Advanced Studies Centre

News from Hilary term

Keble scientists win prizes for their research

Two Keble scientists have received prestigious awards this term. Dr Apala Majumdar was awarded the British Liquid Crystal Society Young Scientist Prize for 2012 and Dr Tom Sørensen received the Danish Lundbeck Foundation Talent Prize for 2011. Both are key members of Keble research clusters, in Complexity and Imaging, respectively.

Dr Apala Majumdar, British Liquid Crystal Society Young Scientist Prize winner, 2012

The British Liquid Crystal Society Young Scientist Prize for 2012, awarded to Dr Apala Majumdar, is presented annually to young researchers in recognition of significant contributions in the field of liquid crystal science. Dr Majumdar completed her Ph.D. in applied mathematics from the University of Bristol, in collaboration with Hewlett Packard Laboratories. Her thesis was motivated by the modelling of the Post Aligned Bistable Nematic Device and demonstrated the existence of a novel topological mechanism for bistability. Since her move to Oxford in 2006, she has worked on a variety of diverse problems in the mathematics of liquid crystals, ranging from variational tools in the theory of liquid crystals, characterisation of singularities and their symmetry properties to multiscale approaches to liquid crystal modelling.

Central to the College's Complexity Cluster, Dr Majumdar has a wide network of national and international collaborators, facilitates regular exchanges between academia and industry and now leads an impressive team on liquid crystal research with a significant research grant.

Dr Thomas Sørensen (Research Associate of Keble and member of the College's Imaging Cluster) has won the prestigious 2011 Lundbeck Foundation Talent Prize for younger scientists.

Sørensen's research is focused on producing novel chemical dyes that can absorb light and emit fluorescence. These can bind to biologically relevant substances, allowing them to be tracked and monitored in real time. The compounds can then be used as contrast agents in the imaging of human organs and tissues.

"*There is still a vast untapped potential for the application of fluorescence in biology, nanotechnology and materials science. By designing and making new fluorescent compounds and using novel technologies, such as plasmonics, it is possible to create fast electronics and ultra-sensitive molecular sensors*" he says. Some of Sørensen's dyes have been successfully used to visualise cells directly, and, when conjugated to biomolecules, to track the latter in cells and tissue.

Sørensen is a key member of the Imaging Cluster at Keble. The Cluster aims to produce real-time imaging of processes that occur in humans and animals at macro, cellular and molecular levels and is a collaboration between chemists, engineers, philosophers and medical scientists.

Dr Thomas Sørensen, the 2011 Lundbeck Foundation Prize winner

Keble ASC Small Research Grants: Results

Keble's Small Research Grants are awarded on a competitive basis (up to £2,000 each) and are designed to help Fellows in the development of a new research area or complete an existing project. The next deadline for applications is 6th Week of Trinity term 2012. Here we report on the results of recent research undertaken by some of our Fellows. First, **Nick Cutler** reports on his work in Iceland and its changing ecology.

Disturbance and ecological change in high-latitude birch woodlands

Annual growth rings in trees provide an invaluable record of environmental change. Differences in ring width can be used to reconstruct past climatic conditions and to assess the impact of ecological disturbances, whether these disturbances are natural or man-made. Many studies have been conducted using tree rings from temperate locations e.g. Europe and North America. Tree ring records from high-latitude regions are much rarer, mainly because there are fewer trees and low/variable growth means that tree rings are harder to interpret. This hampers our ability to understand climatic variability in a part of the world that is undergoing very dramatic warming.

My research focuses on long-term (decades to centuries) ecological change in Iceland. Consequently, I am very interested in the ways in which fluctuations in climate and disturbance events (e.g. ash deposition during the eruption of Eyjafjallajökull in 2009) have on the development of vegetation. Tree ring records are an ideal way of doing this and in 2010 I used a Keble Small Project Grant to collect tree ring cores in Iceland. I took the cores from birch trees growing on Mt Hekla, a volcano in Southern Iceland. Hekla is very active: it erupted five times between 1947 and 2000. It is therefore the ideal location to study the ecological impact of both a warming climate and volcanic disturbance.

The results of my research show a dramatic increase in tree ring width over the last decade. In broad terms, ring widths increase as growth conditions get better. In this case, it is likely that climatic warming has lengthened the Icelandic growing season and allowed the birch trees to grow more strongly. This result has implications for the fate of carbon dioxide (an important greenhouse gas): in theory, increased temperatures in the polar regions could result in more carbon being drawn from the atmosphere and tied up in organic matter such as trees, although a corresponding increase in the carbon dioxide released by warming soils is likely to exceed this effect. The rings also revealed that ash deposition had virtually no impact on tree growth: arctic birches are, perhaps unsurprisingly, hardy in the face of disturbance. Finally, and perhaps most significantly, the tree rings showed great variability from tree-to-tree. An understanding of this individualistic response is extremely important to studies that seek to generalise from tree ring records, as the recent 'Climategate' episode demonstrated.

Contributed by Dr. Nick Cutler, former Keble Fellow in Geography; currently at University of Cambridge.

