*"...scholarships for research and education..."*

# Newsletter April 2011

The Leverhulme Trust

## It's chemistry!

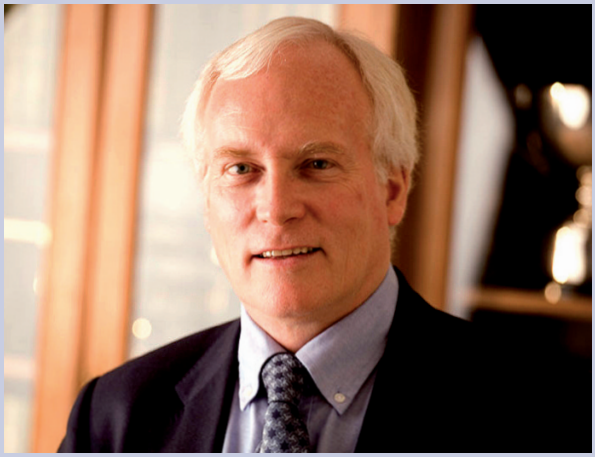
Assyrian-Babylonian scholarly literacy

Secret life in rocks

Magnetoreception in homing pigeons

# Appointment of Director

Members of the Leverhulme Trust Board are delighted to announce that Professor Gordon Marshall FBA, currently Vice-Chancellor at the University of Reading, is to become Director of the Leverhulme Trust with effect from 1st October 2011. He will succeed the present Director, Professor Sir Richard Brook who, after ten years at the Trust, will be retiring at the close of September 2011.



Professor Marshall has achieved distinction in many capacities. His own research interests have involved themes in the social sciences with emphasis on social exclusion, equality of opportunity, distributive justice and the culture of economic enterprise. He has taught at the Universities of Essex and of Bath and at the London School of Economics, prior to becoming Official Fellow in Sociology at Nuffield College, Oxford. His association with research funding agencies has involved a span of three years as Chief Executive at the UK Economic and Social Research Council (2000-2002). His most recent activity, as Vice-Chancellor at the University of Reading (since 2003), has seen the introduction of major changes at the university in terms of teaching and research profile (climate change, health and food security), of organisational structure (the merger with the Henley Management College), and the expansion of the university's facilities (the Minghella Centre for performing arts, the Enterprise Centre, and further residential and academic buildings).

Professor Marshall's range of work in research, teaching and administration has given him wide experience in the sectors covered by the interests of the Trust. The Board is confident that the valued place of the Leverhulme Trust in the world of research, both in the UK and internationally, will be preserved and strengthened by Professor Marshall's appointment.

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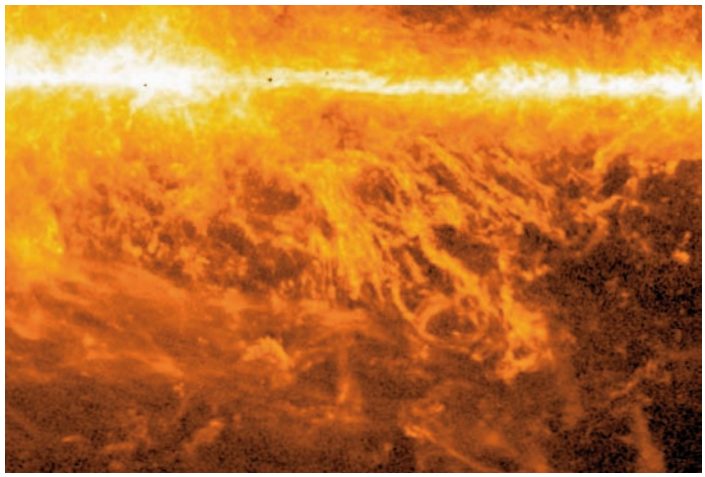
# Quantitative morphology of interstellar gas in the Milky Way

The space between the stars in our Galaxy, the Milky Way, is filled by the interstellar medium (often referred to as the ISM): gas, magnetic fields and particles moving at speeds close to the speed of light known as cosmic rays. Where the interstellar gas collapses into dense clouds new stars form; what triggers the formation of these clouds from the generally diffuse gas is unclear, although turbulence (chaotic patterns in the gas flow similar to the eddies seen in a fast moving river) is thought to play an important role. Stellar winds and exploding massive stars replenish the ISM with new gas and also drive turbulent motions in it.

Radio telescope observations show that the interstellar gas, which is mostly hydrogen atoms, is often concentrated into clouds and elongated filaments. Different regions of the sky appear to contain qualitatively different structures that must be related to the (poorly understood) local dynamical processes, such as turbulence, buoyancy and compression due to shock waves. To date there is no practical method by which the gas morphology can be objectively classified and hence its physical origin revealed. In this Leverhulme-funded Research Project Grant we will use techniques from mathematical topology to develop and apply new tools that will tell us, for example: how filamentary is the gas, and what physical process, such as shock waves or turbulence, drives it into this state?

The project will create a new approach to the analysis of astronomical images dominated by random structures. We shall develop, adapt and use advanced mathematical methods based on wavelet filtering and shape classification. The quantitative outputs will be related to the underlying physical processes in the ISM using theoretical models



*A field from the Galactic All-Sky Survey of Hydrogen (McClure-Griffiths, N.M. et al. ApJS, 181, 398–412, 2009). The horizontal line of brightest emission is the Galactic mid-plane. In some regions the gas has a very filamentary structure, in others there is a prevalence of smaller scale, more isotropic, clouds.*

and computer simulations. These methods will be applicable to a wide range of data, but we shall apply them first to surveys of interstellar hydrogen and then to the total and polarised synchrotron radiation which trace the magnetic field and cosmic ray components of the ISM. This work is especially timely as the new generation of radio telescopes that are rapidly being developed, such as the LOw Frequency ARray (LOFAR) and the Square Kilometre Array (SKA), have new surveys of the Galactic hydrogen and/or synchrotron radiation among their key scientific objectives.

**Dr Andrew Fletcher**
***Newcastle University***

# The only poisonous primates: ecological context and function of slow loris venom

The study of animal venom systems has provided fascinating insight into their interactions with predators, prey and competitors, and has yielded promising pharmacological advances. Venom systems in mammals are far rarer and little known, with research restricted to solenodons, some shrews, and platypuses. Of humans' closest relatives, only one primate – the nocturnal slow loris (Nycticebus) – is purportedly venomous. Despite reports of this exciting phenomenon 40 years ago, virtually nothing is known about how slow lorises use venom.

