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From the Director

I would like to extend a warm welcome to all participants of the 54th Annual Conference of the Australian Mathematical Society. It is very pleasing to see that the AustMS Conference has again managed to attract such a large number of mathematicians and mathematics educators. At the time of writing we have well over 300 participants registered for the Conference, and also more than 60 people registered for the Education Afternoon. It is wonderful to see no fewer than 12 different countries represented at this meeting, and a special welcome is due to all those who have travelled from overseas.

This year's program once again features a number of talks by internationally renowned mathematicians, and on behalf of the program committee I thank all of our plenary speakers for accepting the invitation to speak at the 54th Annual Conference. At the other end of the spectrum we have many budding young mathematicians in attendance, with 53 students vying for this year's B.H. Neumann Prize for the best student presentation. For quite a number of these students this will not only be their first conference, but also their first talk outside their own institution. I wish all students good luck, and hope this meeting will be an inspiration.

Following on from last year's success, this conference again includes an Early Career Workshop, an Education Afternoon for mathematics teachers and a Public Lecture—the latter presented by Jonathan Borwein. His lecture *The life of π* , although not featuring shipwrecks or tigers, promises to be full of adventure and bite.

I am also very pleased to announce that this year's program includes the inaugural Hanna Neumann Lecture. This lecture is a recent initiative of the AustMS to honour the achievements of women in mathematics. Hanna Neumann is one of the most prominent female mathematicians this country has ever known, and it is fitting that another high profile Australian mathematician, Cheryl Praeger—Western Australian Scientist of the Year in 2009—is our first Hanna Neumann Lecturer.

Finally I would like to thank all of the people who have helped organise this conference: from members of the program committee, to session organisers, to all of the students and staff—both academic and professional—at The University of Queensland who have been involved one way or another. Without all your help and support, this meeting would not have been possible. I also wish to thank The University of Queensland, and in particular the Deputy Vice Chancellor (Research) Max Lu, the Deputy Vice Chancellor (Academic) Deborah Terry and the Executive Dean of the Faculty of Science Stephen Walker, for their very generous financial support for this meeting. I also thank the Australian Mathematical Sciences Institute (AMSI) for its support in preparing promotional material and for sponsoring the Education Afternoon.

Finally, it is always risky to single people out for a special word of thanks, but I will throw caution to the wind and mention a few people in particular. As in previous years, registrations were processed using the registration system developed by John Banks at La Trobe University. John not just made his system available to the organisers, but was always happy to make small modifications and explain the workings of the system. John, I am very grateful for all your help, advice and time. With great energy and efficiency, Andree Phillips took care of countless small and not-so-small jobs that are part of organising a conference. Without her, this meeting would undoubtedly have ended in an organisational nightmare for all of the local committee. Last but not least I would like to thank Celestien and the girls for being so understanding in the months leading up to the conference. They have always been used to an absent-minded husband and father, but, when in recent months absent-minded turned into absent, they never once complained. While I do like my office, I am looking forward to eating fewer dinners there.

I hope you will all have a wonderful conference, and will enjoy your visit to The University of Queensland and to Brisbane.

Ole Warnaar
Conference Director

Conference Organisation

Program Committee

Ole Warnaar – Conference Director
Ruibin Zhang – Vice President (Annual Conferences) AustMS
Phil Broadbridge
Vladimir Ejov
Markus Hegland
Kathy Horadam
Phil Howlett
Arun Ram
Mathai Varghese

Organisers of Special Sessions

1. Algebra and Number Theory – James East, Marcel Jackson
2. Applied Differential Equations – Jim Hill, Scott McCue
3. Calculus of Variations and PDEs – James McCoy, Yihong Du
4. Combinatorics – John Bamberg, Judy-anne Osborn
5. Computational Mathematics – Bishnu Lamichhane, Linda Stals
6. Control Theory – Yalcin Kaya, Volker Rehbock
7. Dynamical Systems – Reinout Quispel, John Roberts, Peter Stacey
8. Financial Mathematics – Fima Klebaner, Song-Ping Zhu
9. Geometric Analysis – Rod Gover, Adam Harris
10. Geometry and Topology – Bea Bleile, Emma Carberry
11. Lie Groups and Harmonic Analysis – Chris Meaney, George Willis
12. Mathematics in Biology, Medicine and Conservation – Bruce Gardiner, Graeme Pettet, Hugh Possingham, Anand Tularam
13. Mathematics Education – Michael Bulmer, Birgit Loch
14. Mathematical Physics – Tim Garoni, Jonathan Kress
15. Noncommutative Geometry and Operator Algebras – Adam Rennie, Aidan Sims
16. Optimization and Applications – Jonathan Borwein, Regina Burachik, Andrew Eberhard
17. Probability and Statistics – Jonathan Keith, Dirk Kroese, Ian Wood
18. Stochastic Processes and Modelling – Jerzy Filar, Phil Pollett
19. Education Afternoon – Michael Jennings, Ole Warnaar

Local Organisers

Ole Warnaar – Conference Director
Elizabeth Billington – Secretary and Conference booklet
Tony Roberts – Secretary
Dyrryn Bryant and Barbara Maenhaut – Treasurers
Andree Phillips – Administration
John Banks – On-line registration system
Jon Links and Joseph Grotowski – Special sessions
Lynelle Ross, Leslie Elliott and Ole Warnaar – Website
Phil Isaac and Vivien Challis – Liaison with plenary speakers
Bronwyn Hajek, Anthony Henderson and Stephan Tillmann – Early career workshop
Michael Jennings and Ole Warnaar – Education afternoon
Victor Scharaschkin – Accommodation
Kathy Holmes – Women's lunch
Zdravko Botev, Ben Burton, Tom Mollee, Eric Mortenson, Bevan Thompson, Yao-Zhong Zhang

Conference Program

Overview of the Academic Program

At this meeting there are 11 plenary lectures, one public lecture and 258 contributed talks. There are also two special presentations on *Mathematicians in Schools* and *Mathematics in Industry* scheduled just prior to the AGM on Wednesday. The Education Afternoon on Tuesday features an additional three talks accessible to a general audience, and concludes with the panel discussion *Catering for bright minds*.

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Plenary Lecturers

- James Borger (Australian National University)
- Jonathan Borwein (The University of Newcastle)
- Wolfgang Dahmen (RWTH Aachen)
- Larry Forbes (University of Tasmania) – ANZIAM Lecturer
- Jan de Gier (The University of Melbourne)
- Vladimir Gaiatsgory (University of South Australia)
- Ben Green (University of Cambridge)
- Michael Hopkins (Harvard University)
- Thomas Lam (University of Michigan) – Early Career Lecturer
- Elizabeth Mansfield (University of Kent)
- Cheryl Praeger (University of Western Australia) – Hanna Neumann Lecturer
- ▷ Timetable of Plenary Lectures – page 9

Public Lecturer

- Jonathan Borwein (The University of Newcastle)
- ▷ Timetable of Public Lecture – page 9

Special Sessions

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Conference Program

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Education Afternoon

- ▷ Timetable for Education Afternoon – page 48

Social Program

- ▶ Sunday 16:00 – 18:00
Welcome Reception
The University of Queensland Club
- ▶ Monday 09:30 – 11:00
Opening Ceremony
Abel Smith Lecture Theatre
- ▶ Monday 12:30 – 14:00
Women's Lunch
Terrace Room, Sir Llew Edwards Building
- ▶ Tuesday 12:30 – 14:00
Early Career and Students' Lunch
Terrace Room, Sir Llew Edwards Building
- ▶ Tuesday 17:30 – 18:30
Education Afternoon Reception
Alumni Court
- ▶ Wednesday 19:00
Conference Dinner
The Strand at Rugby Quay

Annual General Meeting of the Australian Mathematical Society

- ▶ Wednesday 16:30 – 17:30
54th AGM of the AustMS
Abel Smith Lecture Theatre

Conference Information and Registration Desk

The information and registration desk for the conference is located in the foyer of the Abel Smith Lecture Theatre, Building 23.

Timetable of Events at a Glance

Except for the Early Career Workshop, held at Rydges Oasis Resort Caloundra, and the conference dinner, held at The Strand at Rugby Quay, all events will take place at the St Lucia Campus of The University of Queensland.

Plenary lectures and keynote talks should finish (including questions) at 55 minutes past their allocated start time, and contributed talks at 25 minutes past their allocated start time.

Times of the talks in each session are listed from page 9 onwards. Concurrent timetables of all session talks can be found from page 37 onwards.

Saturday 25 September

TIME	DETAILS	ROOM
13:30 – 22:00	Early Career Workshop	Rydges Oasis Resort Caloundra

Sunday 26 September

TIME	DETAILS	ROOM
09:00 – 14:00	Early Career Workshop	Rydges Oasis Resort Caloundra
16:00 – 18:00	Registration	The UQ Club
16:00 – 18:00	Welcome Reception	The UQ Club

Monday 28 September

TIME	DETAILS	ROOM
08:45 – 09:30	Registration	Abel Smith 23
09:30 – 11:00	Opening Ceremony	Abel Smith 23
11:00 – 11.30	Morning Tea	Campbell Place
11:30 – 12:30	Plenary talk: Elizabeth Mansfield	Abel Smith 23
12:30 – 14:00	Women's Lunch	Sir Llew Edwards 14-613
12:30 – 14:00	Lunch	
14:00 – 15:00	Plenary talk: Michael Hopkins	Abel Smith 23
15:00 – 15:30	Afternoon Tea	Campbell Place
15:30 – 18:30	Special Sessions	

Tuesday 29 September

TIME	DETAILS	ROOM
08:45 – 09:45	Plenary talk: Ben Green	Abel Smith 23
09:45 – 10:00	Short Break	
10:00 – 11:00	Plenary talk: Larry Forbes	Abel Smith 23
11:00 – 11.30	Morning Tea	Campbell Place
11:30 – 12:30	Plenary talk: Thomas Lam	Abel Smith 23
12:30 – 14:00	Early Career and Students' Lunch	Sir Llew Edwards 14-613
12:30 – 14:00	Lunch	
14:00 – 18:30	Education Afternoon	Parnell 7-222
14:00 – 16:00	Special Sessions	
16:00 – 16:30	Afternoon Tea	Campbell Place
16:30 – 18:00	Special Sessions	
18:30 – 19:30	Public lecture: Jonathan Borwein	Abel Smith 23

Wednesday 30 September

TIME	DETAILS	ROOM
08:45 – 09:45	Plenary talk: Jan de Gier	Abel Smith 23
09:45 – 10:00	Short Break	
10:00 – 11:00	Plenary talk: Cheryl Praeger	Abel Smith 23
11:00 – 11.30	Morning Tea	Campbell Place
11:30 – 12:30	Plenary talk: Wolfgang Dahmen	Abel Smith 23
12:30 – 13:30	Lunch	
13:30 – 15:00	Special Sessions	
15:00 – 15:30	Afternoon Tea	Campbell Place
15:30 – 16:30	Special Presentations	Abel Smith 23
16:30 – 17:30	AustMS Annual General Meeting	Abel Smith 23
17:30 – 18:30	Special Sessions	
19:00 – 22:00	Conference dinner	The Strand at Rugby Quay

Thursday 1 October

TIME	DETAILS	ROOM
08:45 – 09:45	Plenary talk: Vladimir Gaitsgory	Abel Smith 23
09:45 – 10:00	Short Break	
10:00 – 11:00	Plenary talk: James Borger	Abel Smith 23
11:00 – 11.30	Morning Tea	Campbell Place
11:30 – 12:30	Plenary talk: Jonathan Borwein	Abel Smith 23
12:30 – 13:30	Lunch	
13:30 – 16:00	Special Sessions	
15:30 – 16:30	Afternoon Tea	Campbell Place

Plenary Lectures and Public Lecture

Venue Abel Smith Lecture Theatre, 23

▷ Monday 27 September 2010

11:30 Elizabeth Mansfield (University of Kent)
Moving frames and Noether's theorem

14:00 Michael Hopkins (Harvard University)
On the Kervaire invariant problem

▷ Tuesday 28 September 2010

08:45 Ben Green (Trinity College)
Approximate groups and applications

10:00 Larry Forbes (University of Tasmania)
Fluid plumes and bubbles in oceans and galaxies

11:30 Thomas Lam (University of Michigan)
Total positivity in combinatorics and representation theory

18:30 Jonathan Borwein (University of Newcastle)
PUBLIC LECTURE: *The life of π*

▷ Wednesday 29 September 2010

08:45 Jan de Gier (The University of Melbourne)
Solvable models for percolation and stochastic exclusion processes: The ubiquity of the Temperley–Lieb algebra

10:00 Cheryl Praeger (The University of Western Australia)
Homogeneity for graphs

11:30 Wolfgang Dahmen (RWTH Aachen)
Compressed Sensing—beyond the Shannon paradigm

▷ Thursday 30 September 2010

08:45 Vladimir Gaitsgory (University of South Australia)
Averaging of singularly perturbed control systems: Infinite dimensional linear programming perspective

10:00 James Borger (Australian National University)
Geometry—algebraic to arithmetic to absolute

11:30 Jonathan Borwein (University of Newcastle)
Short random walks and ramble integrals

Special Session 1

Algebra and Number Theory

Organisers James East, Marcel Jackson

Venue Social Sciences Building, 24–S304 and 24–S402

Note: There are two sessions in parallel on Tuesday afternoon for this Special Session.

Contributed Talks

- ▷ Monday 27 September 2010 24–S304
 - 15:30 Murray Elder (The University of Queensland)
Logspace computable groups
 - 16:00 Anne Thomas (University of Sydney)
Lattices in complete Kac–Moody groups
 - 16:30 Natalie Aisbett (The University of Melbourne)
Affine cyclic complex reflection groups
 - 17:00 Sichao (Rowland) Jiang (University of Sydney)
Exceptional p -groups of order p^5
 - 17:30 Daniel Horadam (University of Newcastle)
Trees, self-replicating groups and automata
- ▷ Tuesday 28 September 2010 24–S304
 - 14:00 Wadim Zudilin (University of Newcastle)
The Erdős–Moser diophantine equation and the continued fraction of $\log(2)$
 - 14:30 Victor Scharaschkin (The University of Queensland)
Wieferich primes
 - 15:00 Kamel Atan (Universiti Putra Malaysia)
On the estimation of cardinality of common solutions of congruence equations
 - 15:30 Alex Ghitza (The University of Melbourne)
Distinguishing Hecke eigenforms
 - 16:30 Ross Atkins (Australian National University)
Proving polynomials positive
 - 17:00 Samuel Hambleton (The University of Queensland)
A special subgroup of Pell conics over algebraic numbers
 - 17:30 Eric Mortenson (The University of Queensland)
Hecke-type double sums, Appell–Lerch sums and mock theta functions
- ▷ Tuesday 28 September 2010 24–S402
 - 14:00 Boris Lerner (University of New South Wales)
Moduli space of line bundles on some non commutative surfaces
 - 14:30 Greg Stevenson (Australian National University)
Singularity categories of complete intersections
 - 15:00 Nazer Halimi (The University of Queensland)
Non-commutative valuation theory
 - 15:30 Bill Whiten (The University of Queensland)
Unknown, inconsistent and a million dollars

16:30 Anthony Henderson (University of Sydney)
The toric variety of the symmetric group

17:00 Andrew Francis (University of Western Sydney)
Centres of cyclotomic Hecke algebras

17:30 Andrew Crisp (University of Sydney)
Exotic Springer correspondences

▷ Wednesday 29 September 2010 24–S304

13:30 Graham Clarke (Royal Melbourne Institute of Technology)
On the Cayley graphs of completely simple semigroups

14:00 Des FitzGerald (University of Tasmania)
Partition monoids

14:30 James East (University of Sydney)
Relative ranks in infinite partition monoids and dual symmetric inverse semigroups

▷ Thursday 30 September 2010 24–S304

13:30 Shea-Ming Oon (University of Malaya)
New lower bound of least common multiples

14:00 Tim Stokes (University of Waikato)
Function algebra

14:30 Marcel Jackson (La Trobe University)
Equations, membership and definability for a finite algebra

Special Session 2

Applied Differential Equations

Organisers Jim Hill, Scott McCue

Venue Richards Building, 5-213

Keynote Speakers Robert Anderssen and Philip Broadbridge

Contributed Talks

▷ Monday 27 September 2010

- 15:30 Philip Broadbridge (La Trobe University) **Keynote Speaker**
Curve shortening, and surface evolution by evaporation-condensation
- 16:30 John Sader (The University of Melbourne)
Frequency response of cantilever beams in fluid
- 17:00 Michael Dallaston (Queensland University of Technology)
Generating high order series solutions for Stokes waves
- 17:30 Jim Denier (University of Adelaide)
Corner boundary layers

▷ Tuesday 28 September 2010

- 14:00 Robert Anderssen (CSIRO) **Keynote Speaker**
Modelling synchronization
- 15:00 Tony Roberts (University of Queensland)
Anisotropic exploration of networks by random walkers
- 15:30 Vikram Sunkara (Australian National University)
Wavelet approximation of the chemical master equation
- 16:30 William Phillips (Swinburne University of Technology)
On singular parabolic pdes
- 17:00 Tim Marchant (University of Wollongong)
Solitary waves and their stability in colloidal media: Semi-analytical solutions
- 17:30 Scott McCue (Queensland University of Technology)
A Stefan problem with kinetic undercooling, with applications to drug delivery

Special Session 3

Calculus of Variations and PDEs

Organisers James McCoy, Yihong Du

Venue Sir Llew Edwards Building, 14–115

Keynote Speaker Norm Dancer

Contributed Talks

▷ Tuesday 28 September 2010

- 14:00 Edward Norman Dancer (University of Sydney) **Keynote Speaker**
Stable and finite morse index solutions when there are non-nodal zeros
- 15:00 James Holland (Australian National University)
An extremal problem for equations of prescribed curvature
- 15:30 Jalina Widjaja (Institut Teknologi Bandung)
Diffusive Nicholson blowflies equations with single time delay and fixed time impulses
- 16:30 Parinya Sa Ngiamsunthorn (University of Sydney)
Perturbation of abstract semi-linear evolution equations
- 17:00 Matthew Kevin Cooper (The University of Queensland)
The flow of liquid crystals
- 17:30 Zhou Zhang (University of Sydney)
Kähler–Ricci flows over quasiprojective manifolds

▷ Wednesday 29 September 2010

- 13:30 Daniel Daners (University of Sydney)
The Dirichlet problem by variational methods
- 14:00 Florica Cirstea (University of Sydney)
Isolated singularities for weighted quasilinear elliptic equations
- 14:30 Maria Athanassenas (Monash University)
On the convergence of volume-preserving mean curvature flow
- 17:30 Jan Chabrowski (The University of Queensland)
The Hardy potential and eigenvalue problems
- 18:00 Yihong Du (University of New England)
Finite Morse index solutions of an elliptic equation with supercritical exponent

▷ Thursday 30 September 2010

- 13:30 Joseph Grotowski (The University of Queensland)
New results on boundary regularity for elliptic systems
- 14:00 Neil Watson (University of Canterbury)
A unifying definition of a subtemperature
- 14:30 Peter Vassiliou (University of Canberra)
Explicit construction of wave maps
- 15:00 James McCoy (University of Wollongong)
High homogeneity curvature flow

Special Session 4

Combinatorics

Organisers John Bamberg, Judy-anne Osborn

Venue Social Sciences Building, 24-S603

Keynote Speaker Brendan McKay

Contributed Talks

▷ Monday 27 September 2010

- 15:30 Brendan McKay (Australian National University) **Keynote Speaker**
Subgraphs of random graphs with specified degrees
- 16:30 Fiona Skerman (Australian National University)
Binomial models of random bipartite graphs
- 17:00 Fatih Demirkale (The University of Queensland)
Optimal discrete choice experiments
- 17:30 Tim Garoni (MASCOS/The University of Melbourne)
An irreducible Markov-chain dynamics for some loop models and antiferromagnetic Potts models
- 18:00 Leanne Rylands (University of Western Sydney)
Some results on the α -size of trees

▷ Tuesday 28 September 2010

- 14:00 Wendy Baratta (The University of Melbourne)
You, me and symmetry
- 14:30 Nhan Bao Ho (La Trobe University)
Ultimately bipartite subtraction games
- 15:00 Shoetsu Ogata (Tohoku University)
Minkowski sums of lattice polytopes and their normality
- 15:30 Amy Glen (Murdoch University)
Rich, Sturmian, and trapezoidal words
- 16:30 Marsha Minchenko (Monash University)
Using generating functions to count closed walks
- 17:00 Nicholas Beaton (MASCOS/The University of Melbourne)
Enumerating some classes of lattice paths and polygons
- 17:30 Guillermo Pineda-Villavicencio (University of Ballarat)
On graph with cyclic defect or excess

▷ Wednesday 29 September 2010

- 13:30 Barbara Maenhaut (The University of Queensland)
Pairs of decompositions into lists of cycles
- 14:00 Elizabeth Billington (The University of Queensland)
An extra condition on two-fold 2-perfect cycle systems
- 14:30 Midori Kobayashi (University of Shizuoka)
Exact coverings of 2-paths with 4-cycles in the complete bipartite graph

▷ Thursday 30 September 2010

13:30 Nicholas Cavenagh (University of Waikato)
Non-extendable latin cuboids

14:00 Ian Wanless (Monash University)
Eulerian quasigroups and neighbour-balanced designs

14:30 Douglas Stones (Monash University)
Near-automorphisms of Latin squares

15:00 John Bamberg (The University of Western Australia)
Hemisystems of generalised quadrangles

15:30 Michael Giudici (The University of Western Australia)
Point regular automorphism groups of generalised quadrangles