Keble ASC Small Research Grants: Results

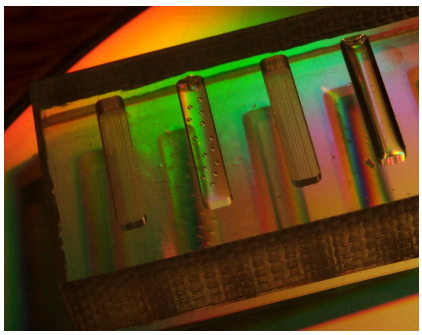
Experiments on increasing permeability in biological membranes

*Dr **Bríd Cronin** Research Fellow and Tutor in Chemistry and member of the Imaging Cluster explains her recent research, again funded through the Small Research Grants scheme*

Electroporation is an approach that is widely used in cell and molecular biology to transiently increase the permeability of the cell membrane by the application of an electric field. The technique is now in clinical use as a method for drug delivery *in vivo*, and trials are underway to investigate its application as a tumor ablation technique. However, there is relatively little knowledge regarding the mechanism of pore formation on a molecular level. Various models for predicting pore size and shape exist, but the kinetics of pore formation are not well understood. Last summer the ASC supported a Keble student, Jason Sengel, to work with me to understand the thermodynamics of this process and to directly image the pores.

The experiments we have designed are novel and technically demanding. We start by constructing a model cell membrane, achieved by contacting an aqueous droplet of nanolitre volume (Figure 1) with a hydrogel substrate in the presence of an oil and lipid mixture. Lipid molecules assemble on the surfaces of the droplet and the planar hydrogel; gravity serves to bring the two into contact, thus forming a bilayer. An electrode is then inserted into the droplet, and a second into the substrate, allowing the application of varying potentials across the membrane. We monitor the current across the membrane: pore formation results in an increase in the detected current. Simultaneously, we can visualise any pores formed using total internal reflection fluorescence (TIRF) microscopy. A fluorescent dye that emits light in the presence of calcium may be included in the droplet, with the hydrogel on the opposing side of the membrane containing calcium ions. When holes form in the membrane, calcium flows from the substrate into the droplet and we can 'see' the pores (Figure 2). The pores are smaller than the diffraction limit, typically between 0.1 and 10 nm. The mechanism of pore formation we observe matches well with the simple models proposed in the 1980s. We are now investigating energetic effects of additional cell membrane components on pore formation as well as the affect of membrane fluidity and defects in the lipid membrane structure.

Contributed by Dr. Bríd Cronin
Keble Research Fellow and Tutor in Chemistry.



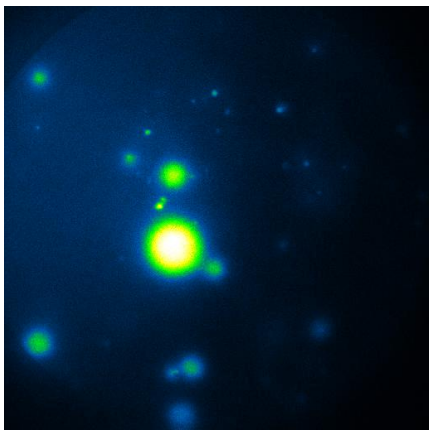


Figure 1 (top): A lipid monolayer is assembled when droplets are prepared in lipid and oil.

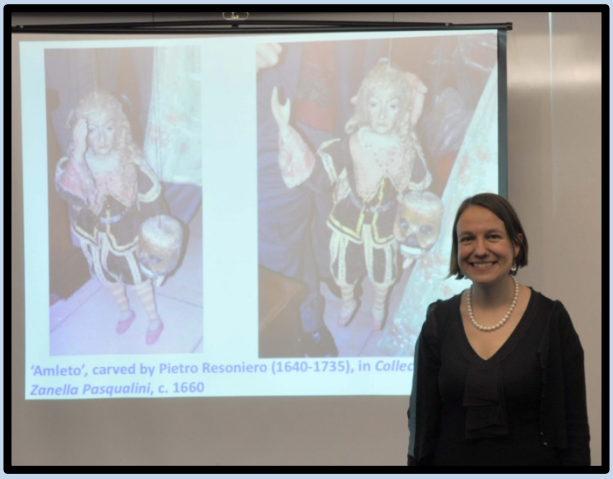
Figure 2 (bottom): Electropores in the membrane, visualised by fluorescence due to calcium ions binding to fluo-8H.

Relevant references on the technique are available in the following research articles:
Journal of the American Chemical Society, 2011, 133, 14507;
JACS, 2009, 131, 1652.

Meetings and events

Inaugural Event for Medieval and Renaissance Studies Cluster

On Friday March 2nd the Medieval and Renaissance Studies Cluster hosted its inaugural lecture. Professor Tiffany Stern delivered a talk entitled '"Such Place, such Men, such Language & such Ware": The Theatre of London's Fairs', which encouraged us to rethink the boundaries between the more 'elite' culture of early modern professional theatre and the 'low' culture of fairground entertainments. Professor Stern's talk illuminated the world of shadow shows and puppet theatre and she also introduced us to enchanting characters such as Morocco the dancing (and counting!) horse and the seventeenth-century puppet Amleto, who still had his Yorick. But behind such fascinating examples of the rich variety of fairground entertainments lay a more serious point: the physical, literary, and dramatic boundaries that modern scholars have created between early modern fairground spectacles and theatre have overlooked the significance of the interplay that appears to have existed between the two.



