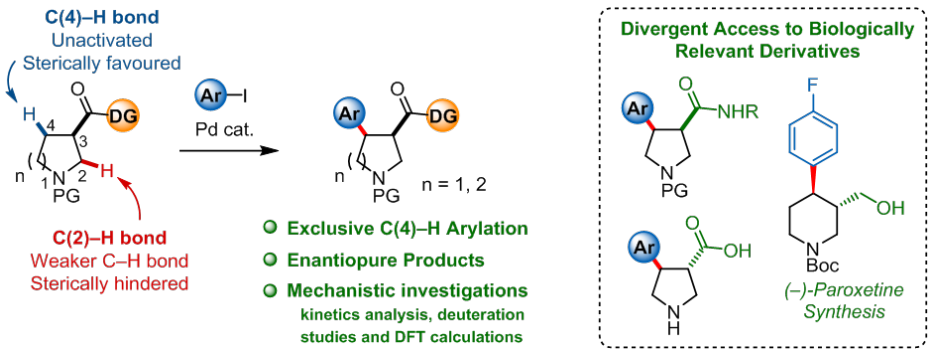
Daniele Antermite | Catalytic Functionalisation of 'Inert' Carbon-Hydrogen Bonds in Heterocycles to Provide a Faster Route to New Medicines
(Supervisor: James A. Bull)

The development of new synthetic methods has a central role in driving the search for new therapeutics, accelerating the discovery of molecules that can interact with biological systems, and enabling the larger scale production of successful candidates.[1]

In recent years, catalytic C–H functionalisation has emerged as a powerful strategy to streamline the synthesis of biologically important molecules.[2]

Carbon-hydrogen (C–H) bonds are ubiquitous in organic molecules but are traditionally considered chemically inert. However, recent advances in transition metal catalysis have uncovered the direct conversion of C–H bonds into more valuable groups. This allows the rapid generation of molecular complexity from very simple materials. Selective functionalisation of a specific C–H bond over all other on the same molecule can be achieved using directing groups (DG) to position the metal catalyst in proximity to the desired C–H bond.[3]

Saturated nitrogen-containing heterocycles, including the 5- and 6-membered pyrrolidine and piperidine, are prevalent components in bioactive molecules and are attractive structures for pharmaceutical screenings. Synthetic methods that can readily access these derivatives are of high potential value for the development of new therapeutics. Catalytic C–H functionalisation offers the potential for the efficient synthesis of complex heterocycles from simple cyclic precursors, but this is little developed.[4]



This presentation will describe a palladium-catalysed C(4)–H functionalisation method to access cis-3,4-disubstituted pyrrolidines and piperidines.[5] Selective functionalisation at C(4) position over competing C(2) is achieved using a directing group at C(3). Removal of the directing group delivers varied biologically relevant building blocks and enables the stereocontrolled formal synthesis of antidepressant drug (–)-paroxetine. Mechanistic investigations to gain insight into the observed selectivity will also be described.

1 (a) K. R. Campos et al., Science, 2019, DOI: 10.1126/science.aat0805.
(b) D. C. Blakemore et al., Nat. Chem., 2018, 10, 383.
2 J. Yamaguchi, A. D. Yamaguchi and K. Itami, Angew. Chem. Int. Ed., 2012, 51, 8960.
3 V. G. Zaitsev, D. Shabashov, and O. Daugulis, J. Am. Chem. Soc., 2005, 127, 13154.
4 For a review, see: D. Antermite and J. A. Bull, Synthesis, 2019, DOI: 10.1055/s-0037-1611822.
5 D. Antermite, D. P. Affron and J. A. Bull, Org. Lett., 2018, 20, 3948.

