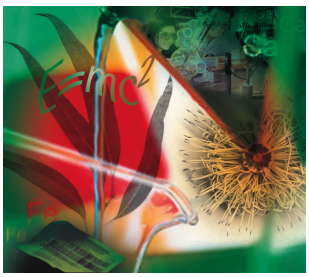
THE AUSTRALIAN NATIONAL UNIVERSITY



Faculty of Science

Proceedings of the Inaugural DSP/PhB Conference

Organising Committee
Melissa Tacy
Graham Dennis
Jolyon Bloomfield
Jacqui Poldy

Tuesday 6th September, 2005
Manning Clark Theatre 5

Schedule of Events

Time	Event
9:45am – 10:00am	Arrival at Manning Clark
10:00am – 11:00am	**Professor Graham Durant:** The importance of science communication as an ideal of good science
11:00am – 11:30am	Morning tea in the Manning Clark Foyer
11:30am – 12:00pm	**Melissa Tacy:** Cryptography: Creating and breaking the secret writing
12:00pm – 12:30pm	**Ruth Mills:** Where does all the weirdness go?
12:30pm – 1:00pm	**Nathan Deutscher:** Site percolation on three-periodic nets
1:00pm – 2:00pm	Lunch in the Manning Clark Foyer
2:00pm – 2:30pm	**Revantha Ramanayake:** Mathematical modelling of diseases and associated threshold theorems
2:30pm – 3:00pm	**Eriita Jones:** Comets: Travellers through the universe
3:00pm – 3:30pm	**Jolyon Bloomfield:** The Superbattery
3:30pm – 4:30pm	Afternoon tea at Vivaldi's & Award presentation

Keynote Speaker

Professor Graham Durant (Director of Questacon) — The importance of science communication as an ideal of good science

Professor Durant is the Director of Questacon, the National Science and Technology Centre. Prior to his move to Australia, Professor Durant was the Deputy Director of the Hunterian Museum at the University of Glasgow and also the Associate Director of the Glasgow Science Centre. He has extensive experience in science and communication and is committed to making science accessible to the wider community particularly schoolchildren, and making science and technology fun, educational and interactive.

Abstracts

Melissa Tacy — Cryptography: Creating and breaking the secret writing

With any development of an ordered system of writing there comes a need to protect written secrets. This can be achieved in a number of ways, in particular through cryptography or secret writing. This technique replaces letters in an alphabet with symbols according to a preset rule. Those who posses the rule, or key, can then read the message while to others it appears as meaningless gibberish. In this talk I shall present the development of ciphers in historical context focussing on how the basic ciphers have evolved as techniques for breaking them have been discovered.

Ruth Mills — Where does all the weirdness go?

Since its development in the 1920's Quantum Mechanics has proved itself extraordinarily useful in understanding how nature works at a very scale. However as well as accurately predicting the energy levels of Hydrogen, Quantum Mechanics also permits behaviour that is extremely weird; particles are allowed to exist in a superposition of states with very different properties and can become entangled so that altering the state of one particle affects the other instantly, even if they are separated by thousands of kilometres.

While this appears surprising and disturbing in the world of electrons and photons, it seems totally wrong when applied to larger objects. Is it really possible, as Schrödinger asked, to have a cat that is both alive and dead? And if not, where does all the weirdness go?

Nathan Deutscher — Site percolation on three-periodic nets

In physics, and in other fields, phase transitions find a fascinating mathematical model in percolation theory. Simple to state, the problem of site percolation concerns itself with the appearance of an infinite cluster of connected sites, on an infinite net of randomly occupied sites. The occupation probability for which this occurs is the site percolation threshold particular to that net.

Despite several decades of study, exact percolation thresholds are known only on a small number of nets. Numerical results are then the norm. Recent advances in algorithms have allowed the enumeration of precise percolation thresholds for many two-periodic nets. One such study suggests that site percolation thresholds correlate particularly well with geometric density. Correlations with other lattice characteristics had also been proposed.

We outline the adaptation of existing code to estimate site percolation thresholds for 26 three-periodic nets. The values arrived at are consistent with previously published results, which are available for only four three-periodic nets. Our analysis shows that a number of lattice characteristics are correlated with the site percolation threshold. In particular, we investigate the reasonably strong relationships that exist between the site percolation threshold of a periodic net and its geometric density.

Revantha Ramanayake — Mathematical modelling of diseases and associated threshold theorems

We describe simple models for epidemics, mostly in the context of viral and bacterial diseases for human populations. Generalisations of these Susceptible-Infected-Removed (SIR) models in terms of transmission functions and the modelling of stratified populations are considered. Threshold theorems provide sufficient conditions for a major outbreak. We will review some such threshold theorems in the context of deterministic models.

Eriita Jones — Comets: Travellers through the universe

Comets have long been of fascination to human kind. With their dramatic visual displays, many over the centuries have turned their eyes upward and sought to understand these strange bodies, and to unlock their secrets on the formation and development of the solar system and even life itself. Comets were once thought to be signals from Satan or the Heralds of Heaven, but now that they are known to be icy bodies formed in the outer solar system they have nonetheless lost little of their mystery.

This talk will reveal some of the fascinating history of comets; describe their birth, structure and evolution; detail both the space missions that have visited and studied comets, and the comets that were their focus; and finally look at some of the questions and mysteries that surround comets today.

Periodic comets like comet Halley, which rendezvous with the Earth every 76 years, provide a natural clock and remind us that there are great processes at work in the universe, of which we are such a tiny part. It is inspiring to envision what wonders these comets witness - the desolate outer reaches of the Solar System and the busy, overpopulated Oort cloud (never seen by human eyes) - and, as we understand them, what perspective we might gain.

Jolyon Bloomfield — The Superbattery

The need for high density energy storage is growing in today's world. We present theoretical calculations on energy density limitations of various energy storage devices, and also investigate practical implementations of some of these "batteries". Methods investigated include rotational kinetic energy storage, chemical potential energy release, electromagnetic storage, nuclear energy, and matter-antimatter reactions. Comparisons between theoretical values and present-day technologies will be discussed.