Special Session 5

Computational Mathematics

Organisers Bishnu Lamichhane, Linda Stals

Venue Forgan Smith Building, 1–E303

Contributed Talks

▷ Tuesday 28 September 2010

- 14:00 Markus Hegland (Australian National University)
Error bounds of regularisation techniques based on variable Hilbert scales
- 14:30 James Wan (University of Newcastle)
Densities of uniform random walks on the plane
- 15:00 Sudi Mungkasi (Australian National University)
A new analytical solution for testing debris avalanche numerical models in the standard Cartesian coordinate system
- 15:30 Paul Leopardi (Australian National University)
Sparse grid quadrature on products of spheres
- 16:30 Karim Ivaz (University of Tabriz)
Newton-product integration for a two-phase Stefan problem with kinetics
- 17:00 Ali Badamchizadeh (University of Tabriz)
Product integration solution of singular system of Volterra integral equations

▷ Thursday 30 September 2010

- 13:30 Jorge Aarao (University of South Australia)
EDEM: analysis and implementation of a solution method for PDEs
- 14:00 Ravindran Ramalingam (National Institute of Technology, Trichy)
Laplace transform solution of a diffusion equation with mixed derivative term
- 14:30 Linda Stals (Australian National University)
Turbulent flow in plasma physics
- 15:00 Bishnu Lamichhane (University of Newcastle)
From the Hu–Washizu formulation to the average nodal strain formulation

Special Session 6 Control Theory

Organisers Yalcin Kaya, Volker Rehbock

Venue Forgan Smith Building, 1–E232

Keynote Speaker Matthias Gerdts

Contributed Talks

▷ Monday 27 September 2010

- 15:30 Tanya Tarnopolskaya (CSIRO)
Synthesis of optimal control for collision avoidance in a close proximity encounter
- 16:00 Nahid Banihashemi (University of South Australia)
Adaptive mesh refinement and inexact restoration method to solve optimal control problems
- 16:30 Yalcin Kaya (University of South Australia)
Numerical methods for multi-objective control
- 17:00 Phil Howlett (University of South Australia)
Optimal train control
- 17:30 Ryan Loxton (Curtin University of Technology)
Optimal control problems with state-dependent stopping criteria

▷ Wednesday 29 September 2010

- 13:30 Matthias Gerdts (University of Würzburg) **Keynote Speaker**
Function space and discretization methods in optimal control: Theory and applications
- 14:30 Volker Rehbock (Curtin University of Technology)
Computational optimal well path design

Special Session 7

Dynamical Systems

Organisers Reinout Quispel, John Roberts, Peter Stacey

Venue Richards Building, 5–207

Contributed Talks

▷ Monday 27 September 2010

- 15:30 Gary Froyland (University of New South Wales)
Coherent sets for time-dependent dynamical systems with geophysical applications
- 16:00 Ognjen Stancevic (University of New South Wales)
Escape in random dynamical systems
- 16:30 Nalini Joshi (University of Sydney)
Okamoto's space for the first Painlevé equation in Brouwer coordinates
- 17:00 Cathy Holmes (University of Queensland)
Coupled nonlinear oscillators in atom optics
- 17:30 Bevan Thompson (The University of Queensland)
On a stability result for a system

▷ Tuesday 28 September 2010

- 14:00 Holger Dullin (University of Sydney)
Bodies in Space: How to turn without angular momentum
- 14:30 Natascha Neumaerker (University of New South Wales)
Orbit structure and orbit length of toral endomorphisms
- 15:00 Guo Hua Zhang (University of New South Wales)
Topological dynamics of Cournot duopoly
- 15:30 Colin Rogers (University of New South Wales)
On Ermakov structure in 2+1-dimensional magnetogasdynamics
- 16:30 Pieter van der Kamp (La Trobe University)
Complete integrability of reductions of lattice equations I
- 17:00 Thi Dinh Tran (La Trobe University)
Complete integrability of reductions of lattice equations II
- 17:30 John Roberts (University of New South Wales)
Poisson structures for difference equations

Special Session 8

Financial Mathematics

Organisers Fima Klebaner, Song-Ping Zhu

Venue Steele Building, 3-309

Keynote Speaker Eckhard Platen

Contributed Talks

▷ Tuesday 28 September 2010

- 14:00 Eckhard Platen (University of Technology, Sydney) Keynote Speaker
Real world pricing of long term contracts
- 15:00 Wen-Ting Chen (University of Wollongong)
Asymptotic behavior of the optimal exercise price of American puts near expiry under stochastic volatility
- 15:30 Kais Hamza (Monash University)
Volatility in the Black-Scholes and other formulae
- 16:30 Jeong Hoon Kim (University of Wollongong)
The constant elasticity of variance model with stochastic volatility
- 17:00 Ivan Guo (University of Sydney)
Multiplayer Game Options.
- 17:30 Daniel Dufresne (The University of Melbourne)
Changes of measure for the square-root stochastic volatility process

Special Session 9

Geometric Analysis

Organisers Rod Gover, Adam Harris

Venue Sir Llew Edwards Building, 14–116

Keynote Speaker Gaven Martin

Contributed Talks

▷ Monday 27 September 2010

- 15:30 Finnur Larusson (University of Adelaide)
Recent developments in Oka theory
- 16:00 Tyson Ritter (University of Adelaide)
A strong Oka principle for embeddings of Riemann surfaces into $\mathbb{C} \times \mathbb{C}^$*
- 16:30 Laurentiu Paunescu (University of Sydney)
Enriched Riemann sphere, Morse stability and equi-singularity in \mathcal{O}_2
- 17:00 Jonathan Kress (University of New South Wales)
Families of superintegrable systems with higher order symmetries
- 17:30 Lorenz Schabrun (The University of Queensland)
Seiberg–Witten flow

▷ Tuesday 28 September 2010

- 14:00 Yuri Nikolayevsky (La Trobe University)
Conformal relatives of Lie groups
- 14:30 Anthony Dooley (University of New South Wales)
On the non-commutative Kirillov formula
- 15:00 Jhanjee Sangeeta (Monash University)
Perturbation theorem for joint spectrum of commuting matrices
- 15:30 Peter Vassiliou (University of Canberra)
On semi-Hamiltonian systems of hydrodynamic type
- 16:30 Geoff Prince (AMSI)
Integrating the Vessiot distribution for PDEs
- 17:00 Matthew Randall (Australian National University)
Projective to Ricci-flat manifolds

▷ Wednesday 29 September 2010

- 13:30 Gaven Martin (Massey University) **Keynote Speaker**
Quasiregular mappings, curvature and dynamics
- 14:30 John William Rice (University of Sydney)
D-modules and derived loop stacks

▷ Thursday 30 September 2010

13:30 Gerd Schmalz (University of New England)

Free CR distributions

14:00 Katharina Neusser (Australian National University)

Prolongation of partial differential equations on filtered manifolds

14:30 Thomas Leistner (University of Adelaide)

The ambient metric for n -dimensional pp -waves

15:00 Jörg Frauendiener (University of Otago)

Some properties of wave maps on 2+1-dimensional Minkowski space

15:30 Rod Gover (University of Auckland)

Projective BGG equations, algebraic sets, and compactifications of Einstein geometries

Special Session 10

Geometry and Topology

Organisers Bea Bleile, Emma Carberry

Venue Sir Llew Edwards Building, 14–217

Keynote Speaker Michael Hopkins

Contributed Talks

▷ Monday 27 September 2010

- 15:30 Laurentiu Paunescu (University of Sydney)
Directional properties of sets definable in \mathcal{o} -minimal structures
- 16:00 Satoshi Koike (Hyogo University of Teacher Education)
Blow-analytic equivalence of two variable real analytic function germs
- 16:30 Ali Elfard (University of Wollongong)
On free paratopological groups
- 17:00 Matthew Kotros (The University of Melbourne)
Relatively hyperbolic groups and relatively quasiconvex subgroups
- 17:30 Thomas Leistner (University of Adelaide)
Half flat structures and special holonomy
- 18:00 Alexander Coward (University of California at Davis)
Upper bounds on Reidemeister moves

▷ Tuesday 28 September 2010

- 14:00 Nora Ganter (The University of Melbourne)
Character formulas
- 14:30 Ana Hinic-Galic (La Trobe University)
Dimensions of totally geodesic subalgebras of filiform nilpotent Lie algebras
- 15:00 Michael Hopkins (Harvard University) **Keynote Speaker**
On the Kervaire invariant problem
- 16:30 Mathai Varghese (University of Adelaide)
Geometric quantisation commutes with reduction
- 17:00 Raymond Vozzo (University of Adelaide)
The calorons correspondence and string classes for loop group bundles
- 17:30 Finnur Larusson (University of Adelaide)
Affine simplices in Oka manifolds

▷ Wednesday 29 September 2010

- 13:30 Emma Carberry (University of Sydney)
Constant mean curvature surfaces and Darboux transforms
- 14:00 Norman Do (The University of Melbourne)
Lattice points in moduli spaces of curves
- 14:30 Craig Westerland (The University of Melbourne)
The stable topology of Hurwitz spaces

▷ Thursday 30 September 2010

- 13:30 Stephan Tillmann (The University of Queensland)
Pseudo-developing maps for ideal triangulations
- 14:00 Benjamin Burton (The University of Queensland)
Is simplifying triangulations as hard as it seems?
- 14:30 Jonathan Hillman (University of Sydney)
The linking pairings of orientable Seifert manifolds
- 15:00 Rupert McCallum (Australian Catholic University)
Local quasi-isomorphisms between topological buildings
- 15:30 Bea Bleile (University of New England)
Homotopy classification of Poincare duality complexes

Special Session 11

Lie Groups and Harmonic Analysis

Organisers Chris Meaney, George Willis

Venue Gordon Greenwood Building, 32–214

Keynote Speaker Anthony Lau

Contributed Talks

▷ Tuesday 28 September 2010

- 14:00 Fedor Sukochev (University of New South Wales)
Operator-Lipschitz functions in Schatten–von Neumann classes
- 14:30 Menaka Lashitha Bandara (Australian National University)
Quadratic estimates for perturbed Dirac type operators on doubling measure metric spaces
- 15:00 Michael Cowling (University of New South Wales)
Mappings preserving cosets of subgroups and the Fourier–Stieltjes algebra
- 15:30 Anthony Dooley (University of New South Wales)
Levy–Kintchine formulae on symmetric spaces
- 16:30 Scott Murray (University of Canberra)
Computing fundamental domains of Kac–Moody groups
- 17:00 Jeff Hogan (University of Newcastle)
The Clifford Fourier transform

▷ Wednesday 29 September 2010

- 13:30 Anthony Lau (University of Alberta) **Keynote Speaker**
Invariant complementation and related properties for the group algebra of a locally compact group
- 14:30 Lesley Ward (University of South Australia)
Geometric-arithmetic averaging of dyadic weights
- 17:30 Christopher Meaney (Macquarie University)
Unitary representations of semisimple Lie groups
- 18:00 George Willis (University of Newcastle)
Contraction subgroups in locally compact groups

Special Session 12

Mathematics in Biology, Medicine and Conservation

Organisers Bruce Gardiner, Graeme Pettet, Hugh Possingham, Anand Tularam

Venue Steele Building, 3–329

Keynote Speaker Geoff Goodhill

Contributed Talks

▷ Monday 27 September 2010

- 15:30 Geoffrey Goodhill (The University of Queensland) **Keynote Speaker**
Nerve fibre chemotaxis
- 16:30 John Murray (University of New South Wales)
Modelling the development of resistance to HIV gene therapy
- 17:00 Bruce Gardiner (The University of Western Australia)
A mathematical model of diffusional shunting of oxygen from arteries to veins in the kidney
- 17:30 Peter Johnston (Griffith University)
A non-dimensional study of the passive bidomain equation
- 18:00 Matthew Simpson (Queensland University of Technology)
Cell invasion with proliferation mechanisms motivated by time-lapse data

▷ Tuesday 28 September 2010

- 14:00 Trisilowati Trisilowati (Queensland University of Technology)
Mathematical model of the interaction between a growing tumour and cells of the innate and specific immune system
- 14:30 Wuryatmo Sidik (Flinders University)
A cross-species avian-human influenza model: disease spread and controls
- 15:00 Chooi Fei Ng (The University of Queensland)
Prioritizing conservation actions for a population that is declining due to multiple threats
- 15:30 William Probert (The University of Queensland)
Clinical trials
- 16:30 Kelly Murphy (Queensland University of Technology)
Biological and therapeutic predictions from a morphoelastic representation of dermal repair
- 17:00 Edward Green (The University of Western Australia)
Non-local models for the formation of hepatocyte—stellate cell aggregates
- 17:30 Thomas Ronald mollee (The University of Queensland)
*Pattern formation in *E. coli* colonies*

12. *Mathematics in Biology, Medicine and Conservation*

▷ Wednesday 29 September 2010

- 13:30 Glenn Fulford (Queensland University of Technology)
Mathematical modelling of the impact of tourism on dengue fever
- 14:00 Roslyn Hickson (Australian National University)
Dengue in Queensland, Australia
- 14:30 Stephen Davis (Royal Melbourne Institute of Technology)
Matrix models for tick-borne disease and other vector-borne pathogens
- 17:30 Steven Barry (Australian National University)
Modelling influenza mutation and dynamics
- 18:00 Dann Mallet (Queensland University of Technology)
Modelling within-host chlamydial infection

▷ Thursday 30 September 2010

- 13:30 Shakti Narayanan Menon (Queensland University of Technology)
ZSS says relax: A mathematical investigation of the contraction of fibroblast-populated collagen lattices
- 14:00 Vivien Challis (The University of Queensland)
Bone implant scaffold prototypes designed via topology optimisation and manufactured by solid freeform fabrication
- 14:30 Yuri Anissimov (Griffith University)
Mathematical aspects of fluorescence recovery after photo-bleaching (FRAP) in SC
- 15:00 Graeme Pettet (Queensland University of Technology)
The regulation of epidermal morphology: insight from in-vitro culture and in-silico modelling

Special Session 13

Mathematics Education

Organisers Michael Bulmer, Birgit Loch

Venue Forgan Smith Building, 1–E302

Contributed Talks

▷ Monday 27 September 2010

- 15:30 Sepideh Stewart (The University of Auckland)
Toward a formal thinking in linear algebra: The case of eigenvalues and eigenvectors
- 16:00 Susan Worsley (The University of Queensland)
Is learning mathematics about learning concepts?
- 16:30 Patricia Cretchley (Queensland University of Technology)
Mathematics confidence, that essential but sometimes elusive ingredient: What is it, and what can we do about it?
- 17:00 Shaun Belward (James Cook University of North Queensland)
A mathematics learning community in North Queensland
- 17:30 Bill Blyth (AMSI)
Computer aided assessment in a CAS immersed vector calculus course
- 18:00 Steve Sugden (Bond University)
Exploring the fundamental theorem of arithmetic in a spreadsheet

▷ Wednesday 29 September 2010

- 13:30 Bill Barton (The University of Auckland)
Have eight colleagues watch me lecture? Why would I agree to that?
- 14:00 Steven Barry (Australian National University)
Experiences from the mathematics in schools program
- 14:30 Carmel Coady (University of Western Sydney)
Diagnostic testing in mathematics and its use across the disciplines
- 17:30 Michael Jennings (The University of Queensland)
First-year students' mathematical understanding
- 18:00 Michael Bulmer (The University of Queensland)
Statistical microarray analysis in a virtual environment

Special Session 14

Mathematical Physics

Organisers Tim Garoni, Jonathan Kress

Venue Gordon Greenwood Building, 32–215

Keynote Speakers Murray Batchelor, Tony Guttman

Contributed Talks

▷ Monday 27 September 2010

- 15:30 Murray Batchelor (Australian National University) **Keynote Speaker**
Bosons and fermions: from mathematical toy models into the lab
- 16:30 Ecaterina Howard (Macquarie University)
Remarks on singularity theorems in general relativity
- 17:00 Vincent Mellor (The University of Queensland)
Numerical simulations of the Ising model on the Union Jack lattice
- 17:30 Nathan Clisby (MASCOS/The University of Melbourne)
The fifth virial coefficient for hard discs
- 18:00 Phillip Isaac (The University of Queensland)
Integrable BEC-BCS crossover with $p+ip$ pairing symmetry

▷ Tuesday 28 September 2010

- 14:00 Sam Kault (The University of Queensland)
Super parafermions: The $osp(2|2)_k/u^2(1)$ case
- 14:30 Joshua Capel (University of New South Wales)
Algebraic varieties for nondegenerate second-order superintegrable systems on the complex three-sphere
- 15:00 Craig Westerland (The University of Melbourne)
Topological T-duality in homotopy theory
- 15:30 Pedram Hekmati (University of Adelaide)
Calculus structure on the variational complex
- 16:30 Yuan-Hang Lee (The University of Queensland)
Exact solutions of a family of spin boson models
- 17:00 Anita Ponsaing (The University of Melbourne)
Separation of variables for the symplectic character using Sklyanin's Q -operator approach
- 17:30 Christopher Ormerod (La Trobe University)
The lattice structure of Connection preserving deformations

▷ Wednesday 29 September 2010

- 13:30 Tony Guttman (MASCOS/The University of Melbourne) **Keynote Speaker**
Lattice Green functions in all dimensions
- 14:30 David Ridout (Australian National University)
Indecomposable representations in physics
- 17:30 Jon Links (The University of Queensland)
Chiral phases in an interacting anyon system

18:00 Jan de Gier (The University of Melbourne)
Exact spin quantum Hall current between boundaries of a lattice strip

▷ Thursday 30 September 2010

13:30 Andrea Bedini (The University of Melbourne)
A tree-decomposed transfer matrix for computing exact partition functions for arbitrary graphs

14:00 Hendrik Grundling (University of New South Wales)
The resolvent algebra of the canonical commutation relations

14:30 Yao-Zhong Zhang (The University of Queensland)
On Wakimoto free field realizations of current algebras and superalgebras

15:00 Xin Liu (University of Sydney)
Kauffman knot polynomials in classical abelian Chern–Simons field

15:30 Gary Iliev (MASCOS/The University of Melbourne)
Copolymer adsorption on striped surfaces: A directed walk model

Special Session 15

Noncommutative Geometry and Operator Algebras

Organisers Adam Rennie, Aidan Sims

Venue Gordon Greenwood Building, 32–213

Keynote Speaker Mathai Varghese

Contributed Talks

▷ Monday 27 September 2010

15:30 Mathai Varghese (University of Adelaide) **Keynote Speaker**
Parametrised strict deformation quantisation of C^ -algebras and modules and T -duality*

16:30 Rishni Ratnam (Australian National University)
Classification of noncommutative torus bundles

17:00 Whittaker Michael (University of Wollongong)
Poincaré duality for hyperbolic dynamical systems

▷ Monday 27 September 2010

17:30 Samuel Webster (University of Wollongong)
The spectrum of the diagonal C^ -algebra of a k -graph*

▷ Tuesday 28 September 2010

14:00 Fedor Sukochev (University of New South Wales)
Lidskii formula for Dixmier traces

14:30 Steven Lord (University of New South Wales)
Singular traces and applications to Connes' noncommutative integral

15:00 Nathan Brownlowe (University of Wollongong)
Boundary quotients of the Toeplitz algebra of the affine semigroup over the natural numbers

15:30 Peter Stacey (La Trobe University)
Purely infinite simple real C^ -algebras*

16:30 David Pask (University of Wollongong)
Primitive ideals of k -graph algebras

17:00 Jahne Meyer (Australian National University)
Constructions of Cuntz–Pimsner algebras for iterated function systems

17:30 Roger Senior (Australian National University)
Towards a modular spectral triple for $SU_q(2)$

▷ Wednesday 29 September 2010 213

13:30 Alan Carey (Australian National University)
Index theory on noncompact manifolds from a noncommutative perspective

14:00 Sooran Kang (University of Wollongong)
The Yang–Mills functional and Laplace's equation on quantum Heisenberg manifolds

14:30 Paolo Bertozzini (Thammasat University)
Modular non-commutative geometries and quantum gravity

▷ Thursday 30 September 2010 213

13:30 Nurulla Azamov (Flinders University)
Spectral flow inside essential spectrum

14:00 Adam Rennie (Australian National University)
Riemannian manifolds in noncommutative geometry

14:30 Aidan Sims (University of Wollongong)
Renault's equivalence theorem for reduced groupoid C^ -algebras*

Special Session 16

Optimization and Applications

Organisers Jonathan Borwein, Regina Burachik, Andrew Eberhard

Venue Forgan Smith Building, 1–E215

Keynote Speaker Roberto Cominetti

Contributed Talks

▷ Tuesday 28 September 2010

- 14:00 Saba Majeed (University of South Australia)
Strong duality for monotropic programming in infinite dimensions
- 14:30 Michelle Dunbar (University of New South Wales)
Robust airline scheduling: Minimising propagated delay in an integrated routing and crewing framework
- 15:00 Mohammed Mustafa Rizvi (University of South Australia)
Regularity conditions in multiobjective optimization problems for strong Karush–Kuhn–Tucker conditions
- 15:30 Siti Amirah Abd Rahman (University of New South Wales)
Rail scheduling on a single track network: Heuristic and exact approaches
- 16:30 Gary Froyland (University of New South Wales)
Multi-stage integer stochastic programming under endogenous uncertainty with an application to open pit mining
- 17:00 Alexander Kruger (University of Ballarat)
Error bounds: necessary and sufficient conditions
- 17:30 Andrew Eberhard (Royal Melbourne Institute of Technology)
A new approach to the feasibility pump