Tom Hopper | Probing ultrafast energy losses in Perovskite materials for solar energy conversion
(Supervisor: Artem Bakulin)

In conventional semiconductors, above-bandgap "hot" carriers rapidly lose their excess energy through lattice vibrations. This "carrier cooling" impedes the maximum theoretical efficiency of many solar cells; therefore mechanistic insights into the process of carrier cooling will be essential for the development of next-generation photovoltaics. At the forefront of contemporary solar energy research are the metal-halide perovskites, which exhibit exceptional efficiencies and materials properties that can be tailored by altering the composition of the "$APbX_3$" structure (A = cation; X = halide). The broad tunability of these perovskites can be further enhanced in nanocrystals. Recent discoveries have revealed slowed cooling in these perovskite-based materials at high carrier densities. By using a novel multi-pulse laser spectroscopy approach, I will definitively show that cooling is slower in the all-inorganic $CsPbBr_3$ than its hybrid counterparts, owing to the relative abundance of phonon modes associated with the organic cation. I will also discuss the role of the "cold" (band-edge) carriers, as well as the effects of quantum confinement and surface properties of these materials on the hot-carrier relaxation dynamics.

Session 2: Department of Mathematics and Centre for Environmental Policy

Professor Emma McCoy (Mathematics) | The Dangers of Observational Data

The majority of statistics teaching is rooted in models of association with scant regard for consideration of model misspecification or bias. Many people believe that the advent of machine learning/AI for big data will negate the need to quantify uncertainty in data. In addition, antipathy to statistics has been one of the hallmarks of the rise of populism with statisticians and other "scientific experts" being rejected as untrustworthy, this view is partly justified, the increased use of observational data to draw causal conclusions has led to some well publicised misuse of statistics. I will make the case for the increased need for rigorous statistics and the need for a new approach to teaching statistics. I will also outline some recent methodological advances in statistical causal inference and highlight some applications.

Dr Alex Sing-Lam Tse (Mathematics) | Some non-standard stochastic control problems and their economic applications

A common assumption behind a mathematical model of investment is that the underlying economic agent is an "expected utility maximiser". However, there is strong psychological evidence that people deviate from expected utility criteria when making choices. For example, individuals' risk attitude usually depends on the "status quo" and cannot be captured by a simple utility function; They also exhibit tendency to overweight the probabilities associated with extreme

events. Incorporating such behavioural biases within a dynamic optimisation framework leads to a number of technical subtleties - the maximisation problem is no longer uniformly concave, dynamic programming principle fails, optimal strategies are not time-consistent, randomisation can be beneficial, etc. In this talk, I will discuss some of the above issues and their economic implications.

Thiago Hector Kanashiro Uehara (Centre for Environmental Policy) | Deepening vulnerabilities and inequalities: A Political economy analysis of the impacts of austerity for the Amazonian family farmer
(Supervisor: Clive Potter)

Since 2013, particularly after the impeachment of its President, Dilma Roussef, Brazil's family farmers have experienced continuing deprivation and economic marginalisation. Drawing on a livelihood analysis and examination of intervention histories and futures for four highly vulnerable communities in the Amazon floodplain, this presentation shows how family farmers have coped with the ending of the Zero Hunger Food Acquisition Programme – a key government programme which was designed to open up new markets for their products. My fieldwork reveals a changing dynamic of migration and social reproduction in the area as a consequence, social security becoming the main income source, with reduced autonomy for many family farmers. People from all age cohorts have experienced austerity, however: older people have turned to state pensions in order to be able to continue on the land, while the younger cohorts are increasingly committed to leaving agriculture, with little sense of a future working the land. A conclusion from the research is that the Food Acquisition Programme has barely left a legacy of prosperity for these rather freedomless Amazonian peasants. Also, the prospects are not promising. Under Jair Bolsonaro's presidency, further marginalisation is likely (i.e. through the extinction of non-contributory rural pensions and unemployment benefits), exacerbating existing vulnerabilities, constraining rural livelihoods, and reproducing deep set inequalities.

Tarik Altuncu (Mathematics) | How graphs and machine learning can help us cluster documents according to their content in an unsupervised manner
(Supervisors: Mauricio Barahona {Mathematics}; Sophia Yaliraki {Chemistry})

Whether news articles, social media and blog posts, or reports written for a variety of purposes, the production and availability of textual content in digital form is growing at an astonishing rate. Yet this source of richly detailed information often remains under-used in practice because of a lack of suitable methodologies to extract interpretable content in a timely manner.

Here we illustrate a framework for the analysis of groups of documents that combines recent advances in deep learning based semantic representation of natural language with multi-resolution, unsupervised clustering capabilities based on graph theory. The method is able to extract clusters of text documents based on the similarity of their content at different levels of resolution in an unsupervised manner.

