



THE AUSTRALIAN NATIONAL UNIVERSITY



**Faculty of Science**

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Proceedings of the Third Annual PhB Conference

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**Organising Committee**

Frank Cai  
Nathan Deutscher  
Shern Ren Tee  
Natalie Spillman

FRIDAY 19TH OCTOBER, 2007  
BAMBI SEMINAR ROOM

## Schedule of Events

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Time	Event
9:45am – 10:00am	<i>Arrival at BaMBi Seminar Room</i>
10:00am – 11:00am	<b>Keynote Speaker:</b> Dr Jason MacKenzie
11:00am – 11:20am	<b>Vicki Hudepohl:</b> Quantum Decoherence in Nuclear Collisions
11:20am – 11:40am	<b>Kirill Talanine:</b> Solitons and Self-Organisation
11:40am – 12:00pm	<b>Joy Thompson:</b> Bright Purple and Fluoro Green: Studying Drosophila Development with Fluorescence Mi- croscopy
12:00pm – 12:40pm	<i>BBQ Lunch</i>
12:40pm – 1:00pm	<b>Stuart Szigeti:</b> Can Dark Matter be a Bose-Einstein Condensate?
1:00pm – 1:20pm	<b>Kate Griffiths:</b> Ecology of a Green Turtle Population on the Great Barrier Reef
1:20pm – 1:40pm	<b>Jessica Hudspeth:</b> The Synthesis and Crystal Structure of Ceramic Oxides
1:40pm – 2:00pm	<b>Kassel Hingee:</b> Equivalence of Polynomial Ranking and Tournament Selec- tion in Evolutionary Algorithms
2:00pm – 2:20pm	<i>Refreshments</i>
2:20pm – 2:40pm	<b>Kim Heenan:</b> From Black Holes to BECs
2:40pm – 3:00pm	<b>Myall Hingee:</b> Controlling the Grain Growth of Synthetic Olivine by Incorporation of Orthopyroxene
3:00pm – 3:20pm	<b>Kelly Nguyen:</b> Improving the Solubility of the Protein Glucose-6-phosphate Dehydrogenase by Directed Evolution
3:20pm – 3:40pm	<b>Dave Hutchinson:</b> Nano-scale Membrane Preparation using a Scanning Elec- tron Microscope
3:40pm – 4:00pm	<i>Refreshments</i>
4:00pm – 4:20pm	<b>Jenn Zhu:</b> Yale University: Initiatives towards a Sustainable Campus
4:20pm – 4:40pm	<b>Cameron Samuel:</b> An Introduction to Membrane Biophysics
4:40pm – 5:00pm	<b>Rose Ahlefeldt:</b> Dislocation Densities in Deformed Synthetic Olivine
5:00pm – 5:20pm	<b>Ashley Carron-Arthur:</b> TBA
5:20pm – 5:30pm	<i>Award presentation</i>

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## **Keynote Speaker**

### **Dr Jason MacKenzie (Intellectual Property Australia) — Intellectual Property Do's and Don'ts, and Other Funny Business**

Jason will present some basic information about the most common IP rights for scientific researchers. He will also cover some basic tips on IP rights from the perspectives of ownership, planning, and protection. “A granted patent is an enforceable IP right having a limited life. It gives the patentee a market niche in exchange for giving the invention up to the public domain.” Jason will also touch briefly on differences in law between patenting jurisdictions, and provide some light-hearted insights into the funny business that can occur in the patenting world.

## **Abstracts**

### **Vicki Hudepohl – Quantum Decoherence in Nuclear Collisions**

Interference effects are well-known feature of quantum mechanics, however performing a measurement of position or allowing interactions with background particles and such effects can be suppressed. This phenomenon is called decoherence and seems ubiquitous in complex systems. This ASC investigated the possibility of directly measuring decoherence effects in the scattering of identical  $^{36}\text{S}$  nuclei, which through interference effects give oscillatory Mott scattering rather than Rutherford scattering. Vicki Hudepohl is a 2nd year PhB student focusing on Physics and Chemistry. She is currently working at Nuclear Physics, RSPHYSSE and enjoys the thrill of the particle accelerator.