▷ Wednesday 29 September 2010

- 13:30 Roberto Cominetti (Universidad de Chile) **Keynote Speaker**
Equilibrium and learning in traffic network games
- 14:30 Brailey Sims (University of Newcastle)
Analysis in $CAT(0)$ spaces

▷ Thursday 30 September 2010

- 13:30 Christina Burt (MASCOS/The University of Melbourne)
An exact model for the k -connected wireless survivable network problem
- 14:00 Reinhard Schulte (Loma Linda University)
Optimization and Feasibility Problems Related to Proton Therapy
- 14:30 Regina Burachik (University of South Australia)
On a sufficient condition for equality of two maximal monotone operators

Special Session 17

Probability and Statistics

Organisers Jonathan Keith, Dirk Kroese, Ian Wood

Venue Gordon Greenwood Building, 32-211

Contributed Talks

▷ Tuesday 28 September 2010

- 14:00 Alan Welsh (Australian National University)
Non-monotonicity of the generalized score statistic
- 14:30 Josef Dick (University of New South Wales)
Consistency of Markov chain quasi-Monte Carlo on continuous state spaces
- 15:00 Zdravko Botev (The University of Queensland)
Rare-event simulation using Markov chain Monte Carlo
- 15:30 Nicole White (Queensland University of Technology)
Bayes' factor computation for hierarchical hidden Markov models
- 16:30 Jiguo Cao (Simon Fraser University)
Estimating differential equations from real data
- 17:00 Chris Strickland (Queensland University of Technology)
A Python package for Bayesian estimation using Markov chain Monte Carlo

▷ Wednesday 29 September 2010

- 13:30 Aidan Sudbury (Monash University)
Random sequential adsorption on random trees
- 14:00 Neville Weber (University of Sydney)
A Functional Limit Theorem for the Empirical Process associated with Spatial Causal ARMA Models
- 14:30 Gareth Evans (The University of Queensland)
Estimating change-points in biological sequences via the cross-entropy method

▷ Thursday 30 September 2010

- 13:30 Geoffrey McLachlan (The University of Queensland)
The Clustering of High-Dimensional Data
- 14:00 Gordon Smyth (Walter and Eliza Hall Institute)
Differential gene expression analyses of data from deep-sequencing technologies
- 14:30 David Warton (University of New South Wales)
Unifying methods for species distribution modelling using presence-only data in ecology
- 15:00 Scott Sisson (University of New South Wales)
Adaptive optimal scaling of Metropolis-Hastings algorithms

Special Session 18

Stochastic Processes and Modelling

Organisers Jerzy Filar, Phil Pollett

Venue Gordon Greenwood, 32–207

Contributed Talks

▷ Monday 27 September 2010

- 15:30 Joshua Ross (University of Adelaide)
Evaluating the distribution of generalised hitting times
- 16:00 Ali Eshragh (University of South Australia)
On random graphs, random walks and the Hamiltonian cycle problem
- 16:30 Philip Pollett (The University of Queensland)
Limits of large metapopulations with patch dependent extinction probabilities
- 17:00 Ross McVinish (The University of Queensland)
The limits of a mainland-island metapopulation model.
- 17:30 Owen Jones (The University of Melbourne)
Multifractal spectra for random self-similar measures via branching processes

▷ Wednesday 29 September 2010

- 13:30 Peter Taylor (The University of Melbourne)
Waiting-time distributions for queues in which customers accumulate priority as a linear function of their time in the system
- 14:00 Andriy Olenko (La Trobe University)
Limit theorems for random fields with cyclical long memory
- 17:30 Phil Howlett (University of South Australia)
Copulas of maximum entropy
- 18:00 Aihua Xia (The University of Melbourne)
Clubbed binomial approximation for the lightbulb process

Special Session 19

Education Afternoon

Organisers Michael Jennings, Ole Warnaar

Venue Parnell Building, 7-222

Speakers

▷ Tuesday 28 September 2010 7-222

14:00 Bill Barton (The University of Auckland)
The Klein Project

14:45 Hugh Possingham (The University of Queensland)
How Maths is saving species

15:45 Michael Evans and Janine McIntosh (Australian Mathematical Sciences Institute)
The Improving Mathematics Education in Schools (TIMES) Project

16:30 Panel Discussion: *Catering for bright minds*
CHAIR: Merrilyn Goos (The University of Queensland)
PANELISTS:
Bill Barton (The University of Auckland)
Michael Evans (Australian Mathematical Sciences Institute)
Jim Lowe (Redcliffe State High School & Queensland Assoc. of Mathematics Teachers)
Wayne Stevens (Queensland Studies Authority)

Conference Timetable

Monday 27 September 2010

■ Registration

08:45 ► Abel Smith Lecture Theatre 23

■ Opening Ceremony

09:30 ► Abel Smith Lecture Theatre 23

□ *Morning Tea – Campbell Place 11:00 – 11:30*

■ Plenary Lecture – Abel Smith Lecture Theatre 23

11:30 ► Elizabeth Mansfield (University of Kent)
Moving frames and Noether's theorem

□ *Lunch 12:30 – 14:00*

Womens' Lunch in 14–613, the Terrace Room, Sir Llew Edwards Building

■ Plenary Lecture – Abel Smith Lecture Theatre 23

14:00 ► Michael Hopkins (Harvard University)
On the Kervaire invariant problem

□ *Afternoon Tea – Campbell Place 15:00 – 15:30*

■ Afternoon Special Sessions

Start	15:30	16:00	16:30	17:00	17:30	18:00
24-S304	1: Elder	1: Thomas	1: Aisbett	1: Jiang	1: Horadam	
5-213	2: Broadbridge		2: Sader	2: Dallaston	2: Denier	
24-S603	4: McKay		4: Skerman	4: Demirkale	4: Garoni	4: Rylands
1-E232	6: Tarnopolskaya	6: Banihashemi	6: Kaya	6: Howlett	6: Loxton	
5-207	7: Froyland	7: Stancevic	7: Joshi	7: Holmes	7: Thompson	
14-116	9: Larusson	9: Ritter	9: Paunescu	9: Kress	9: Schabrun	
14-217	10: Paunescu	10: Koike	10: Elford	10: Kotros	10: Leistner	10: Coward
3-329	12: Goodhill		12: Murray	12: Gardiner	12: Johnston	12: Simpson
1-E302	13: Stewart	13: Worsley	13: Cretchley	13: Belward	13: Blyth	13: Sugden
32-215	14: Batchelor		14: Howard	14: Mellor	14: Clisby	14: Isaac
32-213	15: Varghese		15: Ratnam	15: Michael	15: Webster	
32-207	18: Ross	18: Eshragh	18: Pollett	18: McVinish	18: Jones	

1. Algebra and Number Theory

24-S304

- 15:30 Murray Elder (The University of Queensland)
Logspace computable groups
- 16:00 Anne Thomas (University of Sydney)
Lattices in complete Kac-Moody groups
- 16:30 Natalie Aisbett (The University of Melbourne)
Affine cyclic complex reflection groups
- 17:00 Sichao (Rowland) Jiang (University of Sydney)
Exceptional p -groups of order p^5
- 17:30 Daniel Horadam (University of Newcastle)
Trees, self-replicating groups and automata

2. Applied Differential Equations

5-213

- 15:30 Philip Broadbridge (La Trobe University)
Curve shortening, and surface evolution by evaporation-condensation
- 16:30 John Sader (The University of Melbourne)
Frequency response of cantilever beams in fluid
- 17:00 Michael Dallaston (Queensland University of Technology)
Generating high order series solutions for Stokes waves
- 17:30 Jim Denier (University of Adelaide)
Corner boundary layers

4. Combinatorics

24-S603

- 15:30 Brendan McKay (Australian National University)
Subgraphs of random graphs with specified degrees
- 16:30 Fiona Skerman (Australian National University)
Binomial models of random bipartite graphs
- 17:00 Fatih Demirkale (The University of Queensland)
Optimal discrete choice experiments
- 17:30 Tim Garoni (MASCOS/The University of Melbourne)
An irreducible Markov-chain dynamics for some loop models and antiferromagnetic Potts models
- 18:00 Leanne Rylands (University of Western Sydney)
Some results on the α -size of trees

6. Control Theory

1-E232

- 15:30 Tanya Tarnopolskaya (CSIRO)
Synthesis of optimal control for collision avoidance in a close proximity encounter
- 16:00 Nahid Banihashemi (University of South Australia)
Adaptive mesh refinement and inexact restoration method to solve optimal control problems
- 16:30 Yalcin Kaya (University of South Australia)
Numerical methods for multi-objective control
- 17:00 Phil Howlett (University of South Australia)
Optimal train control
- 17:30 Ryan Loxton (Curtin University of Technology)
Optimal control problems with state-dependent stopping criteria

7. Dynamical Systems

5–207

- 15:30 Gary Froyland (University of New South Wales)
Coherent sets for time-dependent dynamical systems with geophysical applications
- 16:00 Ognjen Stancevic (University of New South Wales)
Escape in random dynamical systems
- 16:30 Nalini Joshi (University of Sydney)
Okamoto's space for the first Painlevé equation in Boutroux coordinates
- 17:00 Cathy Holmes (The University of Queensland)
Coupled nonlinear oscillators in atom optics
- 17:30 Bevan Thompson (The University of Queensland)
On a stability result for a system

9. Geometric Analysis

14–116

- 15:30 Finnur Larusson (University of Adelaide)
Recent developments in Oka theory
- 16:00 Tyson Ritter (University of Adelaide)
A strong Oka principle for embeddings of Riemann surfaces into $\mathbb{C} \times \mathbb{C}^$*
- 16:30 Laurentiu Paunescu (University of Sydney)
Enriched Riemann sphere, Morse stability and equi-singularity in \mathcal{O}_2
- 17:00 Jonathan Kress (University of New South Wales)
Families of superintegrable systems with higher order symmetries
- 17:30 Lorenz Schabrun (The University of Queensland)
Seiberg–Witten flow

10. Geometry and Topology

14–217

- 15:30 Laurentiu Paunescu (University of Sydney)
Directional properties of sets definable in o-minimal structures
- 16:00 Satoshi Koike (Hyogo University of Teacher Education)
Blow-analytic equivalence of two variable real analytic function germs
- 16:30 Ali Elford (University of Wollongong)
On free paratopological groups
- 17:00 Matthew Kotros (The University of Melbourne)
Relatively hyperbolic groups and relatively quasiconvex subgroups
- 17:30 Thomas Leistner (University of Adelaide)
Half flat structures and special holonomy
- 18:00 Alexander Coward (University of California at Davis)
Upper bounds on Reidemeister moves

12. Mathematics in Biology, Medicine and Conservation

3–329

- 15:30 Geoffrey Goodhill (The University of Queensland)
Nerve fibre chemotaxis
- 16:30 John Murray (University of New South Wales)
Modelling the development of resistance to HIV gene therapy
- 17:00 Bruce Gardiner (The University of Western Australia)
A mathematical model of diffusional shunting of oxygen from arteries to veins in the kidney
- 17:30 Peter Johnston (Griffith University)
A non-dimensional study of the passive bidomain equation
- 18:00 Matthew Simpson (Queensland University of Technology)
Cell invasion with proliferation mechanisms motivated by time-lapse data

13. Mathematics Education

1–E302

- 15:30 Sepideh Stewart (The University of Auckland)
Toward a formal thinking in linear algebra: The case of eigenvalues and eigenvectors
- 16:00 Susan Worsley (The University of Queensland)
Is learning mathematics about learning concepts?
- 16:30 Patricia Cretchley (Queensland University of Technology)
Mathematics confidence, that essential but sometimes elusive ingredient: What is it, and what can we do about it?
- 17:00 Shaun Belward (James Cook University of North Queensland)
A mathematics learning community in North Queensland
- 17:30 Bill Blyth (The University of Melbourne)
Computer aided assessment in a CAS immersed vector calculus course
- 18:00 Steve Sugden (Bond University)
Exploring the fundamental theorem of arithmetic in a spreadsheet

14. Mathematical Physics

32–215

- 15:30 Murray Batchelor (Australian National University)
Bosons and fermions: from mathematical toy models into the lab
- 16:30 Ecaterina Howard (Macquarie University)
Remarks on singularity theorems in general relativity
- 17:00 Vincent Mellor (The University of Queensland)
Numerical simulations of the Ising model on the Union Jack lattice
- 17:30 Nathan Clisby (MASCOS/The University of Melbourne)
The fifth virial coefficient for hard discs
- 18:00 Phillip Isaac (The University of Queensland)
Integrable BEC-BCS crossover with $p+ip$ pairing symmetry

15. Noncommutative Geometry and Operator Algebras

32–213

- 15:30 Mathai Varghese (University of Adelaide)
Parametrised strict deformation quantisation of C^ -algebras and modules and T -duality*
- 16:30 Rishni Ratnam (Australian National University)
Classification of noncommutative torus bundles
- 17:00 Whittaker Michael (University of Wollongong)
Poincaré duality for hyperbolic dynamical systems
- 17:30 Samuel Webster (University of Wollongong)
The spectrum of the diagonal C^ -algebra of a k -graph*

18. Stochastic Processes and Modelling

32–207

- 15:30 Joshua Ross (University of Adelaide)
Evaluating the distribution of generalised hitting times
- 16:00 Ali Eshragh (University of South Australia)
On random graphs, random walks and the Hamiltonian cycle problem
- 16:30 Philip Pollett (The University of Queensland)
Limits of large metapopulations with patch dependent extinction probabilities
- 17:00 Ross McVinish (The University of Queensland)
The limits of a mainland-island metapopulation model.
- 17:30 Owen Jones (The University of Melbourne)
Multifractal spectra for random self-similar measures via branching processes

Tuesday 28 September 2010

- Plenary Lecture – Abel Smith Lecture Theatre 23

- 08:45 ► Ben Green (Trinity College)
Approximate groups and applications

- *Short Break 09:45 – 10:00*

- Plenary Lecture – Abel Smith Lecture Theatre 23

- 10:00 ► Larry Forbes – ANZIAM Lecturer (University of Tasmania)
Fluid plumes and bubbles in oceans and galaxies

- *Morning Tea – Campbell Place 11:00 – 11:30*

- Plenary Lecture – Abel Smith Lecture Theatre 23

- 11:30 ► Thomas Lam – Early Career Lecturer (University of Michigan)
Total positivity in combinatorics and representation theory

- *Lunch 12:30 – 14:00*

Early Career & Student Lunch in 14–613, the Terrace Room, Sir Llew Edwards Building

- Afternoon Special Sessions

Start	14:00	14:30	15:00	15:30
24-S402	1: Lerner	1: Stevenson	1: Halimi	1: Whiten
24-S304	1: Zudilin	1: Scharaschkin	1: Atan	1: Ghitza
5-213	2: Anderssen		2: Roberts	2: Sunkara
14-115	3: Dancer		3: Holland	3: Widjaja
24-S603	4: Baratta	4: Ho	4: Ogata	4: Glen
1-E303	5: Hegland	5: Wan	5: Mungkasi	5: Leopardi
5-207	7: Dullin	7: Neumaerker	7: Zhang	7: Rogers
3-309	8: Platen		8: Chen	8: Hamza
14-116	9: Nikolayevsky	9: Dooley	9: Sangeeta	9: Vassiliou
14-217	10: Ganter	10: Hinic-Galic	10: Hopkins	
32-214	11: Sukochev	11: Bandara	11: Cowling	11: Dooley
3-329	12: Trisilowati	12: Sidik	12: Ng	12: Probert
32-215	14: Kault	14: Capel	14: Westerland	14: Hekmati
32-213	15: Sukochev	15: Lord	15: Brownlowe	15: Stacey
1-E215	16: Majeed	16: Dunbar	16: Rizvi	16: Abd Rahman
32-211	17: Welsh	17: Dick	17: Botev	17: White

- *Afternoon Tea – Campbell Place 16:00 – 16:30*

Start	16:30	17:00	17:30
24-S402	1: Henderson	1: Francis	1: Crisp
24-S304	1: Atkins	1: Hambleton	1: Mortenson
5-213	2: Phillips	2: Marchant	2: McCue
14-115	3: Sa Ngiamsunthorn	3: Cooper	3: Zhang
24-S603	4: Minchenko	4: Beaton	4: Pineda-Villavicencio
1-E303	5: Ivaz	5: Badamchizadeh	
5-207	7: van der Kamp	7: Tran	7: Roberts
3-309	8: Kim	8: Guo	8: Dufresne
14-116	9: Prince	9: Randall	
14-217	10: Varghese	10: Vozzo	10: Larusson
32-214	11: Murray	11: Hogan	
3-329	12: Murphy	12: Green	12: mollee
32-215	14: Lee	14: Ponsaing	14: Ormerod
32-213	15: Pask	15: Meyer	15: Senior
1-E215	16: Froyland	16: Kruger	16: Eberhard
32-211	17: Cao	17: Strickland	

■ Public Lecture – Abel Smith Lecture Theatre 23

18:30 ► Jonathan Borwein (University of Newcastle)
The life of π

1. Algebra and Number Theory

24-S402

- 14:00 Boris Lerner (University of New South Wales)
Moduli space of line bundles on some non commutative surfaces
- 14:30 Greg Stevenson (Australian National University)
Singularity categories of complete intersections
- 15:00 Nazer Halimi (The University of Queensland)
Non-commutative valuation theory
- 15:30 Bill Whiten (The University of Queensland)
Unknown, inconsistent and a million dollars
- 16:30 Anthony Henderson (University of Sydney)
The toric variety of the symmetric group
- 17:00 Andrew Francis (University of Western Sydney)
Centres of cyclotomic Hecke algebras
- 17:30 Andrew Crisp (University of Sydney)
Exotic Springer correspondences

24-S304

- 14:00 Wadim Zudilin (University of Newcastle)
The Erdős–Moser diophantine equation and the continued fraction of $\log(2)$
- 14:30 Victor Scharaschkin (The University of Queensland)
Wieferich primes
- 15:00 Kamel Atan (Universiti Putra Malaysia)
On the estimation of cardinality of common solutions of congruence equations
- 15:30 Alex Ghitza (The University of Melbourne)
Distinguishing Hecke eigenforms
- 16:30 Ross Atkins (Australian National University)
Proving polynomials positive
- 17:00 Samuel Hambleton (The University of Queensland)
A special subgroup of Pell conics over algebraic numbers
- 17:30 Eric Mortenson (The University of Queensland)
Hecke-type double sums, Appell–Lerch sums and mock theta functions

2. Applied Differential Equations

5–213

- 14:00 Robert Anderssen (CSIRO)
Modelling synchronization
- 15:00 Tony Roberts (The University of Queensland)
Anisotropic exploration of networks by random walkers
- 15:30 Vikram Sunkara (Australian National University)
Wavelet approximation of the chemical master equation
- 16:30 William Phillips (Swinburne University of Technology)
On singular parabolic pdes
- 17:00 Tim Marchant (University of Wollongong)
Solitary waves and their stability in colloidal media: Semi-analytical solutions
- 17:30 Scott McCue (Queensland University of Technology)
A Stefan problem with kinetic undercooling, with applications to drug delivery

3. Calculus of Variations and PDEs

14–115

- 14:00 Norman Dancer (University of Sydney)
Stable and finite morse index solutions when there are non-nodal zeros
- 15:00 James Holland (Australian National University)
An extremal problem for equations of prescribed curvature
- 15:30 Jalina Widjaja (Institut Teknologi Bandung)
Diffusive Nicholson blowflies equations with single time delay and fixed time impulses
- 16:30 Parinya Sa Ngiamsunthorn (University of Sydney)
Perturbation of abstract semi-linear evolution equations
- 17:00 Matthew Cooper (The University of Queensland)
The flow of liquid crystals
- 17:30 Zhou Zhang (University of Sydney)
Kähler–Ricci flows over quasiprojective manifolds

4. Combinatorics

24–S603

- 14:00 Wendy Baratta (The University of Melbourne)
You, me and symmetry
- 14:30 Nhan Bao Ho (La Trobe University)
Ultimately bipartite subtraction games
- 15:00 Shoetsu Ogata (Tohoku University)
Minkowski sums of lattice polytopes and their normality
- 15:30 Amy Glen (Murdoch University)
Rich, Sturmian, and trapezoidal words
- 16:30 Marsha Minchenko (Monash University)
Using generating functions to count closed walks
- 17:00 Nicholas Beaton (MASCOS/The University of Melbourne)
Enumerating some classes of lattice paths and polygons
- 17:30 Guillermo Pineda-Villavicencio (University of Ballarat)
On graph with cyclic defect or excess

5. Computational Mathematics

1–E303

- 14:00 Markus Hegland (Australian National University)
Error bounds of regularisation techniques based on variable Hilbert scales
- 14:30 James Wan (University of Newcastle)
Densities of uniform random walks on the plane
- 15:00 Sudi Mungkasi (Australian National University)
A new analytical solution for testing debris avalanche numerical models in the standard Cartesian coordinate system
- 15:30 Paul Charles Leopardi (Australian National University)
Sparse grid quadrature on products of spheres
- 16:30 Karim Ivaz (University of Tabriz)
Newton-product integration for a two-phase Stefan problem with kinetics
- 17:00 Ali Badamchizadeh (University of Tabriz)
Product integration solution of singular system of Volterra integral equations

7. Dynamical Systems

5–207

- 14:00 Holger Dullin (University of Sydney)
Bodies in Space: How to turn without angular momentum
- 14:30 Natascha Neumaerker (University of New South Wales)
Orbit structure and orbit length of toral endomorphisms
- 15:00 Guo Hua Zhang (University of New South Wales)
Topological dynamics of Cournot duopoly
- 15:30 Colin Rogers (University of New South Wales)
On Ermakov structure in 2+1-dimensional magnetogasdynamics
- 16:30 Pieter Hubert van der Kamp (La Trobe University)
Complete integrability of reductions of lattice equations I
- 17:00 Thi Dinh Tran (La Trobe University)
Complete integrability of reductions of lattice equations II
- 17:30 John Roberts (University of New South Wales)
Poisson structures for difference equations