Slow lorises (hereafter lorises) occur throughout Southeast Asia, where tales of their bad taste and toxic bite can be traced back centuries. Despite the animals' small size (300g – 2kg), loris bites are intensely painful, may take weeks to heal, and can cause anaphylactic shock and death in humans. The toxin seems to be produced when a loris combines saliva with exudate from its upper arm.

Research into other toxic species provides a framework to begin exploration of the function of loris venom. Lorises are slow-moving omnivores that consume vertebrate prey, insects and plant materials containing secondary metabolites.Many species ingest secondary metabolites and accumulate them in their tissues. Toxins can serve an anti-predatory function making prey unpalatable. Less mobile animals that cannot readily flee from predators are more likely to exploit toxic secondary metabolites. Toxin sequestration may also serve as camouflage to facilitate in capture of prey, such as ants. Anointing with the chemical profile of prey may help predators to infiltrate colonies of social insects, avoiding attack. Wild lorises are remarkably parasite free and are one of few primates that engage in 'anting' - actively or passively applying a noxious substance to the fur. Thus, loris toxins could serve as a key line of defence against ecto parasites.

The study of loris venom will allow us to make a significant contribution to our understanding of the evolution of venomous systems in mammals. Knowledge of how venom is acquired and used by lorises has applied implications for the welfare of released animals. Knowledge of the nature of loris venom may help curtail the rampant pet trade of these highly threatened primates.

*Javan slow loris anointing its head with poison in defensive posture (image credit: K.A.I. Nekaris).*

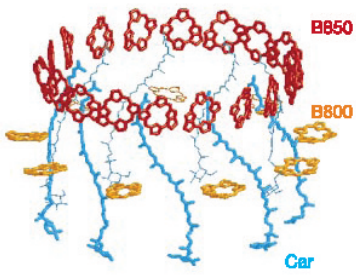
**Dr K. Anne-Isola Nekaris**
***Oxford Brookes University***

# Quantum coherence in natural and artificial light harvesting systems

Photosynthesis is the process by which biological systems convert sunlight into chemical energy, and is thus the driving force behind life itself. It is remarkably efficient; up to 95% of the energy that is captured is ultimately converted into a useful chemical form. This exceeds the best man-made solar cell, which has an efficiency of about 25%. If we could develop a model that fully describes how photosynthesis works, and use the same principles in synthetic devices, then we could go a long way to finding a solution to the problem of energy generation in the 21st century.

Photosynthesis proceeds in three main steps. First, sunlight is captured by a chromophore, a molecule whose electrons can be put into higher energy states by the Sun's rays. This electronic excitation then moves around a network of interacting chromophores that is bound by a protein complex, in a process called energy transfer. The energy moves in a directed way until it reaches a particular position, called the reaction centre, where it is broken up and used to make the chemicals that facilitate the reactions that power life processes.

In some very recent experiments, it has been shown that quantum mechanics plays a key role in energy transfer between chromophores. It has been conjectured that quantum processes mean that this movement is very effective, with hardly any of the excitation energy being lost. Exactly how quantum mechanics does this is not, however, very well understood.




In this project, we aim to develop a new quantum model of the movement of energy through networks of chromophores. It will tell us whether the efficiency of energy transfer can be enhanced through quantum coherent effects. We will also show how to optimise and control the energy transfer rate and direction by choosing particular materials and by exciting the system using designed optical pulses. We hope that at the end of the project, we will have laid the foundation for a new design strategy for building efficient solar cells.

**Dr Brendon Lovett**
***Heriot-Watt University***

*The structure of the LH2 complex of R. Acidophila shows the complex arrangement of the chromophores that capture sunlight. Our project will focus on developing new methods for simulating the quantum dynamics of simplified structures. (Figure adapted from Herek et al. Nature 417 533 (2002)).*

# Proceedings in Parliament in 1624: an edition of the parliamentary record

The 1624 Parliament remains one of the most puzzling and controversial of all the early Stuart Parliaments. The most harmonious of all the early Stuart assemblies, it fits rather awkwardly into the accepted scholarly framework, which views the period between 1604 and 1629 as one of steady and marked deterioration in relations between the king and the Commons. Its burst of legislative activity has helped to inspire important recent research, moving political history into new realms, exploring the connections between Parliament and the public in Stuart England – for example on the relationship between parliamentary politics and petitioners and the publication and circulation of news.

Moving forward our understanding of this Parliament, however, has been hampered by the lack of a good edition of its proceedings. For all of the other Parliaments of the early seventeenth century, the scattered evidence has been brought together and edited by the Yale Center for Parliamentary History. The proceedings of the 1624 Parliament, uniquely, remained unpublished when the Yale Center was closed in 2007, leaving a gaping hole in the material readily available and accessible for this critical year in the history of Parliament.

*The House of Commons and House of Lords in around 1640.*

The History of Parliament Trust agreed to become the repository of the 1624 material collected by the Yale Center, and a grant from the Leverhulme Trust will now enable it to employ research staff to complete the project, under the supervision of a team which has recently published an enormous wealth of material on the Members and constituency politics of the period, in The House of Commons, 1604-29 (soon to be available online), and is now working on the House of Lords over the same time. The 1624 proceedings will be published online as well as in print, and, with the biographies we have already published and other online resources, will begin to offer the prospect of a connected set of resources which will enable scholars to dig more deeply and more easily than ever before into the vexed politics of the early Stuarts.

**Paul Seaward**
***History of Parliament Trust***

# Assyrian-Babylonian scholarly literacy: identifying individual spelling habits

Cuneiform script is one of the world's oldest writing systems and apparently also one of its most complex. It comprises about 1000 different wedge-shaped signs that can each represent one or more words or syllables. There may be several legitimate spellings of even very common words.

But much of this apparent complexity comes from cuneiform's long period of use, across a wide geographical area, for many different languages and purposes. It was written all over the Middle East, especially in the areas corresponding to modern-day Iraq, for over three thousand years until about the 1st century AD. It was adapted to record at least half-a-dozen different languages, including Sumerian, Akkadian, Hittite, Elamite, Urartian, and Hurrian, most of which sounded very different from each other. We already know that no one individual writer ever used the full capacities of cuneiform, but it is difficult to explore the subtleties of personal writing habits using current methods.

In order to study exactly how individuals, families and literate communities used cuneiform script to express themselves, we will be developing computational, statistical methods to investigate spelling habits in cuneiform. We will be testing and documenting easy-to-use query tools, and associated analysis methods, that can be applied to the Open Richly Annotated Cuneiform Corpus (http://oracc.org/), a new online resource which comprises tens of thousands of cuneiform texts in standardised, structured and richly-annotated editions.