We showcase the approach with the analysis of free text descriptions of hospital patient incident reports written by healthcare staff and submitted to Imperial College Healthcare NHS Trust, London. We compare the accuracy of our groupings with hand-coded classifications (a time-consuming and expensive endeavour for staff) and exhibit good correspondence. Our automatic analysis can adapt its resolution by request from very deep and detailed groups to coarse high-level structures with better topical coherence. We also investigate how the found clusters can be monitored over time and across different healthcare providers to detect emerging trends or anomalies that can help us create cautionary alerts. Automatisation of such processes will save time and money for NHS and help its staff to take care of patients better and timely manner.

Paul Mannix (Mathematics)| Understanding the dynamics of subsurface oceans in icy moons
(Supervisor: Andrew Mestel)

Following the surprising discovery of subsurface oceans in the moons of Saturn and Jupiter a number of puzzles have arisen. How do these "icy moons" maintain sub-surface oceans? How do these oceans couple to the moons interior? and What if any is the predominant equilibrium state of their oceans? Following a brief overview of the problem, I will focus on the latter question in this talk, using a combination of numerical methods and tools from nonlinear dynamics to present some simplified models of the convective motion of these oceans.

Session 3: Department of Physics

Professor Lesley Cohen | Antiferromagnets for Spintronics

Spintronics is about the use of electron spin for information storage. Magnetic hard disks remain the most widely used method for long term storage of data and the reading of that data has also used a spintronic device or read head. Magnetic random-access memory using similar device concepts has been in development for many years and there are commercial products. However, there are serious limitations in terms of speed and power consumption. Antiferromagnets are used as a passive element in this current technology but it has been appreciated in recent years that they may play a more active role. This talk will cover some of the fundamental research into chiral antiferromagnets where the magnetic arrangements of the spins allow rather exotic but potentially useful properties particularly for low energy ICT applications. The work is collaborative with the Materials Department at Imperial College, Hitachi Cambridge, a number of groups in Prague and the University of Warwick.

Dr Paula Alvarez Cartelle | Searching for New Physics at the Large Hadron Collider

Recent measurements from the LHCb experiment have shown an interesting pattern of tensions with respect to the predictions of the Standard Model of Particle Physics (SM). However, the interpretation of some of these so-called 'flavour anomalies' is limited by our present understanding of the hadronic uncertainties affecting these predictions. My research focuses on the study of a specific subset of observables, referred to as Lepton Flavour Universality ratios, which profit from large cancellation of the theory uncertainties and provide a very sensitive probe for physics beyond the SM.

Sinead O'Brien | An investigation into how humans and machine systems understand and summarize technical knowledge
(Supervisor: William Proud)

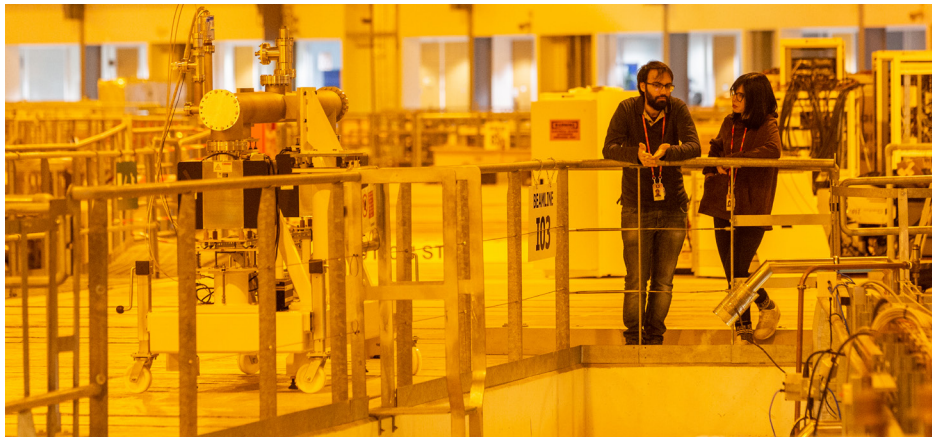
Economic advancement is guided by the development, distribution, and consumption of knowledge, making it an invaluable asset in today's knowledge-driven economy. Hence, expert insights are of great consequence and crucial to maintaining an organisation's competitiveness. The intricate and complex nature of defence research combined with the hurdle of access-restriction make acquiring and sharing information in this field especially difficult. Therefore, establishing viable ways to minimise, even eradicate, loss of knowledge is of utmost importance. The implementation of intelligent ontologies, i.e. the capturing and mapping of key areas of expert understanding, could provide a solution to this. Such technologies rely on natural language processing techniques being able to capture the context and true meaning of technical information. My research aims to compare how humans, in particular experts, and machines interpret an academic text in the field of propellant combustion.