8. Financial Mathematics

3–309

- 14:00 Eckhard Platen (University of Technology, Sydney)
Real World Pricing of Long Term Contracts
- 15:00 Wen-Ting Chen (University of Wollongong)
Asymptotic behavior of the optimal exercise price of American puts near expiry under stochastic volatility
- 15:30 Kais Hamza (Monash University)
Volatility in the Black–Scholes and other formulae
- 16:30 Jeong Hoon Kim (University of Wollongong)
The constant elasticity of variance model with stochastic volatility
- 17:00 Ivan Guo (University of Sydney)
Multiplayer Game Options.
- 17:30 Daniel Dufresne (The University of Melbourne)
Changes of measure for the square-root stochastic volatility process

9. Geometric Analysis

14–116

- 14:00 Yuri Nikolayevsky (La Trobe University)
Conformal relatives of Lie groups
- 14:30 Anthony Dooley (University of New South Wales)
On the non-commutative Kirillov formula
- 15:00 Jhanjee Sangeeta (Monash University)
Perturbation theorem for joint spectrum of commuting matrices
- 15:30 Peter Vassiliou (University of Canberra)
On semi-Hamiltonian systems of hydrodynamic type
- 16:30 Geoff Prince (AMSI)
Integrating the Vessiot distribution for PDEs
- 17:00 Matthew Randall (Australian National University)
Projective to Ricci-flat manifolds

10. Geometry and Topology

14–217

- 14:00 Nora Ganter (The University of Melbourne)
Character formulas
- 14:30 Ana Hinić-Galić (La Trobe University)
Dimensions of totally geodesic subalgebras of filiform nilpotent Lie algebras
- 15:00 Michael Hopkins (Harvard University)
On the Kervaire invariant problem
- 16:30 Mathai Varghese (University of Adelaide)
Geometric quantisation commutes with reduction
- 17:00 Raymond Vozzo (University of Adelaide)
The calorons correspondence and string classes for loop group bundles
- 17:30 Finnur Larusson (University of Adelaide)
Affine simplices in Oka manifolds

11. Lie Groups and Harmonic Analysis

32–214

- 14:00 Fedor Sukochev (University of New South Wales)
Operator-Lipschitz functions in Schatten–von Neumann classes
- 14:30 Menaka Lashitha Bandara (Australian National University)
Quadratic estimates for perturbed Dirac type operators on doubling measure metric spaces
- 15:00 Michael Cowling (University of New South Wales)
Mappings preserving cosets of subgroups and the Fourier–Stieltjes algebra
- 15:30 Anthony Dooley (University of New South Wales)
Levy–Kintchine formulae on symmetric spaces
- 16:30 Scott Murray (University of Canberra)
Computing fundamental domains of Kac–Moody groups
- 17:00 Jeff Hogan (University of Newcastle)
The Clifford Fourier transform

12. Mathematics in Biology, Medicine and Conservation

3–329

- 14:00 Trisilowati Trisilowati (Queensland University of Technology)
Mathematical model of the interaction between a growing tumour and cells of the innate and specific immune system
- 14:30 Wuryatmo Sidik (Flinders University)
A cross-species avian-human influenza model: disease spread and controls
- 15:00 Chooi Fei Ng (The University of Queensland)
Prioritizing conservation actions for a population that is declining due to multiple threats
- 15:30 William Probert (The University of Queensland)
Clinical trials
- 16:30 Kelly Murphy (Queensland University of Technology)
Biological and therapeutic predictions from a morphoelastic representation of dermal repair
- 17:00 Edward Green (The University of Western Australia)
Non-local models for the formation of hepatocyte - stellate cell aggregates
- 17:30 Thomas Mollee (The University of Queensland)
*Pattern formation in *E. coli* colonies*

14. Mathematical Physics

32–215

- 14:00 Sam Kault (The University of Queensland)
Super parafermions: The $osp(2|2)_k/u^2(1)$ case
- 14:30 Joshua Capel (University of New South Wales)
Algebraic varieties for nondegenerate second-order superintegrable systems on the complex three-sphere
- 15:00 Craig Westerland (The University of Melbourne)
Topological T-duality in homotopy theory
- 15:30 Pedram Hekmati (University of Adelaide)
Calculus structure on the variational complex
- 16:30 Yuan-Harng Lee (The University of Queensland)
Exact solutions of a family of spin boson models
- 17:00 Anita Ponsaing (The University of Melbourne)
Separation of variables for the symplectic character using Sklyanin's Q -operator approach
- 17:30 Christopher Ormerod (La Trobe University)
The lattice structure of Connection preserving deformations

15. Noncommutative Geometry and Operator Algebras

32–213

- 14:00 Fedor Sukochev (University of New South Wales)
Lidskii formula for Dixmier traces
- 14:30 Steven Lord (University of New South Wales)
Singular traces and applications to Connes' noncommutative integral
- 15:00 Nathan Brownlowe (University of Wollongong)
Boundary quotients of the Toeplitz algebra of the affine semigroup over the natural numbers
- 15:30 Peter Stacey (La Trobe University)
Purely infinite simple real C^ -algebras*
- 16:30 David Pask (University of Wollongong)
Primitive ideals of k -graph algebras
- 17:00 Jahne Meyer (Australian National University)
Constructions of Cuntz–Pimsner algebras for iterated function systems
- 17:30 Roger Senior (Australian National University)
Towards a modular spectral triple for $SU_q(2)$

16. Optimization and Applications

1–E215

- 14:00 Saba Majeed (University of South Australia)
Strong duality for monotropic programming in infinite dimensions
- 14:30 Michelle Dunbar (University of New South Wales)
Robust airline scheduling: Minimising propagated delay in an integrated routing and crewing framework
- 15:00 Mohammed Mustafa Rizvi (University of South Australia)
Regularity conditions in multiobjective optimization problems for strong Karush–Kuhn–Tucker conditions
- 15:30 Siti Amirah Abd Rahman (University of New South Wales)
Rail scheduling on a single track network: Heuristic and exact approaches
- 16:30 Gary Froyland (University of New South Wales)
Multi-stage integer stochastic programming under endogenous uncertainty with an application to open pit mining
- 17:00 Alexander Kruger (University of Ballarat)
Error bounds: necessary and sufficient conditions
- 17:30 Andrew Eberhard (Royal Melbourne Institute of Technology)
A new approach to the feasibility pump

17. Probability and Statistics

32–211

- 14:00 Alan Welsh (Australian National University)
Non-monotonicity of the generalized score statistic
- 14:30 Josef Dick (University of New South Wales)
Consistency of Markov chain quasi-Monte Carlo on continuous state spaces
- 15:00 Zdravko Botev (The University of Queensland)
Rare-event simulation using Markov chain Monte Carlo
- 15:30 Nicole White (Queensland University of Technology)
Bayes' factor computation for hierarchical hidden Markov models
- 16:30 Jiguo Cao (Simon Fraser University)
Estimating differential equations from real data
- 17:00 Chris Strickland (Queensland University of Technology)
A Python package for Bayesian estimation using Markov chain Monte Carlo

Education Afternoon Tuesday 28 September 2010

All presentations for the Education Afternoon will be in Parnell Building, 7–222

■ Registration at 13:30

■ Talks

14:00 ► Bill Barton (The University of Auckland)
The Klein Project

14:45 ► Hugh Possingham (The University of Queensland)
How Maths is saving species

□ *Afternoon Tea – Alumni Court 15:15 – 15:45*

■ Talk

15:45 ► Michael Evans and Janine McIntosh (Australian Mathematical Sciences Institute)
The Improving Mathematics Education in Schools (TIMES) Project

■ Panel discussion *Catering for bright minds*

16:30 ► Chair: Merrilyn Goos (The University of Queensland);
Panelists:
Bill Barton (The University of Auckland),
Michael Evans (Australian Mathematical Sciences Institute),
Jim Lowe (Redcliffe State High School & Queensland Assoc. of Mathematics Teachers),
Wayne Stevens (Queensland Studies Authority)

□ *Reception – Alumni Court 17:30 – 18:30*

Wednesday 29 September 2010

■ Plenary Lecture – Abel Smith Lecture Theatre 23

08:45 ▶ Jan de Gier (The University of Melbourne)

Solvable models for percolation and stochastic exclusion processes: The ubiquity of the Temperley–Lieb algebra

□ *Short Break 09:45 – 10:00*

■ Plenary Lecture – Abel Smith Lecture Theatre 23

10:00 ▶ Cheryl Praeger – Hanna Neumann Lecturer (The University of Western Australia)

Homogeneity for graphs

□ *Morning Tea – Campbell Place 11:00 – 11:30*

■ Plenary Lecture – Abel Smith Lecture Theatre 23

11:30 ▶ Wolfgang Dahmen (RWTH Aachen)

Compressed Sensing—beyond the Shannon paradigm

□ *Lunch 12:30 – 13:30*

■ Afternoon Special Sessions

Start	13:30	14:00	14:30	17:30	18:00
24–S304	1: Clarke	1: FitzGerald	1: East		
14–115	3: Daners	3: Cirstea	3: Athanassenas	3: Chabrowski	3: Du
24–S603	4: Maenhaut	4: Billington	4: Kobayashi		
1–E232	6: Gerdts		6: Rehbock		
14–116	9: Martin		9: Rice		
14–217	10: Carberry	10: Do	10: Westerland		
32–214	11: Lau		11: Ward	11: Meaney	11: Willis
3–329	12: Fulford	12: Hickson	12: Davis	12: Barry	12: Mallet
1–E302	13: Barton	13: Barry	13: Coady	13: Jennings	13: Bulmer
32–215	14: Guttman		14: Ridout	14: Links	14: de Gier
32–213	15: Carey	15: Kang	15: Bertozzini		
1–E215	16: Cominetti		16: Sims		
32–211	17: Sudbury	17: Weber	17: Evans		
32–207	18: Taylor	18: Olenko		18: Howlett	18: Xia

□ *Afternoon Tea – Campbell Place 15:00 – 15:30*

■ Mathematics: Schools and Industry – Abel Smith Lecture Theatre 23

15:30 ► Charlotte Pezaro (CSIRO) and Ron Addie (University of Southern Queensland)
Mathematicians in Schools

Mathematicians in Schools, a sub-program of the successful Scientists in Schools program, is a national initiative that brings volunteer mathematicians together with teachers in long-term professional partnerships. These partnerships promote deeper understanding of the importance of mathematics in our society to students and teachers, and through them, the wider community. The most valuable type of partnership is one where the mathematician works with students and teachers in a continuing relationship with the school. One such partnership between a teacher at Darling Heights State School in Toowoomba and Associate Professor Ron Addie, a mathematician from the University of Southern Queensland, has been progressing since late 2009.

This presentation will provide an overview of the program including: the background, aims, participation nationally, styles of partnerships and an explanation of how the program works. Additionally, Ron Addie will share his personal experiences and the various activities that he has undertaken with his partner school to highlight the benefits that can be gained from a flexible and creative partnership.

Mathematicians in Schools is funded by the Australian Government and CSIRO. It is managed by CSIRO Education.

16:00 ► Geoff Prince (AMSI)
Mathematics in Industry

AMSI has more than thirty internships available over the next 12 months for postgraduate students in mathematics, statistics and cognate disciplines. These internships offer unmissable opportunities for research-related work experience in Australia's government agencies, large companies and small to medium enterprise. Students receive the opportunity to start their working careers, improve their CVs or start research collaborations which may lead to ARC Linkage Grants. Supervisors can launch their protgs, build research relationships with prospective partners and improve their ARC track record for Linkage Grants. I will introduce the AMSI scheme and answer questions.

■ AustMS Annual General Meeting – Abel Smith Lecture Theatre 23 16:30–17:30

NOTE: *There are a number of special sessions immediately after the AGM.*

■ AustMS Conference dinner

The Strand, Rugby Quay, 123 Eagle Street, Brisbane. Drinks at 19:00 and seating at 19:30.

1. Algebra and Number Theory

24-S304

13:30 Graham Clarke (Royal Melbourne Institute of Technology)
On the Cayley graphs of completely simple semigroups

14:00 Des FitzGerald (University of Tasmania)
Partition monoids

14:30 James East (University of Sydney)
Relative ranks in infinite partition monoids and dual symmetric inverse semigroups

3. Calculus of Variations and PDEs

14–115

- 13:30 Daniel Daners (University of Sydney)
The Dirichlet problem by variational methods
- 14:00 Florica Cirstea (University of Sydney)
Isolated singularities for weighted quasilinear elliptic equations
- 14:30 Maria Athanassenas (Monash University)
On the convergence of volume-preserving mean curvature flow
- 17:30 Jan Chabrowski (The University of Queensland)
The Hardy potential and eigenvalue problems
- 18:00 Yihong Du (University of New England)
Finite Morse index solutions of an elliptic equation with supercritical exponent

4. Combinatorics

24–S603

- 13:30 Barbara Maenhaut (The University of Queensland)
Pairs of decompositions into lists of cycles
- 14:00 Elizabeth Billington (The University of Queensland)
An extra condition on two-fold 2-perfect cycle systems
- 14:30 Midori Kobayashi (University of Shizuoka)
Exact coverings of 2-paths with 4-cycles in the complete bipartite graph

6. Control Theory

1–E232

- 13:30 Matthias Gerdts (University of Würzburg)
Function space and discretization methods in optimal control: Theory and applications
- 14:30 Volker Rehbock (Curtin University of Technology)
Computational optimal well path design

9. Geometric Analysis

14–116

- 13:30 Gaven Martin (Massey University)
Quasiregular mappings, curvature and dynamics
- 14:30 John William Rice (University of Sydney)
D-modules and derived loop stacks

10. Geometry and Topology

14–217

- 13:30 Emma Carberry (University of Sydney)
Constant mean curvature surfaces and Darboux transforms
- 14:00 Norman Do (The University of Melbourne)
Lattice points in moduli spaces of curves
- 14:30 Craig Westerland (The University of Melbourne)
The stable topology of Hurwitz spaces

11. Lie Groups and Harmonic Analysis

32-214

- 13:30 Anthony Lau (University of Alberta)
Invariant complementation and related properties for the group algebra of a locally compact group
- 14:30 Lesley Ward (University of South Australia)
Geometric-arithmetic averaging of dyadic weights
- 17:30 Christopher Meaney (Macquarie University)
Unitary representations of semisimple Lie groups
- 18:00 George Willis (University of Newcastle)
Contraction groups in locally compact groups

12. Mathematics in Biology, Medicine and Conservation

3-329

- 13:30 Glenn Fulford (Queensland University of Technology)
Mathematical modelling of the impact of tourism on dengue fever
- 14:00 Roslyn Hickson (Australian National University)
Dengue in Queensland, Australia
- 14:30 Stephen Davis (Royal Melbourne Institute of Technology)
Matrix models for tick-borne disease and other vector-borne pathogens
- 17:30 Steven Barry (Australian National University)
Modelling influenza mutation and dynamics
- 18:00 Dann Mallet (Queensland University of Technology)
Modelling within-host chlamydial infection

13. Mathematics Education

1-E302

- 13:30 Bill Barton (The University of Auckland)
Have eight colleagues watch me lecture? Why would I agree to that?
- 14:00 Steven Barry (Australian National University)
Experiences from the mathematics in schools program
- 14:30 Carmel Coady (University of Western Sydney)
Diagnostic testing in mathematics and its use across the disciplines
- 17:30 Michael Jennings (The University of Queensland)
First-year students' mathematical understanding
- 18:00 Michael Bulmer (The University of Queensland)
Statistical microarray analysis in a virtual environment

14. Mathematical Physics

32-215

- 13:30 Tony Guttmann (MASCOS/The University of Melbourne)
Lattice Green functions in all dimensions
- 14:30 David Ridout (Australian National University)
Indecomposable representations in physics
- 17:30 Jon Links (The University of Queensland)
Chiral phases in an interacting anyon system
- 18:00 Jan de Gier (The University of Melbourne)
Exact spin quantum Hall current between boundaries of a lattice strip

15. Noncommutative Geometry and Operator Algebras

32–213

- 13:30 Alan Carey (Australian National University)
Index theory on noncompact manifolds from a noncommutative perspective
- 14:00 Sooran Kang (University of Wollongong)
The Yang–Mills functional and Laplace’s equation on quantum Heisenberg manifolds
- 14:30 Paolo Bertozzini (Thammasat University - Bangkok)
Modular non-commutative geometries and quantum gravity

16. Optimization and Applications

1–E215

- 13:30 Roberto Cominetti (Universidad de Chile)
Equilibrium and learning in traffic network games
- 14:30 Brailey Sims (University of Newcastle)
Analysis in $CAT(0)$ spaces

17. Probability and Statistics

32–211

- 13:30 Aidan Sudbury (Monash University)
Random sequential adsorption on random trees
- 14:00 Neville Weber (University of Sydney)
A Functional Limit Theorem for the Empirical Process associated with Spatial Causal ARMA Models
- 14:30 Gareth Evans (The University of Queensland)
Estimating change-points in biological sequences via the cross-entropy method

18. Stochastic Processes and Modelling

32–207

- 13:30 Peter Taylor (The University of Melbourne)
Waiting-time distributions for queues in which customers accumulate priority as a linear function of their time in the system
- 14:00 Andriy Olenko (La Trobe University)
Limit theorems for random fields with cyclical long memory
- 17:30 Phil Howlett (University of South Australia)
Copulas of maximum entropy
- 18:00 Aihua Xia (The University of Melbourne)
Clubbed binomial approximation for the lightbulb process

Thursday 30 September 2010

■ Plenary Lecture – Abel Smith Lecture Theatre 23

08:45 ▶ Vladimir Gaitsgory (University of South Australia)
Averaging of singularly perturbed control systems: Infinite dimensional linear programming perspective

□ *Short Break 9:45 – 10:00*

■ Plenary Lecture – Abel Smith Lecture Theatre 23

10:00 ▶ James Borger (Australian National University)
Geometry—algebraic to arithmetic to absolute

□ *Morning Tea – Campbell Place 11:00 – 11:30*

■ Plenary Lecture – Abel Smith Lecture Theatre 23

11:30 ▶ Jonathan Borwein (University of Newcastle)
Short random walks and ramble integrals

□ *Lunch 12:30 – 13:30*

■ Afternoon Special Sessions

Start	13:30	14:00	14:30	15:00	15:30
24-S304	1: Oon	1: Stokes	1: Jackson		
14-115	3: Grotowski	3: Watson	3: Vassiliou	3: McCoy	
24-S603	4: Cavenagh	4: Wanless	4: Stones	4: Bamberg	4: Giudici
1-E303	5: Aarao	5: Ramalingam	5: Stals	5: Lamichhane	
14-116	9: Schmalz	9: Neusser	9: Leistner	9: Frauendiener	9: Gover
14-217	10: Tillmann	10: Burton	10: Hillman	10: McCallum	10: Bleile
3-329	12: Menon	12: Challis	12: Anissimov	12: Pettet	
32-215	14: Bedini	14: Grundling	14: Zhang	14: Liu	14: Iliev
32-213	15: Azamov	15: Rennie	15: Sims		
1-E215	16: Burt	16: Schulte	16: Burachik		
32-211	17: McLachlan	17: Smyth	17: Warton	17: Sisson	

□ *Afternoon Tea – Campbell Place 15:30 – 16:30*

1. Algebra and Number Theory

24–S304

- 13:30 Shea-Ming Oon (University of Malaya)
New lower bound of least common multiples
- 14:00 Tim Stokes (University of Waikato)
Function algebra
- 14:30 Marcel Jackson (La Trobe University)
Equations, membership and definability for a finite algebra

3. Calculus of Variations and PDEs

14–115

- 13:30 Joseph Grotowski (The University of Queensland)
New results on boundary regularity for elliptic systems
- 14:00 Neil Watson (University of Canterbury)
A unifying definition of a subtemperature
- 14:30 Peter Vassiliou (University of Canberra)
Explicit construction of wave maps
- 15:00 James McCoy (University of Wollongong)
High homogeneity curvature flow

4. Combinatorics

24–S603

- 13:30 Nicholas Cavenagh (University of Waikato)
Non-extendable latin cuboids
- 14:00 Ian Wanless (Monash University)
Eulerian quasigroups and neighbour-balanced designs
- 14:30 Douglas Stones (Monash University)
Near-automorphisms of Latin squares
- 15:00 John Bamberg (The University Of Western Australia)
Hemisystems of generalised quadrangles
- 15:30 Michael Giudici (The University Of Western Australia)
Point regular automorphism groups of generalised quadrangles

5. Computational Mathematics

1–E303

- 13:30 Jorge Aarao (University of South Australia)
EDEM: analysis and implementation of a solution method for PDEs
- 14:00 Ravindran Ramalingam (National Institute of Technology, Trichy)
Laplace transform solution of a diffusion equation with mixed derivative term
- 14:30 Linda Stals (Australian National University)
Turbulent flow in plasma physics
- 15:00 Bishnu Lamichhane (University of Newcastle)
From the Hu–Washizu formulation to the average nodal strain formulation

9. Geometric Analysis

14–116

- 13:30 Gerd Schmalz (University of New England)
Free CR distributions
- 14:00 Katharina Neusser (Australian National University)
Prolongation of partial differential equations on filtered manifolds
- 14:30 Thomas Leistner (University of Adelaide)
The ambient metric for n -dimensional pp -waves
- 15:00 Jörg Frauendiener (University of Otago)
Some properties of wave maps on $2 + 1$ dimensional Minkowski space
- 15:30 Rod Gover (The University of Auckland)
Projective BGG equations, algebraic sets, and compactifications of Einstein geometries

10. Geometry and Topology

14–217

- 13:30 Stephan Tillmann (The University of Queensland)
Pseudo-developing maps for ideal triangulations
- 14:00 Benjamin Burton (The University of Queensland)
Is simplifying triangulations as hard as it seems?
- 14:30 Jonathan Hillman (University of Sydney)
The linking pairings of orientable Seifert manifolds
- 15:00 Rupert McCallum (Australian Catholic University)
Local quasi-isomorphisms between topological buildings
- 15:30 Bea Bleile (University of New England)
Homotopy classification of Poincare duality complexes

12. Mathematics in Biology, Medicine and Conservation

3–329

- 13:30 Shakti Narayanan Menon (Queensland University of Technology)
ZSS says relax: A mathematical investigation of the contraction of fibroblast-populated collagen lattices
- 14:00 Vivien Challis (The University of Queensland)
Bone implant scaffold prototypes designed via topology optimisation and manufactured by solid freeform fabrication
- 14:30 Yuri Anissimov (Griffith University)
Mathematical aspects of fluorescence recovery after photo-bleaching (FRAP) in SC
- 15:00 Graeme Pettet (Queensland University of Technology)
The regulation of epidermal morphology: insight from in-vitro culture and in-silico modelling

14. Mathematical Physics

32–215

- 13:30 Andrea Bedini (The University of Melbourne)
A tree-decomposed transfer matrix for computing exact partition functions for arbitrary graphs
- 14:00 Hendrik Grundling (University of New South Wales)
The resolvent algebra of the canonical commutation relations
- 14:30 Yao-Zhong Zhang (The University of Queensland)
On Wakimoto free field realizations of current algebras and superalgebras
- 15:00 Xin Liu (University of Sydney)
Kauffman knot polynomials in classical abelian Chern–Simons field
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- 14:30 Regina Burachik (University of South Australia)
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0. Plenary Lectures

0.1. Geometry—algebraic to arithmetic to absolute

James Borger (Australian National University)

10:00 Thursday 30 September 2010 – Abel Smith

Classical algebraic geometry is about studying solutions to systems of polynomial equations with complex coefficients. In arithmetic algebraic geometry, one digs deeper and studies the arithmetic properties of the solutions when the coefficients are rational, or even integral. From the usual point of view, it's impossible to go deeper than this for the simple reason that no smaller rings are available—the integers have no proper subrings. In this talk, I will explain how an emerging subject, lambda-algebraic geometry, allows one to do just this and why one might care.

