



College of Physical Sciences
College of Medicine, Biology & Environment

Proceedings of The ANU PhB Student Conference 2009

Organizing Committee

Bo Allan Xiao
Rosalind Attenborough
Dilip Sunder Raj
Emma Thomas
Yang Liu

Friday 23rd October, 2009
Peter Baume Building

Schedule of Events

Time	Event
11.15-11.20	Welcome & Opening Address
11.20-11.40	Quantum Dots in Quantum Wells - High Efficiency Solar Cells Jennifer Zhu
11.40-12.00	Looking for alx3 – Positional Cloning in <i>Arabidopsis</i> Ira Deveson
12.00-12.20	Bose-Einstein Condensates in Rubidium-85 Thomas Barter
12.20-12.40	Functional Analysis of Glucosyltransferase IV (GtrIV) in <i>Shigella flexneri</i> Hsei-Di Law
12.40-13.00	Focusing Light in Photonic Crystals Iain Forsyth
13.00-13.40	- Lunch Break, BBQ at BaMBi Courtyard -
13.40-14.20	Keynote Speaker: Professor Jenny Graves RSBS, ANU
14.20-14.40	Using Mutual Information to Analyse And Predict Biodiversity Emma Thomas
14.40-15.00	Introduction to Quantum Computation Bo Allan Xiao
15.00-15.10	Break
15.10-15.30	New Constraints on The Earth's Inner Core Anisotropy from Seismic Body Waves Daniel Leykam
15.30-15.50	Inevitable Science Students in A Lonely University?: Developing A Module for An Undergraduate Course about The Nature of Science Rosalind Attenborough
15.50-16.10	Intrinsic Physiological Properties of Rat Ganglion Cells Dilip Sunder Raj
16.10-16.30	GPGPU Reconstruction of Cone-beam Tomography Gabriel Collin
16.30-16.40	Break
16.40-17.00	Frequency Shifts in Gradient Echo Quantum Memory Alex Thorman
17.00-17.20	<i>Toxoplasma gondii</i> and <i>Schizophrenia</i> Helen Rickards
17.20-17.40	Carbon 12 and The Hoyle State: Measuring The Radiative Width Byron Vickers
17.40-18.00	Investigation of Taxonomically-Restricted Genes in The Coral <i>Acropora millepora</i> Alvin Pratama
18.00-18.10	Award Presentation

Full Program

Morning Session

(Judge: Dr Nick Robins)

11.15-11.20	Welcome & Opening Address
11.20-11.40	<p><i>Quantum Dots in Quantum Wells - High Efficiency Solar Cells</i> - Jennifer Zhu</p> <p>Abstract: Dots, wells, even dots-in-a-well... what do these have to do with solar cells? Thanks to quantum physics, we can engineer low dimensional structures to harness more of the solar spectrum, and these devices promise better operation and higher efficiency. The cells under investigation have historically been used in space because of their high cost, but with developments in concentrator technology they have found a potential market on Earth. I will present some developments from the lab and highlight the potential of these devices for clean and cheap energy.</p>
11.40-12.00	<p><i>Looking for alx3 – Positional Cloning in Arabidopsis</i> - Ira Deveson</p> <p>Abstract: The <i>alx3</i> mutation in <i>Arabidopsis thaliana</i> induces up-regulated expression of the <i>APX2</i> gene, which codes for the enzyme Ascorbate Peroxidase. This is an enzyme involved in detoxifying Reactive Oxygen Species, which can damage a plant's photosynthetic structures during times of drought or high light stress. Using map-based cloning procedures, this project aimed to determine the rough location of the <i>alx3</i> mutation in the <i>Arabidopsis thaliana</i> genome. Identification of the gene may yield valuable insight into the nature of plant-stress-response signals and have important implications for future agricultural development.</p>
12.00-12.20	<p><i>Bose-Einstein Condensates in Rubidium-85</i> - Thomas Barter</p> <p>Abstract: In 1925 Albert Einstein and Satyendra Nath Bose predicted a new state of matter, accessible only at temperatures tens of millions of times colder than space. At this temperature, the majority of atoms will exist in an identical quantum state, allowing quantum mechanical phenomena to be observed on a macroscopic scale. I present the latest work from an experiment that achieves this new state of matter in Rubidium 85, using modern cooling methods such as laser cooling, evaporative cooling, and sympathetic cooling.</p>
12.20-12.40	<p><i>Functional analysis of Glucosyltransferase IV (GtrIV) in Shigella flexneri</i> - Hsei-Di Law</p> <p>Abstract: "Glucosyltransferase IV (GtrIV) in <i>Shigella flexneri</i> is responsible for specific O-antigen modification, thereby converting serotype Y to serotype IVa. This study aimed to investigate the conserved and specific functions of GtrIV domains, as well as to identify residues that are critical for GtrIV function. As Loop No. 2 of all Gtrs is postulated to have a conserved function in glucosylation, GtrIV/GtrIc chimeric proteins were constructed by swapping Loop No. 2 of the respective Gtrs. Similarly, to investigate the specific function of GtrIV Loop No. 6 and GtrIc Loop No. 10, GtrIV/GtrIc chimeric proteins were constructed by swapping these two loops. Identification of critical residues were carried out by individually replacing all negatively charged amino acids within GtrIV loop No. 2 and loop No. 6 with alanine (neutral) via site-directed mutagenesis. These mutants need to be tested for function via slide agglutination with Type IV antisera."</p>
12.40-13.00	<p><i>Focusing Light in Photonic Crystals</i> - Iain Forsyth</p> <p>Abstract: The project examines localized waves in photonic crystals in the linear regime. Photonic crystals are periodic dielectric structures with a photonic band-gap.</p>
13.00-13.40 (Lunch Break)	- BBQ at BaMBi Courtyard -