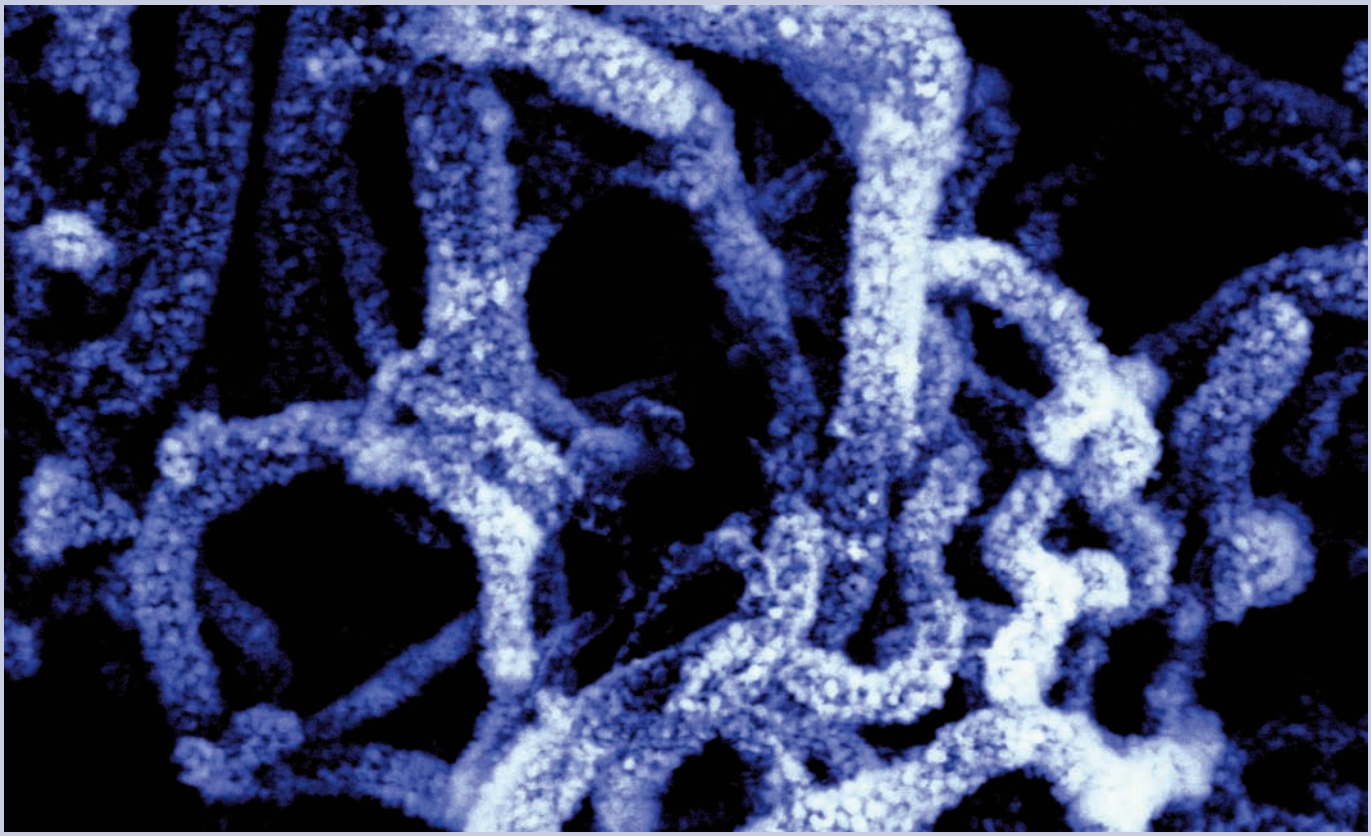
Dr Greta Van Buylaere and I will be advised by Steve Tinney of the University of Pennsylvania and Niek Veldhuis of UC Berkeley. Our case studies will focus on Assyrian and Babylonian scholarly writings of the first millennium BC, in order to explore how knowledge travelled from person to person and place to place. But we will design the query tools so that any interested researcher can use them on any Oracc texts. In this way we hope to foster a new, bottom-up approach to cuneiform literacies that will fundamentally enrich our understanding of personal writing, thinking and communication in the ancient Middle East.

**Dr Eleanor Robson**
***University of Cambridge***

*Professional scribes underwent a formal training in cuneiform. This tablet, written in the Babylonian city of Nippur, southern Iraq, in c.1750 BC, contains a list of professions in Sumerian, with their Akkadian (Babylonian) translations given next to them. Obverse Penn Museum CBS 10466, photograph by Penn Museum staff.*

*Cuneiform was written on clay tablets and on more perishable materials such as parchment and leather. Here two scribes take dictation from a superior, as shown on a low-relief wall carving from the palace of king Tiglath-Pileser III in the Assyrian city of Kalhu, northern Iraq, c.730 BC. Detail of British Museum ME 118882, photograph by Greta Van Buylaere.*

# Fingerprinting time



The use of fine, dry powders to develop latent fingerprints left after criminal activity has been established for over a century. However, various types of surfaces, such as rough materials, fabrics and adhesives are difficult to treat with this type of technique. Other methods have been developed, including acid dyes, chemical fuming and powder suspensions. The Home Office has devised protocol tables that apply broad classification to surfaces and outline appropriate development technique sequences. These procedures for fingerprint analysis have been generally established through empirically based studies; there is a recognised lack of research in this area and utilising routine techniques may, in some cases, be sub-optimal or impossible.

A US report in February 2009 outlined the desirability of additional and rigorous research in forensic techniques, and this is backed up by practitioners such as the chief forensic pathologist of the New York State Police, who states in a New Scientist interview, "so many innocent people get convicted ... based on junk science". More recently, the UK Forensic Science Regulator has also stressed the importance of scientific assessment of the validity of methods as one of the cornerstones of ensuring quality in forensic practice. This conclusion is further reinforced by other studies and court actions that challenge the application and interpretation of fingerprint evidence. The development of an enhanced scientific understanding of forensic fingerprint evidence is therefore both timely and critical in ensuring the continued trust in forensics and the validity of investigative methodology.