0.2. Short random walks and ramble integrals

Jonathan Borwein (University of Newcastle)

11:30 Thursday 30 September 2010 – Abel Smith

Following Pearson in 1905, we study the expected distance of a two-dimensional walk in the plane with n unit steps in random directions—what Pearson first called a *random walk* or a *ramble*.

While, as first shown by Rayleigh, the statistics and large n behaviour are tractable and are now well understood, the precise behaviour of the first few steps is quite remarkable and less tractable. Series evaluations, combinatorics, recursions and differential equations are obtained making it possible to explicitly determine this distance for small number of steps. [In this setting, as we shall show, “four is small but eight is large.”]

From this start and some surprising experimental mathematical discoveries, hypergeometric and elliptic/modular *closed forms*¹ are given for the densities and all the moments of two, three, and four-step walks.

While heavy use is made of analytic continuation of the integral, of various classical and more modern special functions, and of computer algebra (CAS), I intend to focus on an overview of how these tools come together.

This is joint work variously with Wadim Zudilin, James Wan (who is also speaking here), Armin Straub, and Dirk Nuyens. It may be found at www.carma.newcastle.edu.au/~jb616/walks2.pdf and the references therein.

¹In the sense of “Advances in the theory of box integrals,” *Math of Comp.* **79** (2010), 1839–1866. See www.carma.newcastle.edu.au/~jb616/BoxII.pdf.

0.3. Compressed Sensing—beyond the Shannon paradigm

Wolfgang Dahmen (RWTH Aachen)

11:30 Wednesday 29 September 2010 – Abel Smith

The usual paradigm for signal processing is to model a signal as a bandlimited function and capture it by means of its temporal or spatial samples. The Shannon–Nyquist theory says that the sampling rate needs to be at least twice the bandwidth. For broadbanded signals like digital images, such high sampling rates may be impossible to implement in circuitry. Compressed Sensing is a new paradigm in signal processing whose aim is to circumvent this dilemma by sampling signals closer to their information rate instead of their bandwidth while retaining high recovery quality. It is therefore of particular interest in those applications where measurements are expensive or difficult to acquire. More precisely, rather than model the signal as bandlimited, Compressed Sensing assumes that the signal is sparse in that it can be represented or approximated by a few suitably chosen terms from some basis expansion of the signal. It also enlarges the concept of sample to include the application of more general linear functional applied to the signal. We give a brief introduction to Compressed Sensing that centers on the effectiveness and implementation of random sampling. As a central theme, we formulate the notion of instance optimality as a performance benchmark that applies also to non-sparse signals. The subsequent discussion of this performance benchmark touches on the relevant conceptual background relating to Banach space geometry, dimension reduction and random matrices. Moreover, instance optimal decoding techniques are sketched. If time permits, we close with some remarks on emerging applications related to electron microscopy.

0.4. Solvable models for percolation and stochastic exclusion processes: The ubiquity of the Temperley–Lieb algebra

Jan de Gier (The University of Melbourne)

08:45 Wednesday 29 September 2010 – Abel Smith

Critical bond percolation on the square lattice is a classical and solvable model in statistical mechanics. In the continuum limit, this model is assumed to be described by a conformal field theory, from which many interesting results have been derived concerning the behaviour of critical percolation clusters. The rigorous connection of the lattice model with conformal field theory is one of the main research themes in modern probability theory, and has resulted in two recent Fields Medals (Werner in 2007 and Smirnov in 2010) in this area. Using the representation theory of the Temperley–Lieb algebra and multivariate polynomial theory, I will discuss a new approach to obtain direct and rigorous results for the finite size lattice model.

The asymmetric exclusion process is another paradigmatic model in mathematics and physics with an underlying algebraic structure. While the steady state of this stochastic process has been known for some time, its relaxation rates were obtained analytically only recently using methods of solvable lattice models. This result was possible thanks to the existence of exceptional representations of the two-boundary Temperley–Lieb algebra.

0.5. Fluid plumes and bubbles in oceans and galaxies

Larry Forbes (University of Tasmania)

10:00 Tuesday 28 September 2010 – Abel Smith

When a light fluid is injected into a heavier fluid, the interface between them may be unstable to small perturbations. A famous example of this is the Rayleigh–Taylor instability, in which a layer of heavy fluid lies above a layer of light fluid (such as when you paint the ceiling). Any disturbance to the interface grows with time, as the two fluids attempt to exchange positions. Small-amplitude linearized theory predicts that the disturbances grow exponentially fast, but this is moderated by non-linear effects, once the disturbances become of finite size. Asymptotic theories predict that, when fluid viscosity is ignored, a curvature singularity appears within finite time at the interface, and this is borne out by numerical investigations. When viscosity is re-introduced, it appears that those curvature singularities are replaced with small regions of very high vorticity (i.e., rotation), and these cause the interface to roll up into mushroom-cloud shapes. Some examples of these will be discussed, for situations that arise in oceanography (e.g. “black smoker”) and in astrophysics.

0.6. Averaging of singularly perturbed control systems: Infinite dimensional linear programming perspective

Vladimir Gaitsgory (University of South Australia)

08:45 Thursday 30 September 2010 – Abel Smith

Systems of controlled ODEs that evolve in different time scales (this being formalized by the introduction of a small parameter that allows one to characterize some of the state variables as fast and some as slow) arise in many applications and are commonly called singularly perturbed (SP). We will discuss conditions under which the slow-fast dynamics interaction is decomposed into two phases. First is the “fast” phase, during which the slow state variables are “frozen” and the fast state variables converge (in some distributional sense) to a certain limit set of probability measures (called limit occupational measures set-LOMS), the latter being characterized by an infinite system of linear equations. The second is the “slow” phase. During this phase the slow components evolve according to an averaged system, in which the role of effective controls is played by the distributions from the LOMS. We will then consider problems of optimal control of SP systems on the infinite time horizon. We will show that these problems can be reformulated as SP infinite dimensional LP problems and we will discuss a decomposition procedure for solving such problems. Theoretical results will be illustrated by numerical examples

0.7. Approximate groups and applications

Ben Green (Trinity College)

08:45 Tuesday 28 September 2010 – Abel Smith

I will endeavour to answer the following questions.

- (i) What is an approximate group?
- (ii) What can be said about approximate groups? How do they relate to actual groups?
- (iii) What applications are there?

0.8. On the Kervaire invariant problem

Michael Hopkins (Harvard University)

14:00 Monday 27 September 2010 – Abel Smith

The Kervaire invariant problem is one of the oldest problems in algebraic topology, and originates in the interface of homotopy theory with the theory of manifolds. I will discuss the history of this problem and its recent solution by Mike Hill, myself, and Doug Ravenel.

0.9. Total positivity in combinatorics and representation theory

Thomas Lam (University of Michigan)

11:30 Tuesday 28 September 2010 – Abel Smith

A real matrix is totally positive if each of its minors is positive. The theory of totally positive matrices began in the 1930's in the works of Schoenberg and Gantmacher-Krein, who were motivated by the remarkable spectral properties of totally positive matrices. I will discuss some more recent appearances of total positivity in combinatorics and representation theory.

0.10. Moving frames and Noether's theorem

Elizabeth Mansfield (University of Kent)

11:30 Monday 27 September 2010 – Abel Smith

“Moving frames” or “*rèpere mobile*” are associated with the name of Élie Cartan, although the ideas are older, and were used to solve a variety of equivalence problems under Lie group actions in differential geometry. Recent reformulations, in particular that used in the seminal work of Fels and Olver, have freed the ideas to allow for a wider variety of applications, for example in computer vision, discrete variational methods and Lie group invariant numerical schemes.

One major advance made by Fels and Olver, whose ideas were later substantially developed by Hubert, was being able to compute effectively with differential invariants and their differential relations in a symbolic computation environment. This was made possible by the discovery of differential recurrence formulae that can be computed knowing only the group action and the equations of any surface transverse to the group orbits.

In this talk, I will give an overview of moving frames accessible via undergraduate multivariate calculus. I will indicate the relation between Cartan's frame and the new definition, and will discuss in elementary terms how a moving frame yields invariants and their relations. There are substantial differences between the standard differential calculus and that of differential invariants which will be indicated.

The main application will be to the Calculus of Variations, specifically, the derivation and structure of Euler Lagrange equations arising from variational problems having a Lie group symmetry. Typical variational Lie group symmetries include translation and rotation and these give rise to conservation laws, via Noether's Theorem, of energy, and linear and angular momentum. The interplay between the moving frame and the conservation laws that arise via Noether's theorem is a recent result obtained jointly with Tania Gonçalves.

The main running example will be the projective $SL(2)$ action on curves in the plane which is the simplest nonlinear action of general interest. For variational problems invariant under this action, I will indicate how the new results substantially ease the calculations involved in finding the extremal curves, and point to the general results.

The talk is written for a general mathematical audience.

0.11. Homogeneity for graphs

Cheryl Praeger (The University of Western Australia)

10:00 Wednesday 29 September 2010 – Abel Smith

How much symmetry can a graph have? Suppose that, whenever two subsets A and B of k vertices induce isomorphic subgraphs, some automorphism of the graph maps A to B . For example, a graph has this property with $k = 1$ if and only if it is vertex-transitive. If a graph satisfies the property for all k it is called set-homogeneous—a notion introduced by the logician Fraïssé for a wide class of structures including graphs. All the finite set-homogeneous graphs have been known since the 1970s, by work of Gardiner, and it was proved by Ronse and Enomoto that they all have the seemingly stronger property: every isomorphism between induced subgraphs is realised by some automorphism. Graphs with this stronger property are called homogeneous and indeed there are infinite set-homogeneous graphs which are not homogeneous. I will consider how set-homogeneity compares with homogeneity for other natural relational structures, in particular for directed graphs.

0.12. Public Lecture: The life of π

Jonathan Borwein (University of Newcastle)

18:30 Tuesday 28 September 2010 – Abel Smith

The desire to understand π , the challenge, and originally the need, to calculate ever more accurate values of π , the ratio of the circumference of a circle to its diameter, has captured mathematicians—great and less great—for many many centuries and, especially recently, π has provided compelling examples of computational mathematics. π , uniquely in mathematics, is pervasive in popular culture and the popular imagination. In this lecture I shall intersperse a largely chronological account of π 's mathematical status with examples of its ubiquity.

1. Algebra and Number Theory

1.1. Affine cyclic complex reflection groups

Natalie Aisbett (The University of Melbourne)

16:30 Monday 27 September 2010 – 24-S304

Natalie Aisbett

Weyl groups are reflection groups generated by reflections with entries in the integers. Complex reflection groups are reflection groups generated by reflections with entries in the complex numbers. Weyl groups are in bijection with a family of groups known as affine Weyl groups, however this bijection has not been generalized to all of the complex reflection groups. We have found a family of groups (affine cyclic complex reflection groups) which relates to the cyclic complex reflection groups analogously to the way affine Weyl groups relate to Weyl groups.

I will discuss the properties of the affine cyclic complex reflection groups, and compare them to the affine Weyl groups.

1.2. On the estimation of cardinality of common solutions of congruence equations

Kamel Atan (University Putra Malaysia)

15:00 Tuesday 28 September 2010 – 24-S304

K.A. Atan and S.H. Sapar

A method of estimating the cardinality of set of common solutions to congruence equations associated with the partial derivative polynomials of a two-variable polynomials of degree five with integer coefficients will be presented in this talk. The application of the cardinality in determining explicitly an upper bound of a two-variable exponential sum associated with a polynomial of degree five will be demonstrated.

1.3. Proving polynomials positive

Ross Atkins (Australian National University)

16:30 Tuesday 28 September 2010 – 24-S304

Ross Atkins

Polynomial expressions in many variables arise in many areas of mathematics. The talk will discuss some of the tactics one might employ, in order to prove that a certain polynomial expression is always positive valued. The first half of the talk will focus on symmetric means and other homogeneous expressions, while the second half of the talk will look at more general polynomial inequalities. This is likely to be a more hands on talk with many example problems.

1.4. On the Cayley graphs of completely simple semigroups

Graham Clarke (Royal Melbourne Institute of Technology)

13:30 Wednesday 29 September 2010 – 24-S304

Yanfeng Luo, Yifei Hao and Graham T. Clarke

We give conditions for a Cayley graph of a completely simple semigroup to be a disjoint union of complete graphs. We also describe all the completely simple semigroups with strongly connected bipartite Cayley graphs.

1.5. Exotic Springer correspondences

Andrew Crisp (University of Sydney)

17:30 Tuesday 28 September 2010 – 24-S402

Andrew Crisp

Let G be a reductive algebraic group over \mathbb{C} , and V a finite-dimensional representation. The study of G -orbits in the Hilbert nullcone of V leads to intriguing results in representation theory. A well-known example is the Springer correspondence: when G is simple, the orbits in the nullcone of its Lie algebra correspond to irreducible representations of its associated Weyl group W . In type A this correspondence is bijective; in other types, the bijection is between irreps of W and pairs $(\mathcal{O}, \mathcal{L})$ where \mathcal{O} is a nilpotent orbit and \mathcal{L} is a (possibly non-trivial) G -equivariant local system on \mathcal{O} .

The exotic nilpotent cone (of type C) introduced by Syu Kato gives a bijective correspondence between nilpotent orbits and irreducible representations of the Weyl group of type B/C, leading to an “exotic Springer correspondence”. I will discuss a possible generalisation to type F, highlighting some preliminary results.

1.6. Relative ranks in infinite partition monoids and dual symmetric inverse semigroups

James East (University of Sydney)

14:30 Wednesday 29 September 2010 – 24-S304

James East

The relative rank of a semigroup S with respect to a subset $A \subseteq S$, denoted $\text{rank}(S : A)$, is defined to be the minimal cardinality of a subset $B \subseteq S$ such that $S = \langle A \cup B \rangle$. This concept is especially useful in considerations of uncountable semigroups, when the notion of rank is not of interest (since then $\text{rank}(S) = |S|$). For example, if X is an infinite set, $\text{rank}(\mathcal{T}_X : \mathcal{S}_X) = 2$, where \mathcal{S}_X and \mathcal{T}_X denote the symmetric group and (full) transformation semigroup on X . I will discuss the concepts and history, and present some recent results

on relative ranks of infinite partition monoids and dual symmetric inverse semigroups.

1.7. Logspace computable groups

Murray Elder (The University of Queensland)
 15:30 Monday 27 September 2010 – 24-S304
 Murray Elder, Gillian Elston, Gretchen Ostheimer

We investigate groups which have normal forms that can be computed in logspace.

1.8. Partition monoids

Des FitzGerald (University of Tasmania)
 14:00 Wednesday 29 September 2010 – 24-S304
 Des FitzGerald

The elements of the partition monoid P_X on the set X are partitions of the direct sum of X with itself, and so in duality (and Galois correspondence) with relations on X . In joint work with K. W. Lau, we characterise the division preorders on P_X in terms of graphical structures associated with the elements. This leads to a characterisation of the natural order on P_X but one which is not simply expressed in graphical terms. However we do get a nice graphical description of the natural order on the transformation monoid T_X (a submonoid of P_X), and descriptions of the ideal structures of P_X and of a twisted version of P_X .

1.9. Centres of cyclotomic Hecke algebras

Andrew Francis (University of Western Sydney)
 17:00 Tuesday 28 September 2010 – 24-S402
 Andrew Francis

The centre of the cyclotomic Hecke algebra (corresponding to the complex reflection group $G(r, 1, n)$) can be described as the set of symmetric polynomials in analogues of the Jucys-Murphy elements. I will outline the proof of this using the relationship of this algebra to the affine Hecke algebra and the affine braid group.

This is joint work with John Graham and Lenny Jones.

1.10. Distinguishing Hecke eigenforms

Alex Ghitza (The University of Melbourne)
 15:30 Tuesday 28 September 2010 – 24-S304
 Alex Ghitza

An easy and useful way of manipulating modular forms is via their Fourier expansions. If the modular forms happen to be eigenvectors for the Hecke operators, then the Fourier coefficients are algebraic integers and often have interesting arithmetic and combinatorial properties.

A natural question is then: given explicit Fourier expansions of two modular forms f and g , how many coefficients do we need to compare in order to conclude that f and g are distinct? We

answer this question via a strengthening of an elegant method due to Ram Murty.

1.11. Non-commutative valuation theory

Nazer Halimi (The University of Queensland)
 15:00 Tuesday 28 September 2010 – 24-S402
 Nazer Halimi

Non-commutative Valuation theory on infinite dimensional division algebras is different in many essential aspects from the corresponding finite dimensional theory. At the present a full theory for the infinite dimensional case is still lacking. In this talk I will discuss a number of intriguing properties of Dubrovin Valuation Rings in both finite and infinite dimensional division algebras which serve to illustrate the difference between finite and infinite theories.

1.12. A special subgroup of Pell conics over algebraic numbers

Samuel Hambleton (The University of Queensland)
 17:00 Tuesday 28 September 2010 – 24-S304
 Samuel Hambleton

Pell conics have been considered recently in some articles by Franz Lemmermeyer and compared with elliptic curves. Pell conics are affine curves \mathcal{P} , hyperbolae or ellipses depending on the sign of Δ , given by $\mathcal{P} : Q_0(x, y) = 1$ where $Q_0(x, y) = x^2 + \sigma xy - my^2$ is the principal binary quadratic form of fundamental discriminant $\Delta = \sigma + 4m$.

We show that there is a subgroup $\mathcal{P}(\mathbb{S})$ of $\mathcal{P}(\overline{\mathbb{Q}})$, Pell conics over algebraic numbers $\overline{\mathbb{Q}}$, such that

- There is a surjective homomorphism $\mathcal{P}(\mathbb{S}) \rightarrow \text{Cl}^+(K)^2$, the ideal class group of narrow classes of squared ideals.
- $\mathcal{P}(\mathbb{S})$ is isomorphic to the group \mathfrak{S} of all algebraic integer pairs (t, u) representing 1, meaning $Q(t, u) = 1$, with any binary quadratic form Q for which under composition of forms $Q = Q' \cdot Q'$, where Q' is any binary quadratic form of discriminant Δ .
- $\text{Cl}^+(K)^2 \simeq \ker(H^1(G, \mathcal{P}(\overline{\mathbb{Z}})) \rightarrow H^1(G, \mathcal{P}(\mathbb{S})))$.

This allows one to write Dirichlet's class number formula as $L(1, (\frac{\Delta}{\cdot})) =$

$$\frac{\frac{1}{2} \cdot \#\ker(H^1(G, \mathcal{P}(\overline{\mathbb{Z}})) \rightarrow H^1(G, \mathcal{P}(\mathbb{S}))) \cdot R(\mathcal{P}) \cdot \prod_p c_p}{\#\mathcal{P}(\mathbb{Z})_{\text{tors}}}$$

which looks similar to the Birch and Swinnerton Dyer formula for elliptic curves.