Felix Kress | Rare particle decays; A path to explore Physics beyond the Standard Model?
(Supervisor: Mitesh Patel)

Recent observations of rare B decays hint at discrepancies with predictions of the otherwise overwhelmingly successful Standard Model of Particle Physics. These observations are extremely intriguing, as they can be interpreted in a coherent way in a number of new physics models by introducing a new vector particle, such as a Z' or a leptoquark. This talk will give an overview of the most interesting discrepancies, followed by a more detailed explanation of the angular analysis of the rare decay B->K*mumu, performed on data from the LHCb experiment

Stav Zalel | Grains of Spacetime: the Causal Set approach to Quantum Gravity
(Supervisor: Fay Dowker)

General Relativity, our best theory of gravity, tells us that space and time are unified in a single entity called “spacetime”. But what is spacetime made of? We know that matter (like stars, chairs and flowers) are made of atoms. Could it be that spacetime is also granular and is made of “spacetime atoms”? This idea is especially intriguing when considered as part of an attempt to unify gravity with quantum theory and is the heart of the Causal Set approach to Quantum Gravity.



Session 4: Department of Life Sciences

Professor Robert Endres | Where physics meets biology: insights from data-driven modelling

Biological cells are more than genes and networks of interacting proteins - they are also physical objects, which, in addition to sensing chemicals, can also sense physical and mechanical stimuli. With a distinction between living and non-living matter rather blurry, my vision for biological physics (and related disciplines such as systems biology) is the extension of the historic successes of physics, math, and computing to living biological matter, in order to make biology a quantitative predictive science. My specific goal is to identify overarching principles to simplify and understand biological regulation, complexity, optimality, and information processing. Such understanding is expected to also have drastic impact on biomedical sciences. Here, I will briefly discuss recent projects on the response of bacterial and eukaryotic cells to external stimuli (chemotaxis and phagocytosis).

Dr Andrew Hammond | Gene drives for genetic control of the malaria mosquito

Malaria is responsible for almost half a million deaths each year and there is a desperate need for new tools that can help eradicate the disease. Historically, the most effective strategies have targeted the mosquito vector responsible for its transmission. Here at Imperial College, we have been developing an exciting new technology called gene drive that can be used to modify entire mosquito populations for sustainable vector control. Gene drives are unlike other genetic modifications because they can spread autonomously throughout a population by biasing their own inheritance. We have developed gene drives that can be used to suppress the number of malaria mosquitoes by spreading a modification that will make female mosquitoes unable to bite or reproduce. The strategy is potentially transformative because gene drives are species specific, can spread into malaria endemic regions that are difficult to reach with conventional vector control, and they do not need repeated mass release to spread.

Cian Duggan | Investigating the plant innate immune system to generate disease resistant crops
(Supervisor: Tolga Bozkurt)