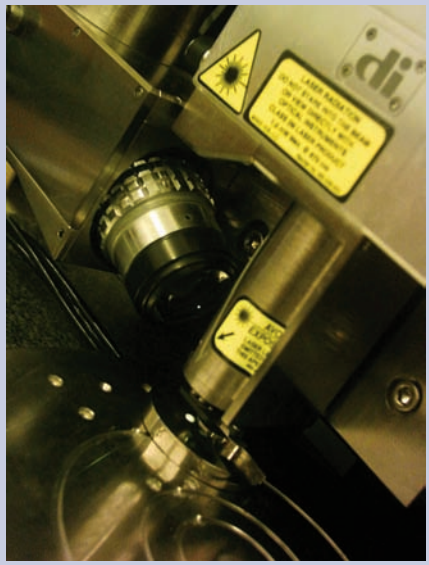
The detection of fingerprints on porous surfaces poses a particular challenge. Techniques exist to study fingerprints on paper and other porous materials, but the nature of the substrate structure results in rapid absorption of the components into the paper, altering surface reactivity, as well as potential trapping of the reagent into the background structure. The biochemistry of fingerprints is complex, containing, for example, fatty acids, proteins and metal ions in various proportions, which differs from person to person. Even for a single individual, chemical composition of fingerprints is strongly affected by factors such emotional state, grooming regime, and intake of food and drugs, which further complicates detection and interpretation. These various components of the deposited print may be absorbed and laterally spread at differing rates, analogous to chromatography.

This Research Project Grant will enable the Experimental Techniques Centre at Brunel University to bring together an interdisciplinary team, working with micro and nano analysis techniques to improve understanding of the time-dependent interactions between fingerprints and porous surfaces, to improve choice of development techniques. The history of documents in forensic investigations can also be highly important. For example, in fraud, counterfeiting or pornography cases, it is important to know if a fingerprint has been deposited before or after the paper is printed with compromising material - avoiding the, "I only loaded the copier" excuse. In addition to improving detection, our study of time and surface dependent interactions of fingerprints will lead to increased information on the relation between fingerprints and printing on questioned documents.

**Dr Benjamin Jones**
***Brunel University***

*Scanning Electron Microscopy imaging shows nanoparticulate decoration of polymeric development from the interaction of two sequential development agents (image credit: Ben Jones; this will also appear shortly in Materials Today www.materialstoday.com).*

*Surface analysis to aid forensic detection utilises equipment such as this atomic force microscope.*



# Secret life in rocks

*Eruption of Eyjafjallajökull Volcano, Iceland. A Volcanic Environment Microbial Observatory is based on the new lava flows about 20 miles from the original field site in Landemannalaugar.*

***Carolyn Allen,** of the Trust, reports*

A study of subglacial volcanic rocks revealed that these apparently cold and lifeless environments are much different from a microbes perspective. The researchers found a surprising diversity of microbial life in the volcanic rock samples including many microbes that have never previously been identified and bacteria that can only thrive in extremely hot conditions.

The study, led by Professor Charles Cockell from the Open University, provides insight into how microorganisms colonise the type of extreme volcanic rocky environments that characterised early Earth and helps point the way to where to look for life on Mars. Professor Cockell and Dr Aude Herrera collected rock samples from Landmannelaugar, a region near the Hekla volcano in the Southern Highlands of Iceland.

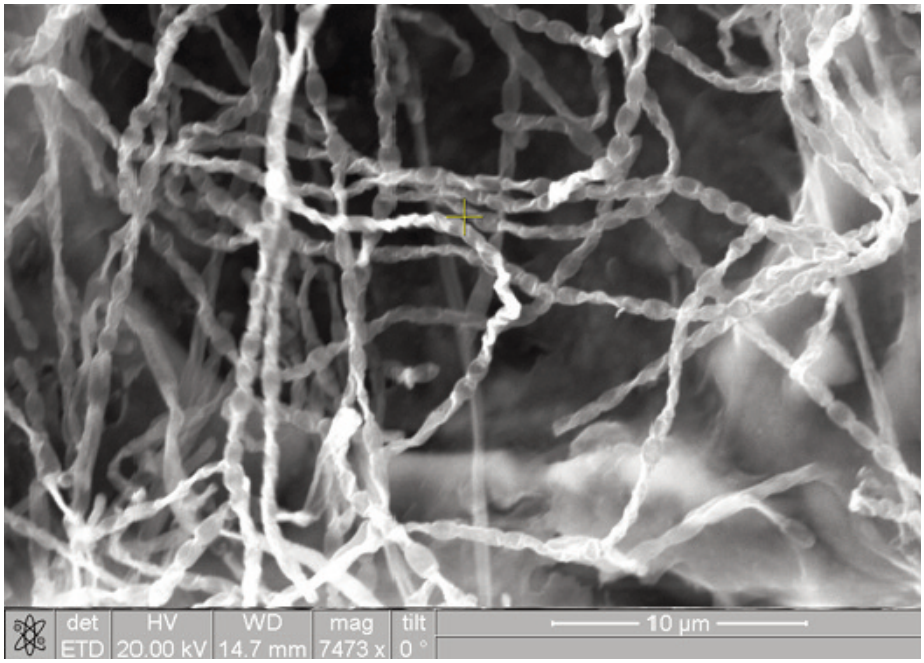
Back in the lab, they extracted and sequenced DNA from the crushed rocks and compared the DNA sequences to those in databases of previously characterised microbes. Another experiment involved crushing the rocks and pouring them on to agar plates to determine what microbes are able to grow using only the nutrients available in the rocks. In some of the rock samples collected, 40% of the DNA extracted and sequenced was associated with microbes with less than 85% similarity to anything known in the databases. As microbes with less than 97% similarity would be considered a new species and less than 95% would be considered a new genus, the microbial communities in these volcanic rocks potentially represent whole new divisions of microbes.

"Interestingly, we can't really culture these novel microbes in the lab which probably means that they are feeding off very unusual organic material that comes from other members of the microbial community," said Professor Cockell.

One organism that the researchers have been able to culture successfully in the lab, however, potentially represents a new genus of microbe whose closest genetic match is fragments of DNA found in the oldest ice on Earth (8 million years old). The microbe, isolated from volcanic glass, is tolerant to extreme dessication and can even grow on polished volcanic rock showing that it can tolerate very low concentrations of nutrients. Professor Cockell believes that this novel organism could provide a model to study how microbes could thrive in the very organic-poor environments that would have been present on early Earth.