1.13. The toric variety of the symmetric group

Anthony Henderson (University of Sydney)
 16:30 Tuesday 28 September 2010 – 24-S402
 Anthony Henderson

The toric variety \mathcal{T}_n associated to the reflecting hyperplanes of the symmetric group S_n is a non-singular projective variety which occurs in several different contexts. One way to define it is as an iterated blow-up of $(n-1)$ -dimensional projective space along coordinate subspaces. The cohomology of the complex locus $\mathcal{T}_n(\mathbb{C})$ is well understood; less so the (rational) cohomology of the real locus $\mathcal{T}_n(\mathbb{R})$. I will present some recent results on the representation of S_n on these cohomologies.

1.14. Trees, self-replicating groups and automata

Daniel Horadam (University of Newcastle)
 17:30 Monday 27 September 2010 – 24-S304
 Daniel Horadam

Self-replicating automorphism groups of rooted n -ary trees are important to the theory of totally disconnected groups. In this talk I will discuss some properties of these groups, how they relate to groups of automata, and how we might attempt to classify them with the aid of software such as MAGMA.

1.15. Equations, membership and definability for a finite algebra

Marcel Jackson (La Trobe University)
 14:30 Thursday 30 September 2010 – 24-S304
 Marcel Jackson

The *variety* generated by a finite algebraic structure \mathbf{A} is the class of algebras satisfying the identities of \mathbf{A} . It is perhaps not surprising that the computational complexity of deciding membership of finite algebras in the variety of \mathbf{A} is related to the complexity issues for the equations satisfied by \mathbf{A} . The talk will give a general overview of these issues, as well as a new example demonstrating the subtleties involved: a finite algebra with optimal variety membership problem, but with complex equational properties. A further result will be the undecidability of the meta-problem of deciding the complexity of variety membership problems for finite algebras.

1.16. Exceptional p -groups of order p^5

Sichao (Rowland) Jiang (University of Sydney)
 17:00 Monday 27 September 2010 – 24-S304
 Sichao (Rowland) Jiang

The minimal degree of a group G is the least non-negative integer n such that G embeds inside $\text{Sym}(n)$. A group is said to be exceptional if there exists a normal subgroup N such that the minimal degree of G/N is strictly greater than the minimal degree of G . This talk will be about

the smallest exceptional groups (extending work of Lemieux), and if time permits, related ideas, such as the abelian quotients conjecture (work of Praeger and Kovacs) and the additivity of minimal degree with respect to direct products (work of Wright and Saunders).

1.17. Moduli space of line bundles on some non commutative surfaces

Boris Lerner (University of New South Wales)
 14:00 Tuesday 28 September 2010 – 24-S402
 Boris Lerner

Orders on (commutative) surfaces are examples of non commutative surfaces. It is natural to ask what concepts from the commutative theory of surfaces can be extended to this setting. In particular whether the concept of algebraic vector bundles can be extended to orders, whether a moduli space of such exists and if so, can we compute what it is? In the talk, I will show a way that orders may be constructed explicitly, and how one might go about computing their moduli space focusing on some cohomological techniques that are available.

1.18. Hecke-type double sums, Appell–Lerch sums and mock theta functions

Eric Mortenson (The University of Queensland)
 17:30 Tuesday 28 September 2010 – 24-S304
 Dean Hickerson and Eric Mortenson

We state and prove a formula, which expresses Hecke-type double sums in terms of Appell–Lerch sums and theta functions. Not only does our formula prove the classical Hecke-type double sum identities such as those found in works of Andrews as well as Kac and Peterson, but once we have the Hecke-type sum forms for Ramanujan’s mock theta functions, our formula also proves the identities for the second, fifth, sixth, seventh, eighth, and tenth order mock theta functions. In particular, our formula gives a new proof of the mock theta conjectures for the fifth order functions and a new proof of Hickerson’s identities for the seventh order functions. Our formula also evaluates all positive-level string functions associated with admissible representations of the affine Lie Algebra $A_1^{(1)}$ as introduced by Kac and Wakimoto.

1.19. New lower bound of least common multiples

Shea-Ming Oon (University of Malaya)
 13:30 Thursday 30 September 2010 – 24-S304
 Shea-Ming Oon

Consider the sequence of the first n positive integers, the estimate of its least common multiple are already discussed by M. Nair and D. Hanson. Now, we study similar question on sequences in arithmetic progression : Suppose $(u_0, r) = 1$. For

$k = 1, \dots, n$ put $u_k = u_0 + kr$. We give an interesting lower bound when $n \geq r^2 + r$.

1.20. Wieferich primes

Victor Scharaschkin (The University of Queensland)

14:30 Tuesday 28 September 2010 – 24-S304

Victor Scharaschkin

If p is a prime, let $W_p = \{a \mid 2 \leq a \leq p-1, a^{p-1} \equiv 1 \pmod{p^2}\}$. If $a \in W_p$ then p is called a Wieferich prime base a . These primes have been well studied in connection with Fermat's Last Theorem and other problems. We exhibit polynomials whose roots are the sets W_p , and establish an explicit upper bound for $|W_p|$. This is joint work with Luis Gallardo.

1.21. Singularity categories of complete intersections

Greg Stevenson (Australian National University)

14:30 Tuesday 28 September 2010 – 24-S402

Greg Stevenson

I will give a brief introduction to the theory of singularities in algebraic geometry and introduce the singularity category associated to a ring. The singularity category measures how singular the ring is and has recently been the subject of much interest. The problem of determining the structure of this category will then be addressed and I will present some recently obtained classification results.

1.22. Function algebra

Tim Stokes (University of Waikato)

14:00 Thursday 30 September 2010 – 24-S304

Tim Stokes

The collection of all binary relations on a set has a lot of algebraic structure, and there is a well-known but inadequate finite axiomatization of concrete relation algebras (indeed no finite axiomatization is possible). By contrast, the set of all (partial) functions on a set has seemingly much less structure. Algebras of functions under composition are axiomatized as the class of semigroups. Under additional assumptions, one can accurately model inversion as well, giving groups and inverse semigroups. We axiomatize arguably the richest algebras of functions so far considered. The axioms consist of a finite set of equations, and the proof of their completeness makes use of Schein's method of determinative pairs. It is a blending of the Stone Representation Theorem for Boolean algebras and Cayley's Theorem for semigroups.

1.23. Lattices in complete Kac-Moody groups

Anne Thomas (University of Sydney)

16:00 Monday 27 September 2010 – 24-S304

Inna (Korchagina) Capdeboscq and Anne Thomas

Let G be a complete Kac-Moody group over a finite field. Then G is a totally disconnected, locally compact group, which may be thought of as an "infinite-dimensional" Lie group. An example is $G = SL(n, K)$ where K is the field of formal Laurent series over the finite field F_q ; in general G is nonlinear. We study the structure and co-volumes of lattices in G , using finite group theory and the action of G on its associated Bruhat-Tits building.

1.24. Unknown, inconsistent and a million dollars

Bill Whiten (The University of Queensland)

15:30 Tuesday 28 September 2010 – 24-S402

Bill Whiten

Logical calculations are usually done using only true and false (or zero and one) to describe the state of logical propositions. However there are advantages in using a four value logic that is defined by two variables, True and False, that describe what is known about each proposition. This logic provides a simple, robust, and fast deduction algorithm. The relation of this algorithm to the Polynomial vs. Non Polynomial algorithms (P=NP) problem will be discussed.

1.25. The Erdős–Moser diophantine equation and the continued fraction of $\log(2)$

Wadim Zudilin (University of Newcastle)

14:00 Tuesday 28 September 2010 – 24-S304

Wadim Zudilin

We report on the diophantine equation $1^k + 2^k + \dots + (m-1)^k = m^k$ which conjecturally does not possess positive integer solutions except the trivial pair $k = 1, m = 3$. The previous record $m > 10^{9.3 \cdot 10^6}$ (for a solution (m, k)) is due to L. Moser (1953). Here we achieve $m > 10^{10^9}$ by showing that $2k/(2m-3)$ is a convergent of $\log(2)$ and making an extensive continued fraction digits calculation of $(\log 2)/N$, with N an appropriate integer. Our result seems to give one of very few instances where a large scale computation of a numerical constant has an application.

2. Applied Differential Equations

2.1. Modelling synchronization

Robert Anderssen (CSIRO)

14:00 Tuesday 28 September 2010 – 5-213

Bob Anderssen

Synchronization is a naturally occurring physical phenomenon. The discovery is credited to Huygens in his investigations of the construction of accurate clocks for the determination of longitude (Bennett et al. (2002)). On the basis of conclusions of Winfree (1980) about biological rhythms, Kuramoto (1984) formulated a system of ordinary differential equations that has become the fundamental model in the study of synchronization (Strogatz (2000)). It is now believed that synchronization is the process that underlies the circadian cycle in plants and the onset of epileptic seizures. The talk will discuss the synchronization experiments of Huygens, review the Kuramoto model, in terms of the exact solution derived by Kuramoto, examine its application to the modelling of the circadian cycle and epileptic events, and discuss some of the recent mathematical developments associated with the Kuramoto model.

2.2. Curve shortening, and surface evolution by evaporation-condensation

Philip Broadbridge (La Trobe University)

15:30 Monday 27 September 2010 – 5-213

P. Broadbridge

In the 1950s, W. Mullins derived nonlinear diffusion equations for evolution of metal surfaces. Evaporation-condensation is modeled by a second order equation that is the simplest curvature-driven flow, with normal component of boundary velocity proportional to mean curvature. For cylindrical and other translation-invariant structures, the governing equation reduces to the curve-shortening equation which is now used in image analysis to smooth rough curves, in a procedure that is invariant with respect to the Euclidean group. Self similar solutions, invariant under combinations of scale transformations, rotations and translations, have been fully classified. These have been instrumental in understanding the dynamics of grain boundary grooves and the evaporation of convex rods and droplets in finite time as they asymptotically approach circular cylinders and spheres. The Doyle–Vassiliou classification of nonlinear diffusion equations by generalized separation of variables leads us to a new exact solution that resembles a diffraction grating evolving asymptotically to a decaying sine wave. This is more relevant to the application of image enhancement.

2.3. Generating high order series solutions for Stokes waves

Michael Dallaston (Queensland University of Technology)

17:00 Monday 27 September 2010 – 5-213

Michael Dallaston

Numerically generated high order expansions have been used in the past to study the properties of Stokes' water wave model in their full nonlinearity. We have computed the series to higher order using exact arithmetic, and will demonstrate that numerical error has a significant effect on the solution near the limiting (highest) wave. In addition, we show that the high order series, improved by the use of Padé approximants, accurately captures the behaviour of near-highest waves, with multiple turning points in the wave speed-amplitude relation.

2.4. Corner boundary layers

Jim Denier (University of Adelaide)

17:30 Monday 27 September 2010 – 5-213

Jim Denier, Nathaniel Jewell

This talk will present some new results on the boundary layer flow both external and internal to a corner. For the internal flow problem we will focus on the stability of the flow whereas the external flow problem will present results on the laminar boundary layer flow.

2.5. Solitary waves and their stability in colloidal media: Semi-analytical solutions

Tim Marchant (University of Wollongong)

17:00 Tuesday 28 September 2010 – 5-213

Tim Marchant

Spatial solitary waves in colloidal suspensions of spherical dielectric nanoparticles are considered. The interaction of the nanoparticles is modelled as a hard-sphere gas, with the Carnahan–Starling formula used for the gas compressibility. Semi-analytical solutions, for both one and two spatial dimensions, are derived using an averaged Lagrangian and suitable trial functions for the solitary waves. Power versus propagation constant curves and neutral stability curves are obtained for both cases, which illustrate that multiple solution branches occur, for both the one and two dimensional geometries. For the one-dimensional case it is found that three solution branches (with a bistable regime) occur, while for the two-dimensional case two solution branches (with a single stable branch) occur, for low background packing fractions. Comparisons are made

between the semi-analytical and numerical solutions, with an excellent comparison obtained.

2.6. A Stefan problem with kinetic undercooling, with applications to drug delivery

Scott McCue (Queensland University of Technology)

17:30 Tuesday 28 September 2010 – 5-213

Scott W. McCue, Mike Hsieh, Tim J. Moroney, Mark I. Nelson

In this talk, I will consider a moving boundary problem that arises from modelling the melting of a spherical ball, including the effects of kinetic undercooling. Various asymptotic limits will be discussed, with particular emphasis on how kinetic undercooling regularises the otherwise singular limit of complete melting. Numerical results will also be included. Finally, the model will be presented in the context of diffusion-controlled drug release from a swellable polymer. Here the moving boundary represents a distinct interface between the glassy and rubbery states of the polymer, while the drug diffuses from the rubbery state only.

2.7. On singular parabolic pdes

William Phillips (Swinburne University of Technology)

16:30 Tuesday 28 September 2010 – 5-213

W.R.C. Phillips

Second order partial differential equations are classified as elliptic, hyperbolic or parabolic, according to the spectrum of eigenvalues of the coefficient functions and this information dictates the boundary / initial conditions necessary to ensure a unique stable solution. For example, we consider a parabolic pde well posed if at least one eigenvalue is zero with the remainder of the same sign. Less common, and somewhat more difficult to handle, is the situation in which one eigenvalue is zero with the remainder of mixed sign. This class is denoted singular parabolic. The key difference is that in order to calculate forward, the former requires spatial information solely from behind, whereas the later requires information from both ahead and behind, and for that reason are also known as forward-backward pdes. Thus, while an initial condition at one instant in time and boundary conditions at two locations in space for all time (open hyperspace) are usually adequate to render a stable solution in a well posed parabolic pde, a further boundary condition is necessary in the singular parabolic situation resulting in boundary conditions on the closed hyperspace, as with an elliptic pde, rendering the calculation more difficult. Boundary layer flows in fluid dynamics are typically described by parabolic pdes and although

most lie in the well posed category there are exceptions. Examples in the singular parabolic class include some oil spreading flows, where the unsteady boundary layer can have two beginnings, one at the leading edge and another at the trailing edge; another is the boundary layer behind a shock wave as it moves over a flat plate. This talk will focus on singular parabolic partial differential equations, and how to identify and classify them using unsteady boundary layers as examples.

2.8. Anisotropic exploration of networks by random walkers

Tony Roberts (The University of Queensland)

15:00 Tuesday 28 September 2010 – 5-213

Tony Roberts

The study of transport on networks continues to attract attention because of its connection with anomalous properties of materials and its ability to reveal interesting features of both the structure and transport dynamics of complex networks. The Alexander-Orbach ($\bar{d} = 2d_f/d_w$) and fractal Einstein ($\zeta = d_w - d_f$) laws are two fundamental relationships linking the spectral \bar{d} , fractal d_f , random walk d_w , and resistance ζ dimensions of networks. While the preponderance of evidence favours the results, which are used extensively as foundational laws, the exception of transport on diffusion limited aggregates remained unexplained. We find classes of networks (PRL: 103, 020601, 2009) which violate both laws, and attribute the anomaly to anisotropic exploration of the network. In other words, a random walker will visit sites the *same* lattice-distance from the origin with vastly different probabilities. We show that this behaviour violates an implicit assumption of the two basic laws, and propose a generalized fractal Einstein law

$$\zeta = d_w(2 - \bar{d})/2.$$

The result appears to be exact for our networks, and significantly improves predictions of the resistance exponent for diffusion limited aggregates. The formula reduces to the conventional result when the Alexander-Orbach law holds. We therefore take the fulfillment of the Alexander-Orbach law to be an *a posteriori* definition of isotropic transport.

2.9. Frequency response of cantilever beams in fluid

John Elie Sader (The University of Melbourne)

16:30 Monday 27 September 2010 – 5-213

John E. Sader

The fluid-structure interaction of resonating microcantilevers in fluid has been widely studied and is a cornerstone in nanomechanical sensor development. Operation in fluid environments presents significant challenges due to the strong enhancement of fluid damping effects with miniaturization. In this talk, I will give an overview of recent work dealing with the behavior of cantilever sensors in the presence of fluid.

2.10. Wavelet approximation of the chemical master equation

Vikram Sunkara (Australian National University)

15:30 Tuesday 28 September 2010 – 5-213

Vikram Sunkara

It is well known that many realistic mathematical models of biological and chemical systems, such as enzyme cascades and gene regulatory networks, need to include stochasticity. These systems can be described as Markov processes and are modeled using the Chemical Master Equation (CME). The CME is a differential-difference equation (continuous in time and discrete in the state space) for the probability of certain state at a given time. The state space is the population count of species in the system. In realistic biological problems, one would be dealing with large state spaces. Our aim is to use the Wavelet approximation method to reduce the dimensionality of the problem, hence decreasing computation time.

3. Calculus of Variations and PDEs

3.1. On the convergence of volume-preserving mean curvature flow

Maria Athanassenas (Monash University)

14:30 Wednesday 29 September 2010 – 14-115

Maria Athanassenas

Proofs of convergence of compact surfaces to spheres under volume-preserving mean curvature flow usually have some assumption on the curvature of the initial surface. We prove this result for axially symmetric surfaces, without any conditions on the curvature. Assuming the surface is not pinching off along the axis at any time we prove that it converges to a sphere, when the hypersurface is compact without boundary, and to a hemisphere, when it has a free boundary and satisfies Neumann boundary data. This is joint work with Sevrandi Kandanaarachchi.

3.2. The Hardy potential and eigenvalue problems

Jan Chabrowski (The University of Queensland)

17:30 Wednesday 29 September 2010 – 14-115

J. Chabrowski

We consider a weighted Hardy inequality. Under some conditions on a weight function the corresponding variational problem admits a minimizer. This leads to the existence of a principal eigenfunction with the Dirichlet (or Neumann) boundary conditions.

3.3. Isolated singularities for weighted quasilinear elliptic equations

Florica Cirstea (University of Sydney)

14:00 Wednesday 29 September 2010 – 14-115

Florica C. Cirstea and Yihong Du

We classify all the possible asymptotic behaviour at the origin for positive solutions of weighted quasilinear elliptic equations. Our central result provides a sharp extension of a well-known theorem of Friedman and Veron given for the special case of power nonlinearities. Our approach relies on the regular variation theory and a new perturbation method for constructing sub- and super-solutions for the equation.

3.4. The flow of liquid crystals

Matthew Cooper (The University of Queensland)

17:00 Tuesday 28 September 2010 – 14-115

Matthew Cooper

The term liquid crystal refers to a state of matter in which a substance shows properties characteristic of both a liquid and a solid, for example fluidity and long-range order. One of the main models of

the liquid crystal state is the Ericksen–Leslie system. This system is the coupling of the incompressible Navier–Stokes system with the gradient flow of the Oseen–Frank energy. Although physicists have been studying the Ericksen–Leslie system for decades the most basic properties one asks for, existence and uniqueness of solutions, have not yet been proven. In this talk the Ericksen–Leslie system will be introduced and current work toward proving existence and uniqueness of solutions will be discussed.

3.5. Stable and finite morse index solutions when there are non-nodal zeros

Norman Dancer (University of Sydney)

14:00 Tuesday 28 September 2010 – 14-115

E.N. Dancer

I survey recent work on stable and finite Morse index solutions of weakly nonlinear elliptic partial differential equations on bounded domains and with small diffusion. I will especially emphasize the case where the nonlinearity has non-nodal zeros. Here there is a surprising connection with problems with infinite boundary values.

3.6. The Dirichlet problem by variational methods

Daniel Daners (University of Sydney)

13:30 Wednesday 29 September 2010 – 14-115

Daniel Daners

We consider the classical problem of the Dirichlet problem for harmonic functions on a domain Ω with continuous boundary data φ . If φ has an extension to a function $\Phi \in H^1(\Omega)$, then Dirichlet's principle allows to get the solution by minimising the Dirichlet integral over $u \in H^1(\Omega)$ with $u - \Phi \in H_0^1(\Omega)$. However, an example due to Hadamard shows not all continuous boundary data admit such an extension, not even on a ball. The main aim of the talk is to show that the Perron solution to the Dirichlet problem can be found by a variational principle provided $\Delta\Phi \in H^{-1}(\Omega)$, therefore giving a possible answer to Hadamard's objection against Dirichlet's principle. This is joint work with Wolfgang Arendt (Bull London Math Soc 40 (2008), 51–56)

3.7. Finite Morse index solutions of an elliptic equation with supercritical exponent

Yihong Du (University of New England)

18:00 Wednesday 29 September 2010 – 14-115

Yihong Du

We study the behavior of finite Morse index solutions of the equation

$$-\Delta u = |x|^\alpha |u|^{p-1} u \text{ in } \Omega \subset \mathbb{R}^N,$$

where $p > 1$, $\alpha > -2$, and Ω is a bounded or unbounded domain. We show that there is a critical power larger than the usual critical exponent $(N+2)/(N-2)$, which plays a crucial role for the behavior of such solutions.

3.8. New results on boundary regularity for elliptic systems

Joseph Grotowski (The University of Queensland)
13:30 Thursday 30 September 2010 – 14-115
Joseph Grotowski

We discuss some recent results on partial regularity at the boundary for solutions to elliptic systems. In particular, we discuss progress in applying the technique of A-harmonic approximation to obtain partial regularity results for Neumann boundary-value problems.

3.9. An extremal problem for equations of prescribed curvature

James Holland (Australian National University)
15:00 Tuesday 28 September 2010 – 14-115
James Holland

The Weingarten Curvatures of a hypersurface (taken here to be the elementary symmetric polynomials of the principal curvatures) generalize the Gauss and Mean Curvatures.

The problem of the existence and regularity of a surface (represented as a graph over an appropriate domain) whose curvatures are a given function of the normal to the surface (or perhaps other quantities) has been extensively studied in many situations—it leads to fully nonlinear PDE closely related to those of Hessian and Monge–Ampère type.