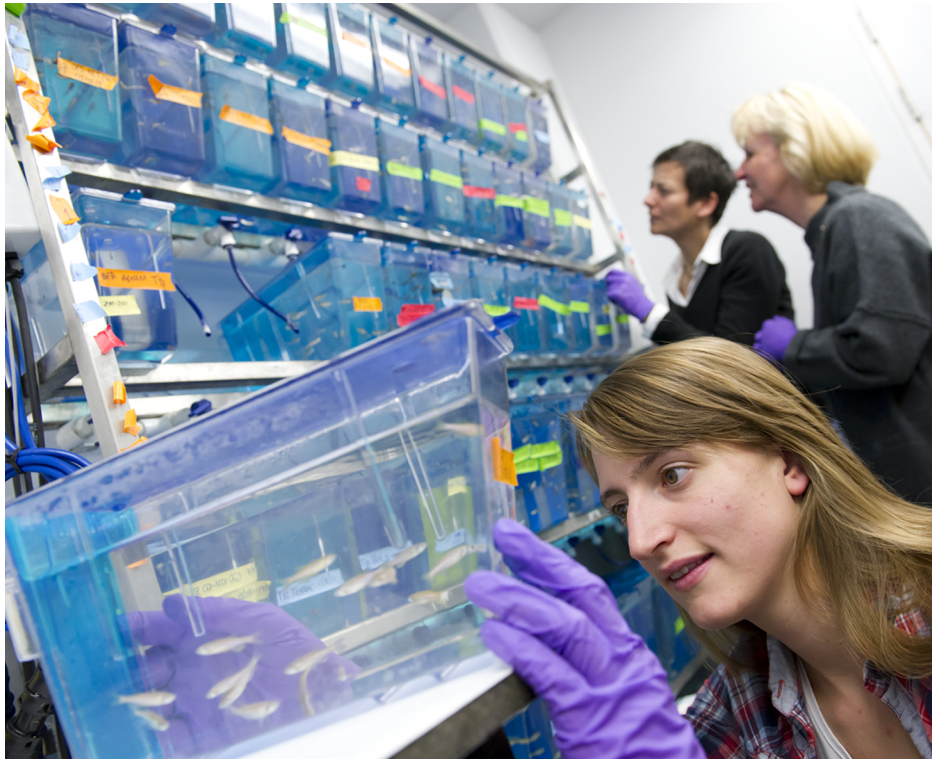
The Irish famine pathogen is still a major problem for potato & tomato farmers worldwide – resulting in ~$6B damage annually. We found a network of immune sensors in plants that are capable of providing resistance to this pathogen as well as bacteria, viruses, nematodes and insects. Here we show that one of these sensors traffics to the sub-cellular site of infection to amplify immune signalling and provide defence against this devastating disease. Further understanding should enable us to engineer broad-spectrum disease resistance in economically important crops, feed more people and limit chemical input in agriculture.

Sophie Howard | The Pseudomonas aeruginosa type VI secretion system: a gun loaded with toxins
(Supervisor: Alain Filloux)

The type VI secretion system (T6SS) is a bacterial weapon that fires toxins into neighbouring eukaryotes and prokaryotes and is prevalent in gram-negative bacteria. Pseudomonas aeruginosa, an opportunistic pathogen, is used as a model organism to study the T6SS. Pseudomonas aeruginosa possesses 3 T6SS, the H1, H2 and H3-T6SS, each with unique toxins. The T6SS machine ejects the Hcp tube which is topped with a spike. The majority of the nearly 20 Pseudomonas aeruginosa identified toxins are delivered by the spike, only three are delivered inside the Hcp tube. The three toxins, Tse1, 2 and 3 interact with the Hcp1 tube of the H1-T6SS. The aim of my PhD is to further characterise delivery of toxins via the Hcp tube. I have discovered that another known toxin, Tse4, is also delivered via Hcp1 and have conducted a screen using Hcp1, 2 and 3 to search for novel toxins. Novel toxins could target prokaryotes or eukaryotes, aiding in bacterial competition or pathogenesis, therefore it is important to identify them. To determine what is important for delivery inside the Hcp tube, such as size of the toxin, I have added a large fusion to the Tse1 toxin which blocks secretion from the system and its killing of E. coli, suggesting that there is a size limit to Hcp toxin delivery. To determine which toxin domains are important for delivery by the Hcp tube, I am assessing the secretion of various toxin truncations. If these domains are identified, researchers could target specific proteins to the system for secretion, manipulating the machine to delivery different proteins, such as antibiotics. Understanding how the T6SS toxins are delivered is key to understanding its crucial role in bacterial competition and pathogenesis.