The study findings have also enhanced our understanding of the distribution of microbes that use iron as a source of energy. Despite the high iron content found in volcanic rocks, most of the microbes found in the rock samples were related to bacteria that use organic material as an energy source rather than those that use iron oxide. In contrast, Icelandic streams carrying the products of volcanic rock weathering had abundant communities of iron-oxidising

*Dr Aude Herrera collecting samples in a hot spring in Landemannalaugar, Iceland.*




*Scanning Electron Micrograph showing colonisation of volcanic glass blocks by bacteria obtained from crushed rocks grown on agar plates.*

bacteria. This has important implications in the search for life on the cold volcanic planet, Mars. The lack of iron-oxidising bacteria in Icelandic volcanic rock suggests that the rocks on Mars would not provide a viable environment for life – ancient riverbeds on the planet's surface are probably more promising locations to look.

According to Professor Cockell, one of the highlights of this Leverhulme-funded study was the discovery not only of a huge diversity of microbial life in volcanic rock environments but also of a huge diversity of extreme environments within the rocks.

"One of the interesting things we found was, despite the fact that they are in a cold desert, the temperature of these rocks can get up to about 40 degrees during the day because they are very dark so they absorb solar energy," he said.

This is at the lower end of the temperature range for thermophiles – a type of microbe that grows at extremely high temperatures - and the researchers have managed to isolate some microbes from Icelandic rocks that will only grow at temperatures above 40 degrees.

"I think there are many hidden surprises in these apparently lifeless, cold volcanic deserts – a very high diversity of microbes, and microbes that we wouldn't even think would be active in those environments might find locations where they can thrive," Professor Cockell said.

The work funded by this Leverhulme Trust Research Project Grant represents one of the most thorough characterisations of the microbiology of volcanic environments and its successful completion could not have been more timely. The eruption of the Eyjafjallajökull volcano in March 2010 coincided with the end of the grant and while many of us complained about the inconvenience caused by the ash cloud, Professor Cockell and his team could see the silver lining.

As a direct result of the success of the Leverhulme-funded project, Professor Cockell was able to apply for a NERC Urgency Grant to establish the Volcanic Environment Microbial Observatory (www.volcaniclife.org) on new lava flows about 20 miles from the Hekla field site. Using research techniques established during the earlier study, this project will investigate which microbes colonise volcanic deserts first and how they get there. By comparing the microbiology of new rocks with the findings from the older rocks, the researchers also hope to unravel the sequence of colonisation over time.

"I'm sure the Icelanders would not be very impressed with this but for a long time we had been saying how useful a new eruption would be. For us, the eruption in March was fantastic – exactly what we needed!" said Professor Cockell.

**Professor Cockell's work was supported by a three year Research Project Grant awarded in 2006.**

*Ash clouds from the eruption of the Eyjafjallajökull volcano in 2010.*

*Professor Charles Cockell and Dr Aude Herrera collecting rock samples in Landemannalaugar, Iceland.*

# Testing the relationship between latitude and biodiversity in the Cretaceous

Today, organisms share a common distribution pattern known as the 'Latitudinal Biodiversity Gradient' (LBG): species numbers are highest in the tropics but diminish steadily towards the poles (Figure 1). This pattern occurs in diverse groups such as insects, plants, marine invertebrates and land animals (e.g. reptiles and mammals). Until recently, it was widely believed that the modern LBG pattern first arose in ancient times (as much as 400 million years ago) and has persisted throughout most of the intervening period. However, recent work on fossil insects, mammals and dinosaurs is beginning to reveal that, at least on land, the modern LBG might only have been established around 40 million years ago. This raises questions about how land organisms were distributed with respect to latitude in older geological periods, and why latitudinal patterns change through time.

The Cretaceous Period (145-65 million years ago) is particularly interesting to researchers who wish to answer the above questions. For example, during the mid-Cretaceous (around 93 million years ago) average global temperatures were 6-14° C. higher than today, and then decreased in the final 20-30 million years of this period. To date, however, there has been no detailed study of the latitudinal distribution patterns of land organisms living during the Cretaceous, and so the effects of these climatic shifts on latitudinal patterns are poorly understood.

Figure 2.

Figure 3.

This three year Research Project Grant will collect new data on the latitudinal distributions of Cretaceous land vertebrate groups (such as dinosaurs, mammals, lizards, frogs, freshwater fish etc.). This will involve studying fossils in museums around the world (Figure 2). The researchers will also carry out fieldwork in India (Figure 3) aimed at collecting new fossils from rocks dated to the very latest Cretaceous Period – the time just prior to the mass extinction 65 million years ago that killed off all dinosaurs except birds. These new data will then be used to answer the following questions:

- Were Cretaceous latitudinal distribution patterns different from those of today, and, if so, how were they affected by climate change?
- Were the latitudinal distribution patterns of Cretaceous vertebrates different in the Northern and Southern hemispheres and, if so, can this be traced to differences in land area, climate and/or evolutionary history?
- Do differences in the latitudinal distribution patterns of particular Cretaceous vertebrate groups reflect body size, physiology and habitat? Current hypotheses predict that freshwater forms are more buffered against climate change and mass extinction than land-dwelling forms, and large-bodied and warm-blooded forms should find it easier to inhabit cooler climatic zones.
- Did Cretaceous vertebrates diversify most strongly in the tropics, with waves of immigration into mid- and higher latitudes, as apparently occurred in marine invertebrates?

Aside from filling gaps in our knowledge of Cretaceous latitudinal distribution patterns among land animals, the results of this project will shed light on aspects of the end-Cretaceous mass extinction. Moreover, the Cretaceous provides an excellent 'natural laboratory' for exploring the effects of long-term climate change on latitudinal distribution patterns. Therefore this research should contribute to our understanding of the causes of the tropical peak in global biodiversity observed today, and the future biological effects of global warming.

**Dr Paul Upchurch**
***University College London***

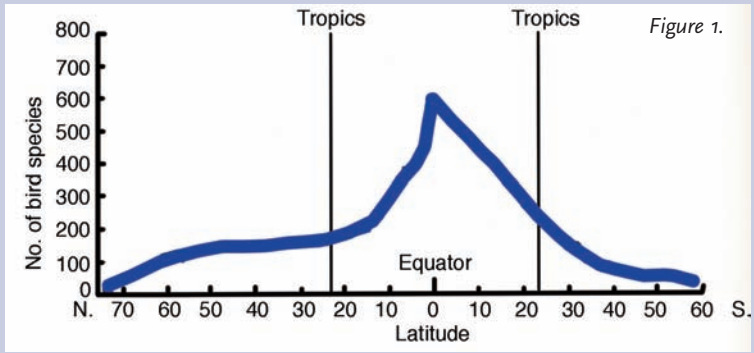



Figure 1.