### **Kirill Talanine – Solitons and Self-Organisation**

Some systems become increasingly complicated as they evolve, almost as if they are being shaped by some guiding influence. But no such influence is needed! Self-organisation is a ubiquitous phenomenon through which simple systems increase in complexity purely by virtue of their own intrinsic properties. Examples include human economies, crystal growth, the folding of proteins and even the even the origin of life from self-organising organic chemicals. Perhaps the simplest example is that of the soliton, a type of wave with remarkable properties. Understanding solitons could provide precious insights into the amazing phenomenon of self-organisation.

### **Joy Thompson – Bright Purple and Fluoro Green: Studying Drosophila Development with Fluorescence Microscopy**

Fluorophores such as the green fluorescent protein (GFP), together with advances in microscopy techniques, have revolutionised our study of developmental processes. In this project we have explored the use of Photoactivatable GFP (PAGFP) fusion constructs as well as a green-red photoconvertible protein, EosFP. Both F-actin and membrane targeted PAGFP fusions were tested for their usefulness in imaging the epithelial-mesenchymal transition of the *Drosophila* mesoderm, while EosFP was applied to the tracking of haemocyte movement in the pupal leg. We report on the outcome of these experiments and also on the use of other GFP fusions to elucidate the role of the Rho1 GTPase exchange factor, Pebble.

### **Stuart Szigeti – Can Dark Matter be a Bose-Einstein Condensate?**

Dark matter is one of the largest mysteries in contemporary astronomy. Whilst we can clearly measure its effects, what dark matter actually is remains unknown. This term I have been

investigating a theory that proposes dark matter is a macroscopic quantum mechanical entity known as a Bose-Einstein condensate (BEC). This novel theory makes strong predictions that could be tested and used to differentiate it from current dark matter models. I will briefly introduce dark matter; discuss the basics of the BEC model and some preliminary computational results I've obtained.

### **Kate Griffiths – Ecology of a Green Turtle Population on the Great Barrier Reef**

Green turtles (*Chelonia mydas*) are migratory marine reptiles distributed throughout tropical and sub-tropical regions of the globe. The Great Barrier Reef (GBR) is a key habitat for Australasian green turtles. A long-term mark-recapture study is being conducted on a foraging (feeding) population of green turtles in the northern GBR. This study and others have revealed some of the population dynamics of green turtles. This seminar looks at population size and structure on a foraging ground in the northern GBR and what these results may mean for conservation programs and viability of green turtles in the GBR. The population analysed here seems to contribute to two genetically distinct metapopulations spanning considerable geographic range and environmental conditions, yet each metapopulation may rely on only a single key breeding area.

### **Jessica Hudspeth – The Synthesis and Crystal Structure of Ceramic Oxides**

Ceramic oxides materials are of vital importance to modern technology. Their applications range from GPS antenna to transistors to high temperature superconductors. This presentation will cover the synthesis of some ceramic oxide materials and the determination of their crystal structure using X-ray diffraction and electron microscopy techniques.

### **Kassel Hingee – Equivalence of Polynomial Ranking and Tournament Selection in Evolutionary Algorithms**

Evolutionary algorithms have a myriad of applications, often achieved through solving optimisation problem. Crucial to the success of an evolutionary algorithm is its selection scheme. I have examined the equivalence (or rather non-equivalence) of two such schemes, namely tournament and polynomial ranking.

### **Kim Heenan – From Black Holes to BECs**

Black holes, like many predictions of General Relativity, are notoriously difficult to study. Effects near black holes, such as superradiance, are not possible to observe presently, or in the foreseeable future. Analogue systems can provide a means by which to study phenomena otherwise inaccessible to experiment. Vortices in Bose-Einstein Condensates prove to be promising systems in which to model rotating black holes. Computational simulations of such systems, and ultimately experiments, have the potential to substantially contribute to our understanding of otherwise only theoretical predictions.