Ralf Wenz | Zebrafish - a window into the evolution of intestinal neuro-immunology
(Supervisors: Maggie Dallman and Laurence Bugeon)

It is well known that there is a close-knit relationship between the immune system and the neuronal system in mammals. The nature and function of this relationship - particularly in the intestine - is now rapidly being untangled. There remains, however, the essential question of why the immune system and the neuronal system are so capable of affecting each other? To answer this question, I posit that neuroimmune communication in the intestine already existed in early vertebrates because it rendered a survival advantage to expel pathogens via peristalsis. Evolutionary pressures could have forced the two systems to merge functionally to combat infections in the intestine by expelling microbes via peristalsis. On this view, intestinal pathogens are expelled by first being sensed by immune cells, which then communicate with surrounding neurons. These neurons in turn then stimulate intestinal muscle cells to increase peristalsis and expulse the pathogen. This presentation showcases the advances that have been made in order to investigate this question.



Expert Panel Session

Theme: The Plastic Challenge: Sustainable Interventions for a Healthy Planet | 17:15–17:45 in SAFB122

A drinks reception will be available on the level 1 concourse for a short break after the talks and before starting this session. Please join our expert panel members to discuss this hot topic led by Dr Arturo Castillo Castillo from the Centre for Environmental Policy.

Abstract: It is estimated that between 4 and 12 million tonnes of plastic enter the ocean every year. Given the growth in consumption and global population, post-consumer plastic waste is likely to continue to increase and so is the rate of leakage into the environment and the ocean unless many profound changes happen. Although research is still needed to understand the pathways of leakage and fate of plastic debris in the marine environment, Imperial scientists are more interested in preventing plastic from becoming waste and entering the ocean in the first place. Members of the Ocean Plastic Solutions Network are working on interventions that will increase material preservation and recovery. They believe in considering every aspect from materials' science and product or service design through to chemistry and recycling technologies. They are also aware that the right policies need to be in place for future societal and technological change to succeed. After a brief overview of how their disciplines fit into the broad picture, our three scientists look forward to a lively discussion with questions from the audience.

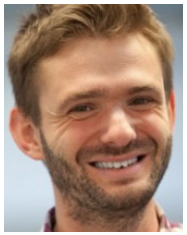
Panel members:

Arturo Castillo Castillo
Research Fellow, Centre for Environmental Policy

Arturo is Research Fellow in Resource Efficiency at the Centre for Environmental Policy. He leads the Imperial College London Ocean Plastic Solutions Network aiming to stop plastic pollution. His research focuses on enabling recycling of plastics and metals and other pre-conditions for the circular economy. He has led numerous European projects on Industrial Symbiosis and has worked previously as energy policy consultant. He aims to improve interactions between engineering, policy making, natural and social science.

Alexandra Porter
Professor of Bio-imaging, Department of Materials

Alexandra holds and MEng from Oxford University, and a PhD from Cambridge University in Biomedical Materials. She worked as a postdoctoral research fellow at the Lawrence Berkeley National Laboratory, MIT and The Nanoscience Centre Cambridge, under the guidance of Sir Mark Welland and Prof. Paul Midgley. She held the Oppenheimer Research fellowship for physical sciences at Cambridge University and a Junior Research Fellowship at Newhall College, Cambridge. Alexandra's group uses correlative electron microscopy techniques to characterise interfaces between biomaterials and cells. Her great interest is in developing a mechanistic understanding of how the chemistry of these materials controls their degradation behaviour, and ultimate bioactivity, to improve their performance and safety. This interest stemmed from her PhD on understanding the mechanisms by which silicon increases the quality of bone around hydroxyapatite bone grafts (now being sold by Baxter). She works on a number of systems, including the environmental fate and toxicology of nanomaterials / plastics and how bone's quality and toughness become altered in pathological tissues. She also designs new nanomaterials to cross the blood brain barrier and treat Parkinson's disease and for treatment of tuberculosis and breast cancers.



Charles Romain
Imperial College Research Fellow, Department of Chemistry

Charles graduated in 2008 from Université de Rennes 1 were he obtained his M.Sc degree as well as his engineering degree from Ecole Nationale Supérieure de Chimie de Rennes (ENSCR), Charles then obtained his Ph.D in 2011 from Université de Strasbourg under the supervision of Dr. Samuel Dagorne and Dr. Stéphane Bellemin-Laponnaz. His thesis project focused on the synthesis and the reactivity studies of group 4 metals complexes bearing NHC ligands and their applications in the ring-opening polymerization of cyclic polar monomers. After a brief period at Econic-Technologies as a research scientist working on new catalysts for making polycarbonate from carbon dioxide, in January 2013, Charles joined the group of Prof. Charlotte K. Williams at Imperial College London, where he developed new methodologies to access well-defined polyesters and polycarbonates from renewable resources. In 2016 Charles was awarded a Junior Research fellowship at Imperial to start his independent research group.