*Figure 1. A graph showing how the biodiversity of living terrestrial birds varies with latitude (modified from Turner JRG & Hawkins BA 2004 In Frontiers of Biogeography: New Directions in the Geography of Nature (eds. MV Lomolino & LR Heaney), 171-190, Sinauer Assoc. Inc.).*

*Figure 2. A tail vertebra belonging to the gigantic mid-Cretaceous saurupod dinosaur Futalognnkosaurus in the Museo de Geología y Paleontología de la Universidad Nacional del Comahue, Neuquén, Argentina. This vertebra is approximately 75 cm tall.*

*Figure 3. The Govipatnam Quarry – a palaeontological fieldsite in the Late Cretaceous rocks of India.*

# A career in the circus

Whether it's jugglers in ancient Egypt or clowns in Hopi Indian tribes, circus skills have been around for thousands of years. The birth of Big Top circus dates back to 1776 when Philip Astley, an ex-officer from the British Cavalry, combined equestrian technique with acrobatic exertion and sold it with unrivalled showmanship. For 200 years, travelling circus was the only form on offer. Populated by people born into the life in the ring, circus was pretty much a closed shop with only the occasional outsider, or 'josser' breaking out of stable duties and joining the show.

This all changed around forty years ago when New Circus emerged across Europe. Like Pandora's Box, once the mysteries of circus skills were opened up to non-circus folk, there was no containing them any longer. Once circus was opened up to new audiences and participants, it started to develop in new ways. One of the best known results from this New Circus experiment is Cirque de Soleil, which has become a multi-billion dollar industry since its foundation in 1985. At the same time in Belfast, an altogether different incarnation of New Circus was taking shape. The Belfast Community Circus School was founded at the height of the Troubles as a response to deep divisions in Northern Ireland when it was discovered that the inherent qualities of circus promoted cooperation, enhanced communication skills, self esteem, respect, trust and team working.

Twenty five years down the line, Belfast Community Circus School (BCCS) occupies a unique position in the world of New Circus (which has now morphed into Contemporary Circus). With the only Circus building on the island of Ireland, BCCS offers one of the largest participatory circus experiences in Europe, working with more than 300 children and young people each week to support the acquisition of circus skills in order to foster personal development and creative endeavour. Alongside this extensive programme of youth activity, BCCS is also responsible for supporting professional development amongst circus professionals and aspiring professionals. It is this latter dimension which has led to the support offered by the Leverhulme Trust.

In September 2011, BCCS will commence the delivery of a ten month intensive programme designed to fast track young adults into a career in circus arts as both performers and teachers. This course will introduce students to acrobatic technique, trapeze skills, juggling and tightwire walking along with clowning training. As well as these 'pure' circus skills, the training will deliver practical lessons aimed at supporting a pathway to professional practice. Graduates will have experienced training in child protection, teaching techniques, business development, accountancy and marketing. The diverse training will be accompanied by quality teaching and performance experiences. The end of year show will involve participation in Northern Ireland's largest ever Outdoor Arts performance, Land of Giants. The aim is to support all of the graduates into careers in circus and to match the 95% success rate achieved in the only previous course of its kind held ten years ago.

**Mr Will Chamberlain**
***Belfast Community Circus School***

# Young children's reasoning about everyday chemistry

This inter-disciplinary project, combining cognitive psychology paradigms with education and chemistry approaches, aims to explore children's knowledge of how substances mix prior to systematic chemistry instruction. More specifically, the project aims to study children's earliest understandings of chemistry, with experiments on how 4 to 11 year olds understand what happens when substances/materials mix. When a solid is mixed with a liquid, it might dissolve forming a solution, with the solid disappearing in the liquid, or it might suspend in the liquid, with particles diffused throughout, or it may do nothing, just floating/sinking, or the two might be involved in a chemical reaction, forming new substance(s). The outcome depends on various chemical properties of the different substances, including substance-kind (roughly, different molecular structure and bonding within molecules) and form (roughly, depending on bonding between molecules).

We focus on mixing, because it is one of the earliest chemistry concepts children are deemed capable of grasping. Very little work – either in cognition or education – concerns such young children. Most existing studies of chemical understanding used interviews, suggesting little or no conception of the particulate nature of matter, with primary school students attending to macroscopic properties of substances instead (i.e. what they can see). Briefly, by particulate nature of matter we mean the idea that substances are made up of invisible, sub-microscopic particles, with molecules being the smallest particles of most substances. Some knowledge of the particulate nature of matter is necessary to understand substances and how they interact with each other. Therefore, investigating the emergence of this level of understanding is important for effective science teaching.

Children's chemistry understanding is usually studied in a qualitative manner, leading to an impression of fairly late emerging knowledge. Instead, this project will use quantitative and largely non-verbal cognitive psychology methods because of their effectiveness at uncovering early understanding in other areas. For example, research from intuitive biology, psychology and biology indicate that limits on children's explanations reflect limitations of their vocabulary, not limits of their understanding. We know this because more sensitive, less verbal, experimental psychology paradigms unearthed substantially earlier understanding from pre-school age. We focus on everyday materials rather than strictly chemical substances (sand, stone, wood, plastic, metal, spices, flour, vitamins, sugars, salts, baking soda/powder, instant coffee, cocoa, soap, dye, etc.), because children may reason better about familiar content (and also for safety).

The aim is to learn about children's natural approach to chemical phenomena before instruction. The value of our approach is three-fold. First, we focus on children younger than those typically studied. Second, this is possible because of sensitive experimental paradigms. Third, our interdisciplinary approach involving researchers in cognitive psychology, education and chemistry will allow us to apply insights from the behavioural sciences to a technically distant topic. We hope the results of this project will shed light on how very early chemical understanding relates to understanding in other domains, with implications for science and chemistry education.

**Dr Michelle Ellefson**
***University of Cambridge***

*Children seeing reactions that occur when they mix everyday substances.*

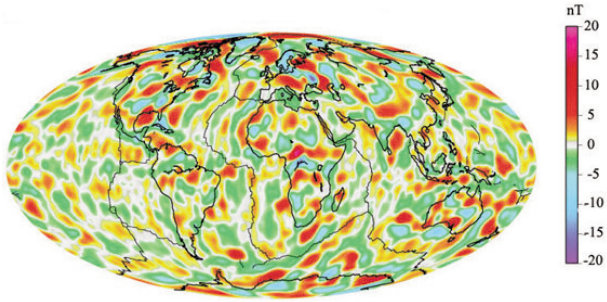
# Magnetoreception in homing pigeons

Numerous animals, including many bird species such as the European robin, are able to perceive the Earth's magnetic field and then use this information to navigate often very long distances (using a magnetic map-like sense) and/or orient in a specific direction (using a compass sense). Homing pigeons also navigate using the Earth's magnetic field, and the 'sensor' has been localised to the head. More recently, studies have shown that migratory birds require visible light to perceive the Earth's magnetic field, leading many to suspect that magnetoreception occurs in the eye. Whether the pigeon can actually 'see' the Earth's magnetic field is unknown, but it opens up the possibility of finding out more about how magnetoreception works by altering the animals' visual environment.