### **Myall Hingee – Controlling the Grain Growth of Synthetic Olivine by Incorporation of Orthopyroxene**

Olivine ( $(\text{Mg,Fe})_2\text{SiO}_4$ ) is one of the most common minerals on Earth, thus understanding its behaviour under various conditions is of great geological use. For this purpose, synthetic rock samples are made in conditions mimicking the high temperatures and pressures found within the

Earth, however it was found that introducing water to reflect reality produced samples with grain sizes far larger than desired. It was predicted that including another mineral, orthopyroxene ((Mg,Fe)<sub>2</sub>Si<sub>2</sub>O<sub>6</sub>), in the sample would restrict the grain growth of the olivine. This was tested in this project and appears to be valid.

### **Kelly Nguyen – Improving the Solubility of the Protein Glucose-6-phosphate Dehydrogenase by Directed Evolution**

The initial purpose of the study was to synthesize the protein Glucose-6-phosphate dehydrogenase for a metabolic pathway study. Modern DNA cloning techniques were utilized to insert the gene encoding for the protein into bacterial DNA, making the bacteria produce the desired protein. Nonetheless, the majority of the protein obtained was insoluble and unusable. To overcome the problem, directed evolution had been used to introduce random mutations into the gene coding for the protein and resulted in protein modifications. Some mutated forms of the protein, in fact, improved in their solubility and selected for further study.

### **Dave Hutchinson – Nano-scale Membrane Preparation using a Scanning Electron Microscope**

Electron Momentum Spectroscopy requires the preparation of membranes about 10nm thick. In this experiment, a gold membrane was cleaned and thinned by argon sputtering (i.e. ion bombardment). This process was closely monitored using a Scanning Electron Microscope, to produce a membrane which was self-supporting and transparent to electrons. This membrane was then used as a target in an (e, 2e) experiment, in which a high energy electron was fired at the target, ejecting an electron from the gold membrane. Both the incident and the ejected electron were detected after the collision, from which the target electron's initial energy and momentum was deduced.

### **Jenn Zhu – Yale University: Initiatives towards a Sustainable Campus**

The six weeks I spent in the US summer at the Yale Office of Sustainability can only be described as simply amazing. My work on establishing global standards for the IARU and greenhouse gas emissions reporting taught me a lot about the challenges of global sustainability. I found myself involved in everything from climbing onto the roof to see the largest solar panel array in the Ivy League, to getting out in the field with the locals with a spade shovelling topsoil. And between working full time, studying in the evenings and cramming a social life in the graduate dormitory, I somehow managed to find time to do some serious travel all over the East Coast. So come and hear all about my experiences.

### **Cameron Samuell – An Introduction to Membrane Biophysics**

Biophysics is the home of a new age of Renaissance men. Whilst the glory days of Da Vinci and Aristotle are long past, the ideals of combining the knowledge and ideas of disparate fields to solve new and unique problems is still very much alive. This talk will discuss the ways in which Biology and Physics have joined forces in order to explain the function and operation of ion channels: the structure by which cells communicate and interact with the outside world. You will find this talk relevant to your field whether you're a biologist, physicist or violinist.

## **Rose Ahlefeldt – Dislocation Densities in Deformed Synthetic Olivine**

One of the major mechanisms for deformation in a crystalline solid like the Earth's mantle is by dislocation creep, where linear defects (dislocations) are created and move through crystal grains. In order to understand the physical properties of the upper mantle it is necessary to understand how the major constituent, the ferro-magnesian silicate mineral olivine, deforms under various conditions. The relationship between density of dislocations and applied stress and temperature in very pure synthetic samples of olivine examined in this project provides a baseline for understanding the deformation of olivine-rich rocks under upper-mantle conditions.

**Ashley Carron-Arthur – TBA**