Poster presenters

1. Christopher Adams, Department of Life Sciences
Supervisor: Maruf Ali
Structural and biochemical analysis of PERK and ATF6, towards understanding the mechanism of UPR signal activation

2. Carlota Bozal-Ginesta, Department of Chemistry
Supervisor: James R. Durrant
Charge Accumulation Studies in Molecular Catalysts for Multi-Redox Solar Fuels Generation

3. Ryan Brown, Department of Chemistry
Supervisor: Mark Crimmin
Palladium catalysed C-O bond alumination

4. Tiffany Chan, Department of Chemistry
Supervisors: Ramon Vilar-Compte, James Choi (Bioengineering)
Delivering novel therapeutic agents across the blood-brain barrier using ultrasound for the treatment of Alzheimer's disease

5. Gregory Chaplain, Department of Mathematics
Supervisor: Richard Craster
Graded metasurfaces: A design tool for wave control

6. Elise Damstra, Department of Life Sciences
Supervisors: Cristina Banks-Leite and Kate Jones
Could vertebrates help mitigate the consequences of climate change on coffee?

7. Samuel Davis, Department of Physics
Supervisors: James McGinty and Paul French
Three dimensional imaging of live adult zebrafish using optical projection tomography

8. Mohit Devgan, Department of Chemistry
Supervisors: John M. Seddon, Nick. J. Brooks and Robert V. Law; David J. Moore (GSK) and Michael Thompson (GSK)
The Interaction of Personal Care Formulations with Skin Mimetics

9. Martí Garçon Padilla, Department of Chemistry
Supervisor: Mark R. Crimmin
Pd–Catalysed C–H Functionalisation of Fluoroarenes with Main Group Hydrides: Reactivity, Mechanism and Intermetallic Complexes

10. Oliver Gittus, Department of Chemistry
Supervisor: Fernando Bresme
Thermophoretic Response of Anisotropic Colloids: The Role of Internal Composition

11. Christopher Ho, Department of Physics
Supervisors: Ben Sauer and Mike Tarbutt
Measuring the electric dipole moment of the electron with YbF molecules

12. Katia Hougaard, Department of Life Sciences
Supervisor: Colin Turnbull
The Molecular Arms Race Between Plants and Aphids: Host R Genes

13. Luke Johnson, Department of Physics
Supervisor: Yvonne Unruh
Unveiling Earth 2.0: simulating cool star variability with ACTReSS

14. Daniel Kenna, Department of Life Sciences
Supervisor: Richard Gill
Bumblebee flight performance under pesticide stress

15. Faezeh Khoshsepehr, Department of Mathematics
Supervisor: Prof Anatoly Ruban
Stability Analysis of High Speed Flows

16. Vasiliki Kioupi, Centre for Environmental Policy
Supervisor: Nick Voulvoulis
Assessment of sustainability competences in Higher Education

17. Felix Laumann, Centre for Environmental Policy
Supervisors: Mike Tennant, Mauricio Barahona (Mathematics)
Causal discovery amongst the Sustainable Development Goals

18. Yibei Li, Department of Mathematics
Supervisor: David Evans
Coloured graphs determined by forbidden triangles

19. Yu Liu, Department of Life Sciences
Supervisors: Kurt Drickamer and Maureen Taylor
Investigation of oligomeric states of cell surface glycan-binding receptors during immune signalling

20. Vukasin Milosevic, Department of Physics
Supervisor: Alexander Tapper
The search for invisibly decaying Higgs bosons at the LHC

21. Thomas Oliver, Department of Life Sciences
Supervisors: Bill Rutherford and Tanai Cardona
Ancestral Sequence Reconstruction of Photosystem II

22. Lorenzo Palmieri, Department of Mathematics
Supervisor: Henrik Jeldtoft Jensen
Herd behaviour and financial crashes: an evolutionary perspective