This project aims to develop new methods for testing birds' sensitivity to magnetic fields based on the intrinsic responses of the vertebrate nervous system to any sensory stimulation. Potentially, this approach can help reveal more details about the nature of magnetic detection (for example, is it truly visual?) as well as its underlying neural mechanisms, both in birds and ultimately in other animals as well.

Together with Dr Turgut Meydan, I have developed instrumentation that can generate and control an artificially generated earth-like magnetic field both in time and space. This allows the team to manipulate the magnetic field in the laboratory to see under what specific conditions the birds respond (e.g. brightness, colour, etc.) as well as the exact nature of their response. More importantly, in view of recent intense media interest in magnetoreception, the proposed groundbreaking research is both timely and novel in that it will provide a much sought after laboratory-based technique for studying the precise properties of this biological sense without depending on 'migratory restlessness' (i.e. a bird's desire to fly in a particular direction at only certain times of the year).

This innovative multidisciplinary approach will provide the team with a firm experimental foundation for advancing our understanding of the properties and limitations of this remarkable sensory ability in the pigeon, which are essential to elucidating this "sixth sense" in birds as well as other animal species. If magnetoreception is visual, much work will ultimately be needed to determine the retinal structure(s) and molecular mechanisms involved. Although some way off yet, there is even the exciting possibility that we may learn from the natural world how to build our own super sensitive magnetic field sensors.




**Dr Jonathan Erichsen**
***Cardiff University***

*Satellite-imaged map of the Earth's magnetic field (image credit: Terrence Sabaka et al./NASA GSFC).*

*Homing pigeon (image credit: Andreas Trepte, www.photo-natur.de).*

# The East India Company at home, 1757-1857

This project seeks to enhance historical understanding of the form and function of British country house culture by situating changes in elite domestic interiors within wider global contexts. Specifically, it explores the domestic and imperial routes by which Asian luxury goods (ceramics, textiles, metal-ware, furniture, fine art and the like) found their way into the homes of Britain's governing elite in the Georgian period. The project builds upon recent developments in the study of consumer culture, gender studies, globalisation, and material culture. It also capitalises upon the recent explosion of historical research conducted by community-based family historians, seeking to integrate findings produced by amateur researchers into a wider systematic research project.

From Clive's victory at Plassey in 1757 to the outbreak of the Mutiny of 1857, Britain's Empire on the subcontinent was administered by the East India Company. A chartered monopoly, the Company significantly expanded its fiscal, territorial and military grip in India in the century before its abolition in 1858. By the later 1750s, its servants (that is, its civil and military officers) enjoyed unprecedented access to Asian goods. Together with the Company's official cargoes of Indian and Chinese commodities, these goods transformed British families' homes. From the early 1790s, however, the flow of Asian goods into British households was increasingly problematic. Restrictions on Company servants' private trade reduced their specialised knowledge of Asian textile producers; simultaneously, rising anxiety about the supposedly degenerative tendencies of 'Oriental' cultures made Britons' large-scale acquisition and domestic incorporation of Asiatic goods suspect. British manufacturers' ability to create new luxury wares with Asian motifs and the reopening of European markets to British consumers in 1815, moreover, offered nineteenth-century British consumers access to luxury goods more easily accommodated with emerging Western conceptions of national identity. The project will produce a series of interlinked case studies as a platform for analysis of change over time and space within British country houses, focusing specifically on the acquisition, use, meaning and circulation of Asian luxury goods. The research team will illuminate the ways in which material culture helped to mediate wider historical processes, such as family formation and reproduction, the creation and maintenance of trade networks, and the operation of political and military systems (for example, through webs of patronage). The project will also assess the ways in which Asian luxuries incorporated within British country houses expressed regional, national and global identities. Over the three years of the grant, the project will integrate academic research on the global genealogies of British country house interiors with research by amateur and family historians, whose activities have risen dramatically in the past decade in response to the availability of new digital resources and online forms of communication.

**Professor Margot Finn**
***University of Warwick***

*Mid-19th-century Indian sandalwood box: ornate, exotic objects such as this were offered by East India Company servants as gifts to family members and patrons in Britain (© Victoria and Albert Museum, London).*

# Grants awarded by the Board at their March 2011 meeting

The numbers in parentheses are the awards duration in months.

## Research Project Grants

### Applied sciences (including architecture)

| | | | |
|---|---|---|---|
| **Dr Benjamin Jones**<br>*Brunel University* | Determination of chronological context of latent fingerprints on porous surfaces | £171,448 | (36) |
| **Dr Ligang He**<br>*University of Warwick* | Predicting performance for applications running under authorisation mechanisms | £62,390 | (36) |
| **Dr Kianoush Nazarpour**<br>*Newcastle University* | Imaging and optimisation techniques for co-adaptively myoelectric prosthetics | £98,936 | (24) |