Prof. Tiffany Stern introducing the 17th century puppet Amleto

Early modern plays were littered with references to fairground entertainments and even to the organisation of the fairs, while the theatres sought to replicate conjuring tricks found at fairs for dramatic effect. Equally, fairground entertainers sought to emulate what was popular in the professional theatre and in doing so, fairs gave characters and stories from Renaissance plays a life of their own outside the theatre. Professor Stern's talk showed that there are numerous passages in the works of William Shakespeare, Ben Jonson and other early modern playwrights that we can only truly understand by examining the ephemeral entertainments performed at London's fairs. As we have cluster members working on the relationship between performance and text, early modern London, and magic, Professor Stern's talk gave us much food for thought for our own research. Keble History, English and Modern Languages undergraduates also benefitted from attending the lecture, as did Fellows and post-graduates from the wider Oxford research community.

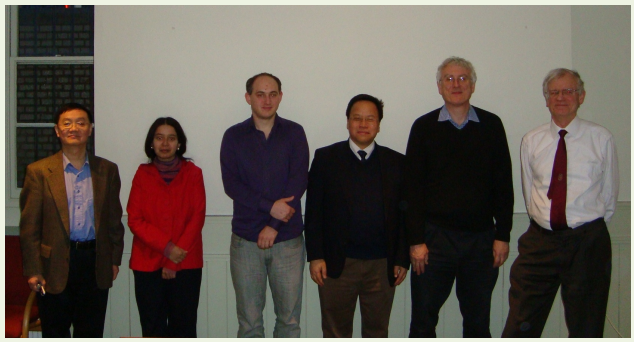
by Dr Tracy Sowerby, CDF in Renaissance History

During the same week the Cluster welcomed Carine Barbafieri (Université de Valenciennes) as Senior Research Visitor. She is a specialist in seventeenth-century French theatre and gave a talk at the Maison Française on her current research, which concerns the influence of bad taste on a kind of drama often thought to shun it. Finalists also benefitted from her presence, as she taught classes on Molière and Racine. Later this year, we can look forward to talks by Helen Hackett (University College, London) and Andrew Pettegree (University of St Andrews).

Meetings and events

Complexity Cluster Workshop

The Complexity Research Cluster Workshop had its second workshop on March 6th, aiming to promote collaborations and discussion for those working with and interested in non-linear problems. This workshop consisted of several talks of a broad range of interests: Some of these included, the consequences of phase for ocean waves by Prof. Paul Taylor; transonic flows and embedding of surfaces by Prof. Dehua Wang; multi-wave medical imaging by Dr. Yves Capdeboscq; the mathematics behind liquid crystals by Dr. Apala Majumdar; understanding the properties of quantum memory for a quantum computer by Dr. Alastair Kay; and the need to create better models for energy security and sustainability by Prof. Richard Darton.
The cluster, led by outstanding mathematicians, is quickly attracting diverse research areas.



Left: Prof. Dehua Wang delivering his talk. Top: some of the speakers (left to right): Prof. D. Wang, Dr. A. Majumdar, Dr. A. Kay, Prof. G-Q. Chen, Prof. P. Taylor and Prof. R. Darton.

Coming events...

Molecular Networks and the Internet: Are They Similar?

The Networks Cluster is pleased to announce a talk called "*Molecular Networks and the Internet: Are They Similar?*" to be given by Prof. Fengzhu Sun on 1 May, 5:00 pm at O'Reilly Theatre, Keble College.
Prof. Sun will be showing several examples of the close relationships that exist between the internet and molecular networks: 1) protein function prediction versus image analysis, 2) disease gene prioritization versus Google search, and 3) disease pathway inference versus information flow over networks. Future research directions involving molecular networks in the understanding of complex diseases, drug development and community genomics will also be discussed.

Dr. Fengzhu Sun is Professor and Head of Computational Biology and Bioinformatics within the Molecular and Computational Biology Program at USC.
For more information, visit:-
http://www-rcf.usc.edu/~fsun/

All are welcome to the talk!

Creativity Lecture Series 2012

The second Creativity Lecture Series, organised by Dr Lambros Malafouris, continues with three more talks in Trinity Term: 'Creativity in musical performance' (27th April), 'The challenge of empathy in knowledge economies' (4th May) and 'Creativity as a neuroscientific mystery' (18th May). All are welcome. For more details, visit: *http://www.keble.ox.ac.uk/about/events*

Imaging Cluster Workshop

The Imaging Cluster will be having its next workshop on 16th April at O'Reilly Lecture Theatre. This will consist of two talks given by Dr. Piotr Orlowski (Keble Research Fellow and Tutor in Engineering Science) and Dr. Jacob Filik (Diamond Light Source) on "*The Virtual Physiological Brain: a path towards the treatment of stroke and neurodegenerative diseases?"* and "*Vibrational micro-spectroscopy in biomedicine*", respectively. All are welcome.