Venue: Seminar room, Peter Baume Building [42a]

Organizing Committee: Bo Allan Xiao, Rosalind Attenborough, Dilip Sunder Raj, Emma Thomas and Yang Liu

PhB Program Coordinator: Dr Paula Newitt

Enquiries: E: Sue.Wigley@anu.edu.au T: (02) 6125 7659

Afternoon Session
(Judges: Dr Ulrike Mathesius
Dr Julie-Anne Fritz)

13.40-14.20	<p>Keynote Speaker: Professor Jenny Graves Comparative Genomics Group, RSBS, ANU</p>
14.20-14.40	<p><i>Using mutual information to analyse and predict biodiversity</i> - Emma Thomas Abstract: Mathematical concepts from information theory- such as Shannon entropy and mutual information- are increasingly being recognised as powerful tools for analysing and predicting diversity on a variety of biological scales. However, there exists little theory to predict expected values of such entropy-based biodiversity measures under different conditions. In this project, a mathematical model was used to quantify how genetic diversity depends on different population-genetic processes in terms of the mutual information between population index and allelic frequency distribution. The results were compared to data from experimental <i>Drosophila</i> populations.</p>
14.40-15.00	<p><i>Introduction to Quantum Computation</i> - Allan Xiao Abstract: Quantum computing has become an area of immense interest to physicists and computer scientists since the discovery of the Shor algorithm in 1994. This talk will provide a brief overview of this advanced multidisciplinary subject by introducing the concepts of qubits and quantum circuits, computational complexity, Shor's and Grover's algorithm and quantum error correction. The ultimate question that we attempt to answer is whether quantum computation is indeed faster than its classical counterpart.</p>
15.00-15.10 (Break)	Afternoon Tea
15.10-15.30	<p><i>New Constraints on The Earth's Inner Core Anisotropy from Seismic Body Waves</i> - Daniel Leykam Abstract: The inner core was discovered in 1936, and inner core anisotropy (directional dependence of elastic properties) was hypothesized fifty years later, to explain anomalous travel times of core-sensitive seismic waves. Recent results have lead to increasingly complex models of inner core structure, each with different implications for its formation. Inadequate spatial sampling of the inner core by seismic waves means these models are poorly constrained. In this study, we examined what new seismic receivers deployed by the ANU in Antarctica can reveal about the inner core.</p>
15.30-15.50	<p><i>Inevitable Science Students in A Lonely University?: Developing A Module for An Undergraduate Course about The Nature of Science</i> - Rosalind Attenborough Abstract: This project was inspired by the feeling that science undergraduates at ANU lack the opportunities and encouragement to reflect on the nature of science. Coincidentally, a course with precisely this aim is currently being developed. I have therefore been designing a case study which might fit into that course: it focuses on the debate between Stephen Jay Gould and Simon Conway Morris (two eminent evolutionary palaeobiologists) about whether the evolution of humans is inevitable or not. I ask how this debate of big ideas can prompt students to challenge their own ideas about what it means to be scientific.</p>
15.50-16.10	<p><i>Intrinsic Physiological Properties of Rat Ganglion Cells</i> - Dilip Sunder Raj Abstract: Ganglion cells in normal rats were stimulated and recorded under a range of stimulus paradimes to determine their electrical properties. The morphologies of the cells were then reconstructed using a confocal microscope which allowed a particular morphology (type) to be associated with certain electrical properties. In subsequent time this same procedure will be applied to rats treated with an agent that causes photoreceptor degeneration. After a period of a month or so the ganglion cells of these rats will then be tested to determine the electrophysiology properties of the rats to determine if they are different. This is part of the Bionic Eye Project.</p>