In certain ‘extremal’ cases the gradient of the solution blows up as one approaches the boundary of the domain so that one no longer has global regularity for the solution. However, one can still ask if the graph of the solution is regular when considered as a manifold. This problem was solved by John Urbas in the case of the Gauss curvature. In this talk I will explain how Xu-Jia and I have solved the problem for general Weingarten curvatures (modulo a few small details still to be completed).

3.10. High homogeneity curvature flow

James McCoy (University of Wollongong)
15:00 Thursday 30 September 2010 – 14-115
James McCoy

We discuss a new curvature pinching result for smooth strictly convex hypersurfaces which facilitates convergence of sufficiently pinched smooth

convex hypersurfaces to round points under a class of high homogeneity fully nonlinear curvature flow, without the need for specialised regularity results for porous medium type equations. This is joint work with Ben Andrews.

3.11. Perturbation of abstract semi-linear evolution equations

Parinya Sa Ngiamsunthorn (University of Sydney)
16:30 Tuesday 28 September 2010 – 14-115
Parinya Sa Ngiamsunthorn

We give a general perturbation result for abstract semi-linear initial value problems in a Banach space. Under pointwise convergence of the nonlinear inhomogeneous terms, we prove convergence of solutions under perturbation. An application in domain perturbation problems will also be discussed.

3.12. Explicit construction of wave maps

Peter Vassiliou (University of Canberra)
14:30 Thursday 30 September 2010 – 14-115
Peter Vassiliou

Let $\varphi : M \rightarrow N$ be a map between Riemannian manifolds M, N . Then φ is *harmonic* if it is a critical point of its energy. In case M has indefinite signature then φ is said to be a *wave map*. A reasonable question is for which metrics on M and N is the partial differential equation defining wave maps “explicitly” integrable? In this talk I describe a solution to this problem in case M is the Minkowski plane and $\dim N = 2$. Surprisingly, the metric on N does not have constant curvature. Joint work with Jordane Mathé (student of the École Normale Supérieure, Bretagne).

3.13. A unifying definition of a subtemperature

Neil Watson (University of Canterbury)
14:00 Thursday 30 September 2010 – 14-115
Neil A. Watson

The potential theory of the heat operator in \mathbb{R}^{n+1} is now well developed, but it has been developed in two different ways. First there was the harmonic space approach of Heinz Bauer, and second the heat ball approach of myself. In 1985, Bauer proved the equivalence of the two approaches. More precisely, he showed that the subsolutions in the two theories — the subcaloric functions and the subtemperatures — are the same. He used relatively sophisticated results from both theories. In this talk, I shall present a new approach using a new definition of subtemperature. This unifies the theory from the outset, as the two earlier definitions arise as characterizations of subtemperatures, almost simultaneously.

3.14. Diffusive Nicholson blowflies equations with single time delay and fixed time impulses

Jalina Widjaja (Institut Teknologi Bandung)

15:30 Tuesday 28 September 2010 – 14-115

Jalina Widjaja

A system of diffusive Nicholson blowflies equations with single time delay, impulses, and homogeneous Neumann boundary condition is discussed. The impulses occur at fixed times and the magnitude of them is represented by a continuous function. The existence and uniqueness of solution is proved using method upper and lower solution. Some conditions under which the system has a positive attractor are presented.

3.15. Kähler–Ricci flows over quasiprojective manifolds

Zhou Zhang (University of Sydney)

17:30 Tuesday 28 September 2010 – 14-115

John Lott and Zhou Zhang

We consider Kähler–Ricci flows over complete noncompact manifolds. Quasiprojective manifolds serve as the standard examples. The asymptotic behavior of the flow metric towards the spatial infinity is of great interest in this topic. After providing the proper set-up and other preparations, we achieve the optimal existence result of these flows, which is comparable to the optimal existence result for the corresponding flows over closed manifolds.

4. Combinatorics

4.1. Hemisystems of generalised quadrangles

John Bamberg (The University of Western Australia)

15:00 Thursday 30 September 2010 – 24-S603

John Bamberg

Generalised quadrangles are objects in finite geometry which are closely related to groups of Lie rank 2, and the “hemisystems” of the generalised quadrangles we are interested in are certain sets of lines giving rise to interesting strongly regular graphs, two-weight codes and partial quadrangles. Segre (1965) showed that there exists a hemisystem of the classical generalised quadrangle $H(3, 9)$, and it was conjectured by J.A. Thas in 1995 that no hemisystem of $H(3, q^2)$ exists for $q > 3$. Ten years later, Cossidente and Penttila proved that for every q odd, there exists a hemisystem of $H(3, q^2)$. The only known generalised quadrangles with the same parameters of $H(3, q^2)$, q odd, are the flock generalised quadrangles. We will present in this talk an improvement of Cossidente and Penttila’s results to flock generalised quadrangles. The speaker will give an overview of the basic notions in finite geometry needed to understand the main result.

(Joint work with Michael Giudici and Gordon Royle)

4.2. You, me and symmetry

Wendy Baratta (The University of Melbourne)

14:00 Tuesday 28 September 2010 – 24-S603

Wendy Baratta

We (you and me) will spend some time discussing the concepts of symmetry and symmetrisation. We then add a touch of flavour by considering t -symmetrisations and their connection to my favourite polynomial, the Macdonald polynomial. The applications of the theory will be sprinkled throughout.

4.3. Enumerating some classes of lattice paths and polygons

Nicholas Beaton (MASCOS/The University of Melbourne)

17:00 Tuesday 28 September 2010 – 24-S603

Nicholas Beaton

With the problem of enumerating self-avoiding walks or polygons on a square lattice still being very much unsolved, one approach that has found some traction is to study sub-classes formed by placing restrictions on how the objects can be formed. In this talk I will discuss several of these

classes, including *prudent*, *perimeter* and *quasi-prudent*, and some recent progress that has been made towards finding exact solutions.

4.4. An extra condition on two-fold 2-perfect cycle systems

Elizabeth J. Billington (The University of Queensland)

14:00 Wednesday 29 September 2010 – 24-S603

Elizabeth J. Billington

A [twofold] 2-perfect m -cycle system is an edge-disjoint decomposition of K_n [$2K_n$] into copies of m -cycles such that every pair of vertices of K_n is also joined by a path of length *two* in exactly one [exactly two] of the m -cycles.

The smallest even order cycle for which a 2-perfect cycle system exists is 6. The spectrum for twofold 2-perfect 6-cycle systems was found in 1992. Here an *extra* condition is imposed: the two paths of length 2 between every pair of vertices of K_n must be distinct, and so must form a 4-cycle. We construct a twofold 2-perfect 6-cycle system of order n with this *extra* property for all orders $n \equiv 0$ or $1 \pmod{3}$, $n \geq 7$ and also for $n \equiv 2 \pmod{3}$, $n \geq 8$, after removal of a single double edge from the graph.

Joint work with C.C. Lindner, M. Meszka and A. Rosa.

4.5. Non-extendable latin cuboids

Nicholas Cavenagh (University of Waikato)

13:30 Thursday 30 September 2010 – 24-S603

D. Bryant, N. Cavenagh, B. Maenhaut, K. Pula, I. Wanless

In this talk we examine the problem of completing a “stack” of latin squares of order n to a latin cube of order n .

4.6. Optimal discrete choice experiments

Fatih Demirkale (The University of Queensland)

17:00 Monday 27 September 2010 – 24-S603

Fatih Demirkale

A Discrete Choice Experiment (Stated Choice Experiment) consists of several choice sets, each containing two or more options. Respondents are shown the choice sets in turn and are asked which option they prefer. Each option is described by a set of attributes and each attribute can take one of several levels. Discrete Choice Experiments are widely used in various areas including marketing, transport, environmental resource economics and public welfare analysis. In this talk, the efficiency

and the optimality of an experiment will be discussed and some constructions for optimal experiments will be presented.

4.7. An irreducible Markov-chain dynamics for some loop models and antiferromagnetic Potts models

Tim Garoni (MASCOS/The University of Melbourne)

17:30 Monday 27 September 2010 – 24-S603

Tim Garoni and Youjin Deng

Studying the proper q -colourings of a graph is a problem which lies squarely within the intersection of mathematical physics and combinatorics. Amongst physicists, this problem is more commonly referred to as the zero-temperature antiferromagnetic Potts model, and a great deal has been learned about these models from Monte Carlo simulations. In particular, the Wang-Swendsen-Kotecký (WSK) algorithm has defined the state-of-the-art in algorithms for these problems for the past two decades. In combinatorial language, the WSK dynamics simply correspond to the so-called “Kempe changes”, introduced by Kempe over a century ago in his failed attempt to prove the Four Colour Theorem. Despite the success of WSK, it has recently been proved (Mohar & Salas 2009, Mohar & Salas 2010) that the WSK dynamics is non-irreducible (and therefore invalid) at zero temperature for certain values of q and certain natural classes of maps on the torus (including 4-state model on the triangular lattice).

A related model of significant interest to physicists (and combinatorialists?) is the $O(n)$ -loop model, which is defined analogously to the (Fortuin-Kasteleyn representation of the) Potts model, but with a state space which is the cycle space of the given graph, rather than the edge space. Bijections are known which link the fully-packed limit of certain loop models to certain zero-temperature antiferromagnetic Potts models. In this talk, we will describe a “worm” dynamics (Markov-chain Monte Carlo algorithm) for the $O(n)$ -loop model on bipartite cubic graphs for general $n > 0$. In particular, we will prove that this new dynamics remains irreducible in the fully-packed limit. By then applying the known bijections between loop and Potts models, we will go on to show that the new worm dynamics provides a provably irreducible Markov-chain dynamics for all the cases for which WSK has recently been proved to fail.

4.8. Point regular automorphism groups of generalised quadrangles

Michael Giudici (The University of Western Australia)

15:30 Thursday 30 September 2010 – 24-S603

Michael Giudici

Studying regular automorphism groups of combinatorial objects has had a long history. Recently there has been some focus on groups of automorphisms of generalised quadrangles that act regularly on the set of points. In this talk I will give a classification of all point regular automorphism groups of the thick classical generalised quadrangles. I will also construct point regular automorphism groups of some nonclassical generalised quadrangles. The constructions show that the class of groups which can act regularly on the set of points of a generalised quadrangle contains nonabelian 2-groups, groups of exponent 9 and nonspecial p -groups, and is thus wilder than previously thought. I will also discuss how these examples are interesting for the study of normal Cayley graphs. This is joint work with John Bamberg.

4.9. Rich, Sturmian, and trapezoidal words

Amy Glen (Murdoch University)

15:30 Tuesday 28 September 2010 – 24-S603

Amy Glen

The *factor complexity function* $C_w(n)$ of a finite or infinite word w associates to each integer $n \geq 0$ the number of distinct *factors* (i.e., blocks of consecutive letters) in w of length n . A finite word w of length $|w|$ is said to be *trapezoidal* if the graph of its factor complexity $C_w(n)$ as a function of n (for $0 \leq n \leq |w|$) is that of a regular trapezoid: $C_w(n)$ increases by 1 with each n on some interval of length r , then $C_w(n)$ is constant on some interval of length s , and finally $C_w(n)$ decreases by 1 with each n on an interval of length r . Necessarily $C_w(1) = 2$ (since there is one factor of length 0, namely the *empty word*), so any trapezoidal word is on a binary alphabet. Trapezoidal words were first introduced by A. de Luca (1999) when studying the behaviour of the factor complexity of *finite Sturmian words*, i.e., factors of infinite “cutting sequences”, obtained by coding the sequence of cuts in an integer lattice over the positive quadrant of \mathbb{R}^2 made by a line of irrational slope. Every finite Sturmian word is trapezoidal, but not conversely. However, both families of words (trapezoidal and Sturmian) are special classes of so-called *rich words* – a new (wider) class of finite and infinite words characterised by containing the maximal number of palindromes – recently introduced by J. Justin, S. Widmer, L.Q. Zamboni, and myself.

In this talk, I will discuss various interconnections between rich words, Sturmian words, and trapezoidal words. I will also briefly outline current research and open problems concerning rich words.

This talk is based on joint work with A. de Luca (Università degli Studi di Napoli Federico II, Italy) and L.Q. Zamboni (Université Lyon 1, France).

4.10. Ultimately bipartite subtraction games

Nhan Bao Ho (La Trobe University)
 14:30 Tuesday 28 September 2010 – 24-S603
 Nhan Bao Ho

Subtraction game is a two-player impartial game involving a heap of size n and a finite set $\{s_1, \dots, s_k\}$ of positive integers. The players move alternately. In his move the player subtracts some s_i from n . The winner is the player who makes the last move. It has been shown that the sequence of Grundy values of a subtraction game is periodic when n is large enough. However, the understanding of the manner of periodicity of subtraction games has been still poor. In this talk, I will introduce one simple form of periodicity of subtraction games called ultimately bipartite subtraction games.

4.11. Exact coverings of 2-paths with 4-cycles in the complete bipartite graph

Midori Kobayashi (University of Shizuoka)
 14:30 Wednesday 29 September 2010 – 24-S603
 Midori Kobayashi and Gisaku Nakamura

Let K_n be the complete graph on n vertices and $K_{n,n}$ the complete bipartite graph. A $C(n, k, \lambda)$ [a $C(n, n; k, \lambda)$] design is a family of k -cycles in K_n [$K_{n,n}$], in which each 2-path (path of length 2) of K_n [$K_{n,n}$] occurs exactly λ times.

A $C(n, n, 1)$ design is a solution of the famous Dudeney's Round Table Problem. It has been conjectured that there exists a $C(n, n, 1)$ design for every n , but the conjecture is not settled.

It is known that there is a $C(n, 4, \lambda)$ design if and only if one of the following holds: 1. n is even, 2. $n \equiv 1 \pmod{4}$ and $\lambda \equiv 0 \pmod{2}$, 3. $n \equiv 3 \pmod{4}$ and $\lambda \equiv 0 \pmod{4}$; and there exists a resolvable $C(n, 4, 1)$ design if and only if $n \equiv 0 \pmod{4}$.

In this talk, we will show that there exists a $C(n, n; 4, \lambda)$ design if and only if one of the following holds: 1. n is even, 2. n is odd and λ is even; and there exists a resolvable $C(n, n; 4, 1)$ design if and only if n is even.

4.12. Pairs of decompositions into lists of cycles

Barbara Maenhaut (The University of Queensland)
 13:30 Wednesday 29 September 2010 – 24-S603
 Barbara Maenhaut and Ben Smith

Suppose $M = m_1, m_2, \dots, m_s$ and $N = n_1, n_2, \dots, n_t$ are arbitrary lists of positive integers. In this talk I will present necessary and sufficient conditions on M and N for the existence of a simple graph whose edge-set can be partitioned into s cycles of lengths m_1, m_2, \dots, m_s and also into t cycles of lengths n_1, n_2, \dots, n_t .

4.13. Subgraphs of random graphs with specified degrees

Brendan McKay (Australian National University)
 15:30 Monday 27 September 2010 – 24-S603
 Brendan McKay

If a graph is chosen uniformly at random from all the graphs with a given degree sequence, what can be said about its subgraphs? The same can be asked of bipartite graphs, equivalently 0–1 matrices. These questions have been studied by many people. In this paper we provide a partial survey of the field, with emphasis on two general techniques: the method of switchings and the multi-dimensional saddle-point method.

4.14. Using generating functions to count closed walks

Marsha Minchenko (Monash University)
 16:30 Tuesday 28 September 2010 – 24-S603
 Marsha Minchenko

The goal here is to present an alternative approach to counting all closed walks in connected regular graphs. Thus, given such a graph, G , we look at extending a set of base walks to the set of all closed walks of G . These chosen base walks and the types of extensions will be described. But more importantly, we explain the use of generating functions to give all closed walks that are extensions of a given closed walk; and explain why this helps reach the desired goal.

4.15. Minkowski sums of lattice polytopes and their normality

Shoetsu Ogata (Tohoku University)
 15:00 Tuesday 28 September 2010 – 24-S603
 Shoetsu Ogata

We prove that if a lattice polytope of dimension three is a Minkowski sum of two lattice polytopes of dimension three then it is normal. As an application, we show that an ample line bundle on a nonsingular toric 3-fold whose anti-canonical map is generically finite is normally generated.

4.16. On graph with cyclic defect or excess

Guillermo Pineda-Villavicencio (University of Ballarat)
 17:30 Tuesday 28 September 2010 – 24-S603
 Charles Delorme and Guillermo Pineda-Villavicencio

The Moore bound constitutes both an upper bound on the order of a graph of maximum degree d and diameter $D = k$ and a lower bound on the order of a graph of minimum degree d and odd girth $g = 2k + 1$.

Graphs missing or exceeding the Moore bound by ϵ are called *graphs with defect or excess* ϵ , respectively.

Regular graphs with defect ϵ satisfy the equation $G_{d,D}(A) = J_n + B$, and regular graphs with excess ϵ satisfy the equation $G_{d,\lfloor g/2 \rfloor}(A) = J_n - B$, where A denotes the adjacency matrix of the graph in question, n its order, J_n the $n \times n$ matrix whose entries are all 1's, B a matrix with the row and column sums equal to ϵ , and $G_{d,k}(x)$ a polynomial with integer coefficients such that the matrix $G_{d,k}(A)$ gives the number of paths of length at most k joining each pair of vertices in the graph. For *Moore graphs* (graphs with $\epsilon = 0$), the matrix B is the null matrix. For graphs with defect or excess 1, B can be considered as the adjacency matrix of a matching with n vertices, while for graphs with defect or excess 2, B can be assumed to be the adjacency matrix of a union of vertex-disjoint cycles.

Graphs with defect 1 do not exist for any degree ≥ 3 and diameter ≥ 2 , while graphs with excess 1 do not exist for any degree ≥ 3 and odd girth ≥ 5 . However, graphs with defect or excess 2 represents a wide unexplored area.

Graphs with defect or excess 2 having the adjacency matrix of a cycle of order n as the matrix B are called *graphs with cyclic defect or excess*; these graphs are the subject of our attention in this paper.

We obtain the following results about graphs with cyclic defect or excess. We prove the non-existence of infinitely many such graphs, for example, graphs of any degree ≥ 3 , diameter 3 or 4 and cyclic defect; and graphs of degree $\equiv 0, 2 \pmod{3}$, girth 7 and cyclic excess. As the highlight of the paper we provide the asymptotic upper bound of $O(\frac{64}{3}d^{3/2})$ for the number of graphs of odd degree $d \geq 3$ and cyclic defect or excess. This bound is in fact quite generous, and as a way of illustration, we also show that there are no graphs of degree 3 or 7, for diameter ≥ 3 and cyclic defect or for odd girth ≥ 5 and cyclic excess, nor graphs of odd degree ≥ 3 , girth 5 or 9 and cyclic excess.

Actually, we conjecture that, apart from the Möbius ladder on 8 vertices, no non-trivial graph of any degree ≥ 3 and cyclic defect or excess exists.

To obtain our results we rely on algebraic methods, for instance, on the connection between the polynomial $G_{d,k}(x)$ and the classical Chebyshev polynomials, on eigenvalues techniques and on elements of algebraic number theory.

4.17. Some results on the α -size of trees

Leanne Rylands (University of Western Sydney)

18:00 Monday 27 September 2010 – 24-S603

Gunnar Brinkmann, Simon Crevals, Hadrien Mélot, Leanne Rylands and Eckhard Steffen

Let $T = (V, E)$ be a tree with $n = |V|$. A *labeling* of T is a bijection f from V to the set $\{0, 1, \dots, n-1\}$.

A tree can be considered as a bipartite graph with parts A and B . If there exists an integer k such that for each edge $\{x, y\}$ of T either $f(x) \leq k < f(y)$ or $f(y) \leq k < f(x)$ then the labeling is bipartite. The induced label on each edge $\{x, y\}$ is $|f(x) - f(y)|$. If the resulting edge labels are distinct, then the labeling is said to be *graceful*. This notion was introduced by A. Rosa in 1967.

A graceful labeling that is bipartite is an α -labeling. There are examples of trees that do not have an α -labeling, but in general not much is known about which trees do not have such a labeling. The α -size of a tree T is the maximum number of distinct edge labels over all bipartite labelings of T .

Some new results about the α -size of trees will be presented.

4.18. Binomial models of random bipartite graphs

Fiona Skerman (Australian National University)

16:30 Monday 27 September 2010 – 24-S603

Fiona Skerman and Brendan McKay

We show that the joint distribution of the degrees of a random bipartite graph can be accurately approximated by several simpler models derived from a set of independent binomial distributions. On the one hand we consider the distribution of degree sequences of random bipartite graphs with $m + n$ vertices and N edges. For a wide range of values of m, n, N , this distribution is almost everywhere in close correspondence with the conditional distribution $\{(X_1, \dots, X_m, Y_1, \dots, Y_n) \mid \sum_j X_j = \sum_k Y_k\}$ where X_1, \dots, X_m are independent binomials in (n, p) and the Y_1, \dots, Y_n are independent binomials in (m, p) .

We also consider random bipartite graphs where the degree sequence for one side has been fixed. In this model, the distribution of the degree sequence for the remaining vertices can be approximated by $\{(Y_1, \dots, Y_n) \mid \sum_k Y_k = N\}$, where N is the sum of the m fixed degrees and the Y_k are independent random variables having the distribution $\text{Binom}(m, p)$.

Furthermore consider random bipartite graphs with $m + n$ vertices and edge probability p . For a wide range of functions $p = p(n)$, the distribution of the degree sequence can be approximated by $\{(X_1, \dots, X_m, Y_1, \dots, Y_n) \mid \sum_j X_j = \sum_k Y_k\}$, where $X_1, \dots, X_m, Y_1, \dots, Y_n$ are independent random variables with each X_k having the distribution $\text{Binom}(n, p')$ and each Y_k having a distribution $\text{Binom}(m, p')$, where p' is itself a random variable with a particular truncated normal distribution.