### Basic sciences

| | | | |
|---|---|---|---|
| **Dr Andrew Fletcher**<br>*Newcastle University* | Quantitative morphology of interstellar gas in the Milky Way | £133,902 | (36) |
| **Dr Philip Biggin**<br>*University of Oxford* | Investigating receptor dynamics with molecular simulation | £164,370 | (36) |
| **Dr Brendon Lovett**<br>*Heriot-Watt University* | Quantum coherence in natural and artificial energy harvesting | £247,884 | (36) |
| **Dr Matthew Gibson**<br>*University of Warwick* | Ice growth inhibition by synthetic macromolecules: experiments and modelling | £158,080 | (42) |
| **Professor David J Procter**<br>*University of Manchester* | Asymmetric copper–catalysis in the first total synthesis of the taedolidols | £104,000 | (24) |
| **Dr Paul Upchurch**<br>*University College London* | Testing the relationships between latitude and biodiversity in the Cretaceous | £158,089 | (36) |
| **Professor Maggie Cusack**<br>*University of Glasgow* | Biomineralisation: protein and mineral response to ocean acidification | £255,234 | (42) |
| **Dr Michelle Ellefson**<br>*University of Cambridge* | Young children's reasoning about everyday chemistry | £198,211 | (36) |
| **Professor Jonathan Keating**<br>*University of Bristol* | Arithmetical correlations from random matrix theory | £231,584 | (42) |
| **Dr Michael Hanley**<br>*University of Plymouth* | Signalling intent: do seedling volatiles influence attack by mollusc herbivores? | £145,538 | (36) |
| **Dr Jim Provan**<br>*Queen's University Belfast* | Can a dual refugial hypothesis explain the distribution of Lusitanian species? | £104,612 | (24) |
| **Dr Susan Crosthwaite**<br>*University of Manchester* | New insights into the function of non-protein-coding antisense RNA | £146,683 | (36) |
| **Dr K. Anne-Isola Nekaris**<br>*Oxford Brookes University* | The only poisonous primates: ecological context and function of slow loris venom | £201,403 | (36) |
| **Dr Jonathan Erichsen**<br>*Cardiff University* | Magnetoreception in homing pigeons: a novel approach | £248,049 | (36) |
| **Dr Darren Croft**<br>*University of Exeter* | The evolution of cooperation in structured animal societies | £143,814 | (24) |
| **Dr Stefan Howorka**<br>*University College London* | Sizing forensic nucleotide repeat sequences with nanopores | £113,001 | (24) |
| **Professor Marco Marletta**<br>*Cardiff University* | WIMCS/ Leverhulme Fellowships in `Dissipative and non-self-adjoint problems' | £160,977 | (12) |
| **Professor Daniel Robert**<br>*University of Bristol* | The influence of electrostatic fields on plant pollinator interactions | £220,808 | (36) |
| **Dr Jan Verlet**<br>*Durham University* | Spectroscopy, dynamics and reactivity of hydrated electrons at interfaces. | £66,168 | (36) |
| **Professor Iain Coldham**<br>*University of Sheffield* | Selective metallation and reactions of organonitrile compounds | £97,966 | (24) |
| **Dr Matt King**<br>*Newcastle University* | GPS time series homogenisation for sea level studies | £83,258 | (24) |
| **Dr Kevin Paterson**<br>*University of Leicester* | Improving secondary school students' science text comprehension | £72,821 | (24) |
| **Dr Anna Pratoussevitch**<br>*University of Liverpool* | Real forms of higher spin bundles | £63,268 | (36) |
| **Dr Lee Sweetlove**<br>*University of Oxford* | Exploring the use of bacterial enzymes to detoxify cyanogenic plants | £76,222 | (12) |

## Humanities

| | | | |
|---|---|---|---|
| **Professor Simon Hillson**<br>*University College London* | Do larger molars and robust jaws in early hominins represent dietary adaptation | £101,806 | (24) |
| **Dr John Drew**<br>*University of Buckingham* | Enriching Dickens Journals Online: attributions, accessibility, and innovation | £116,423 | (18) |
| **Professor Edmund Herzig**<br>*University of Oxford* | Exploration, maps and silk road history from Balkh, northern Afghanistan | £257,233 | (36) |
| **Dr Michael Willis**<br>*British Museum* | Politics, ritual and religion: cultural formation in early medieval India | £248,455 | (36) |
| **Professor Margot Finn**<br>*University of Warwick* | The East India Company at home, 1757-1857 | £220,860 | (36) |
| **Professor John Morrill**<br>*University of Cambridge* | A new critical edition of all the writings and speeches of Oliver Cromwell | £204,337 | (24) |
| **Dr Sian Nicholas**<br>*Aberystwyth University* | A social and cultural history of the British press in World War II | £249,785 | (36) |
| **Professor Peter Kornicki**<br>*University of Cambridge* | Translation and vernacularisation in pre-modern East Asia | £137,323 | (36) |
| **Dr Paul Seaward**<br>*History of Parliament Trust* | Proceedings in Parliament in 1624: an edition of the parliamentary record | £97,741 | (30) |
| **Dr Eleanor Robson**<br>*University of Cambridge* | Assyrian-Babylonian scholarly literacy: identifying individual spelling habits | £62,377 | (18) |
| **Dr Alan Ross MacDonald**<br>*University of Dundee* | Climate change in early modern Scotland as revealed in church records | £22,495 | (6) |

## Economics, business studies, industrial relations

| | | | |
|---|---|---|---|
| **Dr Max-Stephan Schulze**<br>*London School of Economics and Political Science* | Integration and growth: capital and goods markets in 14th to 18th c. Europe | £267,655 | (36) |
| **Dr Claudio Piga**<br>*Loughborough University* | Price discrimination and competition: new evidence from European airlines | £37,161 | (12) |

## Social studies (incl. anthropology, geography, social psychology)

| | | | |
|---|---|---|---|
| **Professor Peter Wade**<br>*University of Manchester* | Public engagement with genomic research and race in Latin America | £249,966 | (18) |
| **Professor David Thomas**<br>*University of Oxford* | Climatic hazards in the Gobi Desert | £186,997 | (36) |
| **Professor Roger Ingham**<br>*University of Southampton* | Early sexual socialisation and sexuality education; parental perspectives | £106,549 | (24) |
| **Dr Gavin Brown**<br>*University of Leicester* | Non-stop against apartheid: the spaces of transnational solidarity activism | £93,117 | (24) |

## Law, politics, international relations

| | | | |
|---|---|---|---|
| **Professor Leif Wenar**<br>*King's College London* | Clean trade: the resource curse and consumer demand for oil, gas, and minerals | £48,820 | (4) |

# International Networks

## Applied sciences (including architecture)

| | | | |
|---|---|---|---|
| **Dr Kathrin Schreckenberg**<br>*University of Southampton* | Preserving safety and nutrition of 24 months indigenous fruits and their derivatives | £124,772 | (24) |

## Humanities

| | | | |
|---|---|---|---|
| **Dr Ignacio de la Torre**<br>*University College London* | Percussive technology in human evolution: a comparative approach | £122,760 | (36) |
| **Professor Jennifer Saul**<br>*University of Sheffield* | Implicit bias and philosophy | £107,002 | (13) |

# Arts Bursaries / Arts Initiatives

| | | | |
|---|---|---|---|
| **Mr Tony Castro**<br>*Trinity Laban* | Bursaries for musical theatre performance | £91,500 | (36) |
| **Mr Will Chamberlain**<br>*Belfast Community Circus School* | Community circus arts training programme | £66,575 | (10) |
| **Ms Alison Hope**<br>*National Children's Orchestra of Great Britain* | National Children's Orchestra Leverhulme bursaries | £89,100 | (36) |