16.10-16.30	<p><i>GPGPU Reconstruction of Cone-beam Tomography</i> - Gabriel Collin</p> <p>Abstract: Computed tomography is a method of finding the internal structure of an object, it is an important tool in both medicine and industry. In cone-beam tomography, X-rays are taken of an object from many angles and are used to reconstruct the internal details. This reconstruction process is very computationally expensive. Traditionally this process is performed on CPUs. This project aims to leverage the enormous parallel processing power of modern graphics cards to improve reconstruction times. This would allow tomograms to be reconstructed on personal computers, rather than requiring super-computers.</p>
16.30-16.40 (Break)	
16.40-17.00	<p><i>Frequency Shifts in Gradient Echo Quantum Memory</i> - Alex Thorman</p> <p>Abstract: Quantum memory is currently of interest as it is necessary for the development of quantum computing and quantum cryptography. A candidate for quantum memory being investigated by a group at the ANU is Gradient Echo Memory (GEM); a frequency encoding memory that maps information between optical and atomic systems. In this project the computer package Xpdeint was used to develop a numerical code to solve the coupled differential equations that describe the GEM scheme. Using the code the frequency shift that occurs between the input and output in GEM was investigated.</p>
17.00-17.20	<p><i>Toxoplasma gondii and Schizophrenia</i> - Helen Rickards</p> <p>Abstract: In 1896 it was first proposed that infectious agents may contribute to the development of the psychiatric disorder schizophrenia. There is now much evidence to suggest that the protozoan parasite <i>Toxoplasma gondii</i> plays a role in some cases of schizophrenia. As an Add On to BIOL3142 Parasitology I have looked at the research on this topic and will present some of the evidence, which I believe provides strong support for a link between <i>Toxoplasma gondii</i> infection and <i>schizophrenia</i>.</p>
17.20-17.40	<p><i>Carbon 12 and The Hoyle State: Measuring The Radiative Width</i> - Byron Vickers</p> <p>Abstract: The production of carbon in stars occurs when three alpha particles fuse together within a short space of time. For this reaction to occur, there must be an energy level in the resultant Carbon 12 with certain properties, and this state is known as the 'Hoyle state'. The likelihood of a particle in this state decaying to lower energy states (the 'radiative width') can then be related to a number of important astrophysical processes. At present, this likelihood is not well known, but our experiment aims to improve the accuracy of this value.</p>
17.40-18.00	<p><i>Investigation of Taxonomically-Restricted Genes in The Coral <i>Acropora millepora</i></i> - Alvin Pratama</p> <p>Abstract: Cnidarians are the simplest animals at the tissue level of organization, and are of particular interest in terms of understanding the evolution of metazoan (higher animals) developmental mechanisms and the nature of the common metazoan ancestor. The cnidarian <i>Acropora millepora</i> (class Anthozoa), a reef building scleractinian coral, is used as a model organism in this project. It has proved to be surprisingly complex and vertebrate-like in terms of its gene repertoire. This project investigated the expression of ten taxonomically-restricted genes (TRGs) in <i>A. millepora</i> using two different methods, namely <i>in situ</i> hybridisation and Virtual Northern blotting. <i>In situ</i> hybridisation was conducted to determine the spatio-temporal expressions of these TRGs in <i>A. millepora</i> embryos. It was observed that the expression of these TRGs was not only restricted to certain embryonic stages, such as the planula and the post-settlement, but also localised to distinct body parts of the embryos and hence creating unique patterns. These results were later confirmed with Virtual Northern blotting, which revealed the relative amount and size of the TRG transcripts in various developmental stages of <i>A. millepora</i>.</p>
18.00-18.10	Award Presentation