23. Christopher Parperis, Department of Chemistry
Supervisor: Mark Wallace
Imaging the Mechanism of Nanopore Sensing

24. Phoebe Pearce, Department of Physics
Supervisor: Ned Ekins-Daukes and Jenny Nelson
Modelling complex optical structures and solar cells with RayFlare

25. Marie Rider, Department of Physics
Supervisors: Derek Lee, Vincenzo Giannini (CSIC-IEM, Madrid), and Peter Haynes (Materials)
Topological quantum dots

26. Francesco Sanna Passino, Department of Mathematics
Supervisor: Nick Heard
Predicting links in large computer networks using Poisson matrix factorisation

27. Shababa Selim, Department of Chemistry
Supervisor: Andreas Kafizas and James R. Durrant
Impact of oxygen vacancy occupancy on charge carrier dynamics in bismuth vanadate photoanodes for water oxidation

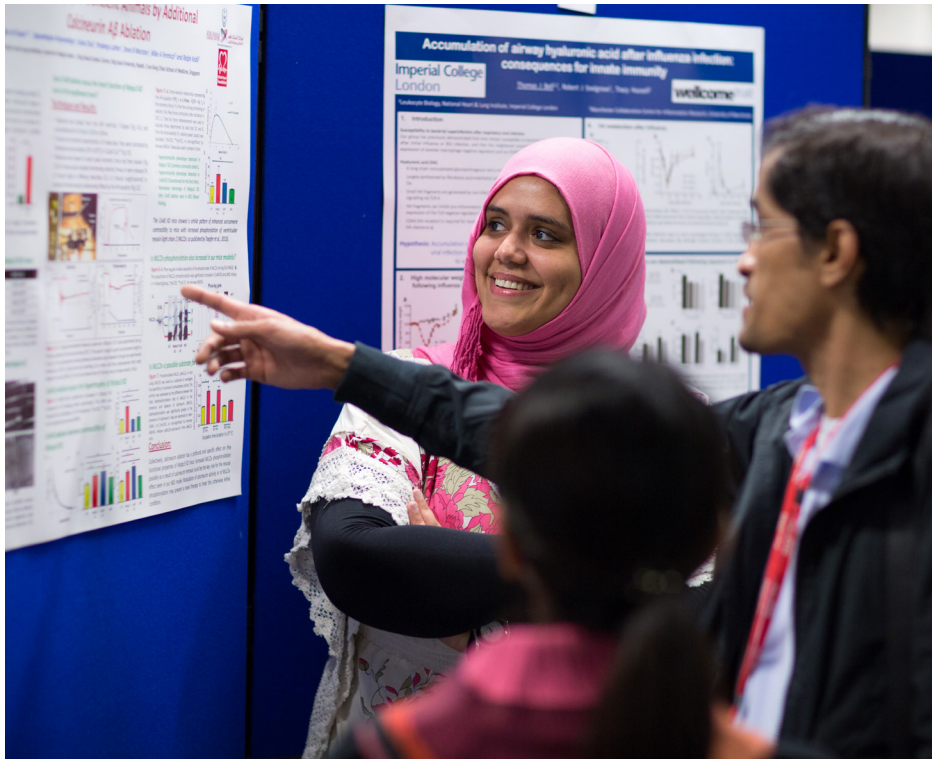
28. Wei Hao Tey, Department of Mathematics
Supervisors: Jeroen S.W. Lamb and Marin Rasmussen
Computational Analysis of Minimal Invariant Set for Discrete Dynamical Systems

29. Jure Tica, Department of Life Sciences
Supervisor: Mark Isalan
Engineering Turing patterns in E. coli with a bottom-up synthetic biology approach

30. Katie Willis, Department of Life Sciences
Supervisors: Austin Burt and Neil Ferguson
A novel approach to estimating the intrinsic population growth rate of Anopheles gambiae mosquitoes

31. Anton Zajac, Department of Physics
Supervisor: Amihay Hanany
Mathematical and Geometrical Tools used in the Study of Moduli Spaces of CFTs living on Brane Systems

32. Giacomo Zecchinelli, Department of Physics
Supervisor: Sarah Malik
Differential measurement of the Z/gamma ratio with the CMS experiment



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