To facilitate computations, we demonstrate techniques by which statistics in the random graph models can be inferred from those in the independent binomial models described above. Where

they apply, the accuracy of our method is sufficient to determine asymptotically all probabilities greater than n^{-k} for any fixed k . This extends work done by Wormald and McKay on the degree sequence of ordinary random graphs.

4.19. Near-automorphisms of Latin squares

Douglas Stones (Monash University)

14:30 Thursday 30 September 2010 – 24-S603

Douglas Stones

If a Latin square L contains a 2×2 subsquare M , then M can be replaced by the other 2×2 Latin square on the same symbol set as M to generate a distinct Latin square L' . This process is called turning an intercalate. In some cases, L' is isomorphic to L — this is equivalent to finding a near-automorphism. We will discuss the existence question for near-automorphisms.

4.20. Eulerian quasigroups and neighbour-balanced designs

Ian Wanless (Monash University)

14:00 Thursday 30 September 2010 – 24-S603

Ian Wanless

I will discuss some interesting combinatorial problems arising from a marine biology experiment. The experimenter wanted a circular sequence that was balanced for neighbours at distance one and distance two. In other words, in the sequence every ordered pair (a, b) occurs once consecutively, and also once with one intermediate symbol. Variants where the pairs are unordered will be considered, as will the two cases where you either allow or forbid pairs with $a = b$.

One of these variations is equivalent to an “Eulerian quasigroup”, in which repeated application of the quasigroup operation causes you to tour the entire Cayley table before returning to your starting point. It turns out that Eulerian quasigroups of odd order can easily be created by permuting the symbols of cyclic groups. However, no Eulerian quasigroup can be created by permuting any group of even order, and I will explain why. Despite this obstacle, many Eulerian quasigroups of even order do exist.

5. Computational Mathematics

5.1. EDEM: analysis and implementation of a solution method for PDEs

Jorge Aarao (University of South Australia)
13:30 Thursday 30 September 2010 – 1-E303
Jorge Aarao

An eigenfunction-based method for solving elliptic partial differential equations in bounded domains with complicated boundaries is discussed. The presentation includes an analysis of viability, a discussion of illposedness, numerical stability and regularisation and examples of applications.

5.2. Product integration solution of singular system of Volterra integral equations

Ali Badamchizadeh (University of Tabriz)
17:00 Tuesday 28 September 2010 – 1-E303
B. Babayar Razligi, K. Ivaz, M.R. Mokhtarzadeh and A. Badamchizadeh

We describe the development of product integration technique for which error analysis can be proven for a large class of weakly singular system of Volterra integral equations. Sufficient condition for convergence of the this method are given and their applicability is illustrated with an example of heat conduction problem.

5.3. Error bounds of regularisation techniques based on variable Hilbert scales

Markus Hegland (Australian National University)
14:00 Tuesday 28 September 2010 – 1-E303
Markus Hegland

In my talk I will discuss error bounds based on range inclusions using variable Hilbert scales for general index functions. I will also present some related formulae for the modulus of continuity of linear operators with non-closed range and discuss connections to related results by Mathe and Pereverzyev.

As an application of this theory I will consider spectral sharpening where explicit range inclusions are known.

The talk is partly based on joint research with B. Hofmann, Chemnitz and Bob Anderssen, CISIRO

5.4. Newton-product integration for a two-phase Stefan problem with kinetics

Karim Ivaz (University of Tabriz)
16:30 Tuesday 28 September 2010 – 1-E303
K. Ivaz, B. Babayar Razlighi and A. Badamchizadeh

We reduce the two phase Stefan problem with kinetic to a system of nonlinear Volterra integral equations of second kind and apply Newton's

method to linearize it. We found product integration solution of the linear form. Sufficient conditions for convergence of the numerical method are given and their applicability is illustrated with an example.

5.5. From the Hu–Washizu formulation to the average nodal strain formulation

Bishnu Lamichhane (University of Newcastle)
15:00 Thursday 30 September 2010 – 1-E303
Bishnu Lamichhane

We present a stabilized finite element method for the Hu–Washizu formulation of linear elasticity based on simplicial meshes leading to the stabilized nodal strain formulation or node-based uniform strain elements. We show that the finite element approximation converges uniformly to the exact solution for the nearly incompressible case.

5.6. Sparse grid quadrature on products of spheres

Paul Leopardi (Australian National University)
15:30 Tuesday 28 September 2010 – 1-E303
Markus Hegland and Paul Leopardi

In 2007, Hesse, Kuo and Sloan described a component-by-component construction for quasi-Monte Carlo quadrature on weighted tensor product function spaces based on products of spheres. We adapt the Weighted Tensor Product sparse grid quadrature methods of Wasilkowski and Woźniakowski (1999) to this setting and examine the initial and asymptotic rates of convergence of the quadrature error, comparing these with the rates achieved by the Hesse, Kuo and Sloan quadrature method.

5.7. A new analytical solution for testing debris avalanche numerical models in the standard Cartesian coordinate system

Sudi Mungkasi (Australian National University)
15:00 Tuesday 28 September 2010 – 1-E303
Sudi Mungkasi and Stephen Gwyn Roberts

An analytical solution to a debris avalanche problem in the topography-linked coordinate system has been found by Mangeney, Heinrich, and Roche [“Analytical solution for testing debris avalanche numerical models”, *Pure and Applied Geophysics*, 157:1081-1096, 2000]. In this talk, we extend the presentation of Mangeney et al. We derive a new analytical solution to a debris avalanche problem in the standard Cartesian coordinate system. A characteristic method and a transformation technique are used to obtain the analytical solution. This analytical solution is used to test two numerical methods for solving the Saint-Venant model.

The numerical methods are finite volume methods with reconstruction of the conserved quantities based on: either stage, height, and velocity; or stage, height, and momentum. Comparison between the analytical and numerical solutions shows that the finite volume method with reconstruction based on stage, height, and momentum is more accurate, that is, leading to smaller error in solving the debris avalanche problem.

5.8. Laplace transform solution of a diffusion equation with mixed derivative term

Ravindran Ramalingam (National Institute of Technology, Trichy)

14:00 Thursday 30 September 2010 – 1-E303
E. Momoniat and R. Ravindran

We consider a diffusion equation with a mixed derivative term modelling the transient flow of a second grade fluid. The same diffusion equation with a mixed derivative term also comes up in the modelling of heat conduction in which the history of the temperature gradient is included. The equations differ in the sign of the coefficient of the mixed derivative term. We show that the method of lines solution is stable for the transient flow of a second grade fluid and unstable for heat conduction with the temperature gradient history included. A Laplace transform solution for the heat conduction case is then investigated. The Laplace transform solution is inverted numerically using a Fourier based method. A stable solution is obtained. The solutions are compared and discussed.

5.9. Turbulent flow in plasma physics

Linda Stals (Australian National University)
14:30 Thursday 30 September 2010 – 1-E303
Linda Stals

To design or predict the behaviour of turbulent flows we need data sets for ranges of tunable parameters of practical interest. For these purposes the ability to compute prolonged time series is essential. In previous work we analysed several multistep numerical method that allowed long time steps without polluting the results with numerical instabilities. We have implemented an implicit-explicit BDF method in Fortran90.

An important step in the implementation process is validation of the results. The behaviour of the turbulent flow is highly nonlinear and is hard to predict, except for a small trivial choice of parameters.

We present a centre manifold based analysis of the nonlinear equations. Such analysis is not only beneficial for validating the code (in a wide range of parameters), it also helps us to better understand the physical properties of the turbulent flow.

For example, it highlights which frequency components most influence the flow.

5.10. Densities of uniform random walks on the plane

James Wan (University of Newcastle)

14:30 Tuesday 28 September 2010 – 1-E303

James Wan

Over 100 years ago, Karl Pearson asked for the probability density of a uniform random walk on the plane after n steps. It turns out the behaviour for a small number of steps is quite different from, and more interesting than, the behaviour after a large number of steps.

Though little progress had been made on this problem, we will highlight some recently discovered features of small-step densities, with particular focus on closed forms for $n = 3$ and 4. We will also attempt to illustrate the benefits of mathematics by experimentation which made much of this work possible.

This will be related to J. Borwein's plenary talk.

6. Control Theory

6.1. Adaptive mesh refinement and inexact restoration method to solve optimal control problems

Nahid Banihashemi (University of South Australia)

16:00 Monday 27 September 2010 – 1-E232

Nahid Banihashemi

A new algorithm involving a recent optimization technique, called the Inexact Restoration (IR) method, as applied to Euler discretization of unconstrained optimal control problem with free, as well as fixed, terminal state variables is presented. We describe an approach, called the adaptive mesh refinement (AMR) algorithm, which manages the discretization mesh from coarse to fine using flexible features of the IR method in each iteration, so the significant computational saving can be achieved. Finally, we illustrate the AMR algorithm on example optimal control problems.

6.2. Function space and discretization methods in optimal control: Theory and applications

Matthias Gerdts (University of Würzburg)

13:30 Wednesday 29 September 2010 – 1-E232

Matthias Gerdts

The talk provides an overview on numerical methods for solving optimal control problems governed by ordinary differential equations or differential-algebraic equations, mixed control-state constraints and pure state constraints. The first part of the talk is concerned with two different approaches for the numerical solution of such optimal control problems: the direct discretization approach and a semismooth Newton method, which is a function space method.

The direct discretization approach transforms the optimal control problem into a nonlinear program which is solved by an SQP method and turns out to be very powerful in practice. Especially the treatment of sparse large-scale nonlinear programs, which frequently result from discretized PDE constrained problems, is challenging and requires tailored methods to deal with sparsity and high dimensions. The semismooth Newton method is a version of Newton's method for nonlinear equations and aims at satisfying the first order necessary optimality conditions of the optimal control problem using a nonlinear complementarity function. It is challenging from a theoretic viewpoint, but it shows good convergence properties and turns out to be particularly well-suited for problems with mixed control-state constraints. Moreover, it will be briefly shown how the previously discussed methods can be extended towards mixed-integer optimal control problems. Finally,

applications from mechanics and space engineering will be presented and experiences with an automatically driven prototype car will be reported.

6.3. Optimal train control

Phil Howlett (University of South Australia)

17:00 Monday 27 September 2010 – 1-E232

Phil Howlett, Peter Pudney, Amie Albrecht, Xuan Vu

It is well known that the optimal driving strategy for a train takes the form of a *power-hold-coast-brake* strategy unless the track contains steep grades. In such cases the predominant *speedhold* mode must be interrupted by phases of *maximum power* on steep uphill sections and phases of *coast* on steep downhill sections. Although *Freightmiser* uses a fast and efficient numerical algorithm to solve a key local energy minimization problem to find the optimal switching points there is no direct proof that the numerical algorithm converges to uniquely determined optimal solution. We propose an extended perturbation analysis to discuss this problem and find suitable sufficient uniqueness conditions.

6.4. Numerical methods for multi-objective control

Yalcin Kaya (University of South Australia)

16:30 Monday 27 September 2010 – 1-E232

C. Yalcin Kaya and Henri Bonnel

We consider multi-objective convex optimal control problems. We establish that the set of all parametric solutions (obtained by solving the scalarized problem) is equal to the efficient set. Next we consider an additional objective over the efficient set. Based on the main result, the new objective can instead be considered over the (parametric) solution set of the scalarized problem. For constructing numerical methods, we point to solution differentiability results for parametric optimal control problems. We propose numerical methods and give an example application as illustration.

6.5. Optimal control problems with state-dependent stopping criteria

Ryan Loxton (Curtin University of Technology)

17:30 Monday 27 September 2010 – 1-E232

Ryan Loxton

In this talk, we consider an optimal control problem whose terminal time is governed by a stopping criterion. This stopping criterion is defined by a smooth surface in the state space; when the state trajectory hits this surface, the system

stops. We first derive an approximate optimization problem by restricting the admissible controls to piecewise constant functions whose values and switching times are decision variables to be determined optimally. We then show that a solution of this approximate problem can be obtained indirectly by solving a much easier equivalent problem. We discuss how this equivalent problem can be solved using standard nonlinear programming techniques. Finally, we give some results from using our new method to solve a difficult problem in aeronautics.

6.6. Computational optimal well path design

Volker Rehbock (Curtin University of Technology)

14:30 Wednesday 29 September 2010 – 1-E232

V. Rehbock and D. Prince

Wells are drilled into oil and gas reservoirs to drain hydrocarbons, and also to inject fluids for supporting reservoir pressure or enhanced oil recovery methods. The drilling of wells is costly, and the path of a well needs to be planned carefully before the actual drilling process commences. In a typical drilling operation, the steering mechanism is only adjusted at a finite number of time points during the operation. Consequently, the resulting well path consists of a sequence of sections which are either straight lines or circular arcs. A well path must be chosen to avoid a range of obstacles (other wells, for example) and often points are specified (in the reservoir) which the path must pass through or terminate at. We devise an optimal control model to solve the well path design problem and look at the various objective criteria that should be minimized.

6.7. Synthesis of optimal control for collision avoidance in a close proximity encounter

Tanya Tarnopolskaya (CSIRO)

15:30 Monday 27 September 2010 – 1-E232

T. Tarnopolskaya and N. Fulton

Close proximity encounters (i.e., when the participants are sufficiently close in space and time to be of operational concern) can occur in many situations in aviation, navigation and robotics. The problem of collision avoidance in a close proximity encounter is a continuous optimal control problem characterised by a free terminal time, a three-dimensional state vector, a two-dimensional control vector, a terminal cost objective function and inequality constraint on the function of the state variables.

The focus of this work is on development of analytic and semi-analytic synthesis of optimal control solutions. The non-dimensional problem includes two parameters: ω (the ratio of the maximum turn rates of the participants) and γ (the ratio of the linear speeds of the participants). We

study two special cases of the problem: 1) any ω , $\gamma = 1$ (i.e., the case of participants with unequal turn capabilities) and 2) $\omega = 1$, any γ (the case of participants with unequal linear speeds). The necessary conditions for the existence of non-singular optimal controls near the terminal time are derived, based on the Pontryagin maximum principle. The synthesis of optimal control is constructed based on the analysis of the properties of the extremals. We show that the optimal solutions for each of the two cases have their distinctive features. The classical case of identical participants is a degenerate case of these more general solutions.

7. Dynamical Systems

7.1. Bodies in Space: How to turn without angular momentum

Holger Dullin (University of Sydney)

14:00 Tuesday 28 September 2010 – 5-207

Holger Dullin

The Hamiltonian dynamics of non-rigid bodies is naturally described using the bundle structure of configuration space as shape space (base) and orientation (fibre). The shape dynamics drives the orientation, and this is the mechanism by which orientation change is possible without angular momentum in a shape changing system. Orientation change is split into a dynamics phase proportional to angular momentum and geometric phase which only depends on the loop in shape space. I will present applications of these ideas to the aerial motion of athletes, in particular in trampolining and diving.

7.2. Coherent sets for time-dependent dynamical systems with geophysical applications

Gary Froyland (University of New South Wales)

15:30 Monday 27 September 2010 – 5-207

Gary Froyland, Simon Lloyd, Naratip

Santitissadeekorn

We describe a mathematical formalism and numerical algorithms for identifying and tracking slowly mixing objects in time-dependent dynamical systems. In the autonomous setting, such objects are variously known as almost-invariant sets, metastable sets, persistent patterns, or strange eigenmodes, and have proved to be important in a variety of applications. We explain how to extend existing autonomous approaches to the nonautonomous setting. We call these time-dependent, slowly mixing objects “coherent sets” as they represent regions of phase space that disperse very slowly and remain coherent. We illustrate the new methods of analysis on oceanic and atmospheric data.

7.3. Coupled nonlinear oscillators in atom optics

Cathy Holmes (The University of Queensland)

17:00 Monday 27 September 2010 – 5-207

Cathy Holmes

Central to the dynamics of coupled nonlinear oscillators is the question of synchronisation. Synchronisation often results in systems with sufficiently strong all to all coupling. It is known that the motion of two atoms trapped in a single mode

cavity field, which effectively couples them together, synchronise at the same amplitude. However an analysis of approximate amplitude equations for the n atom case reveals that the result does not generalise.

7.4. Okamoto's space for the first Painlevé equation in Boutroux coordinates

Nalini Joshi (University of Sydney)

16:30 Monday 27 September 2010 – 5-207

Nalini Joshi

We consider all possible asymptotic behaviours of the first Painlevé equation in Okamoto's space, i.e., the space of initial values compactified and regularized by embedding in \mathbb{CP}^2 . We give explicit formulas for each coordinate transformation to Okamoto's space starting with Boutroux's coordinates and analyse completely the complex analytic dynamics of solutions of the resulting Painlevé–Boutroux system in this space.

7.5. Orbit structure and orbit length of toral endomorphisms

Natascha Neumaerker (University of New South Wales)

14:30 Tuesday 28 September 2010 – 5-207

Natascha Neumaerker, Michael Baake, John Roberts

Periodic orbits of toral automorphisms have been studied for more than 30 years, Arnold's cat map being the most prominent example. Many investigations focus on the 2-torus, making largely use of number theoretic methods. But also in other mathematical fields, much work has been done on related questions which has not been fully exploited in the context of toral automorphisms so far. In this talk, I will give an overview of some standard results on the orbit structure of toral automorphisms on the rational lattices and show how algebraic and dynamical concepts like reversibility can be used to explain some of the observations made in concrete systems. I generalise some of the known results to both higher dimensions and to the case of general toral endomorphisms.

7.6. Poisson structures for difference equations

John Roberts (University of New South Wales)
 17:30 Tuesday 28 September 2010 – 5-207
 John Roberts

We investigate the existence of Poisson structures for ordinary difference equations, equivalently for the related map associated with such a difference equation. The existence of such structures reduces to a system of bilinear equations relating the map and the structure. We discuss the solution for the map given the Poisson structure and for the Poisson structure given the map. A motivation for us is the special case of difference equations derived from reductions of integrable lattice equations, for which we want to know nondegenerate Poisson structures, i.e. symplectic structures.

7.7. On Ermakov structure in 2+1-dimensional magnetogasdynamics

Colin Rogers (University of New South Wales)
 15:30 Tuesday 28 September 2010 – 5-207
 Colin Rogers

An elliptic vortex type ansatz introduced into a $2 + 1$ -dimensional system governing rotating homentropic magnetogasdynamics with a parabolic constitutive law is shown to lead to an eight-dimensional nonlinear dynamical system which admits exact analytical solution in terms of an elliptic integral representation. A novel magnetogasdynamic analogue of the pulsodion of shallow water f -plane theory is isolated thereby. In the case of a purely transverse magnetic field, the general dynamical systems shown to have underlying Hamiltonian structure of Ermakov type.

7.8. Escape in random dynamical systems

Ognjen Stancevic (University of New South Wales)
 16:00 Monday 27 September 2010 – 5-207
 Ognjen Stancevic and Gary Froyland

In this talk I will present an introduction to open dynamical systems and escape rate followed by the natural generalisation to random dynamical systems. Our main result links escape rates of certain sets to Lyapunov exponents of the Perron–Frobenius cocycle.

7.9. On a stability result for a system

Bevan Thompson (The University of Queensland)
 17:30 Monday 27 September 2010 – 5-207
 Jayne Thompson, Bevan Thompson and Michal Feřkan

We establish stability and instability results for a domain wall brane model arising in classical field theory. In particular, we show the nonexistence of nontrivial bounded solutions on the real line for a coupled pair of parameter dependent linear second order ordinary differential equations for an open

set of those parameters. Moreover we establish the existence of nontrivial solutions for a hypersurface of the parameters. We use Fredholm theory for compact linear operators combined with the Lyapunov–Schmidt method to prove our results. The model is stable, respectively unstable, for those parameters for which the coupled system does not, respectively does, have nontrivial solutions.

7.10. Complete integrability of reductions of lattice equations II

Thi Dinh Tran (La Trobe University)
 17:00 Tuesday 28 September 2010 – 5-207
 Thi Dinh Tran

To prove the complete integrability (in the sense of Arnold–Liouville) of a mapping one needs:

- (1) the map to be symplectic
- (2) sufficiently many integrals (half its dimension)
- (3) their involutivity
- (4) functional independence.

An overview will be given of recent results on the complete integrability of reductions of various integrable lattice equations in the first part followed by some more details in the second part.

7.11. Complete integrability of reductions of lattice equations I

Pieter van der Kamp (La Trobe University)
 16:30 Tuesday 28 September 2010 – 5-207
 Peter H. van der Kamp

To prove the complete integrability (in the sense of Arnold–Liouville) of a mapping one needs:

- (1) the map to be symplectic
- (2) sufficiently many integrals (half its dimension)
- (3) their involutivity
- (4) functional independence.

An overview will be given of recent results on the complete integrability of reductions of various integrable lattice equations in the first part followed by some more details in the second part.

7.12. Topological dynamics of Cournot duopoly

Guo Hua Zhang (University of New South Wales)
 15:00 Tuesday 28 September 2010 – 5-207
 Guo Hua Zhang

Recently, the Cournot duopoly model has been studied in the literature from many different points of view. In this talk, we shall introduce some recent results about it from the viewpoint of topological dynamics. In particular, we shall give a complete description of the dynamics of a locally Cournot model in dimension four.

8. Financial Mathematics

8.1. Asymptotic behavior of the optimal exercise price of American puts near expiry under stochastic volatility

Wen-Ting Chen (University of Wollongong)

15:00 Tuesday 28 September 2010 – 3-309

Song-Ping Zhu, Wen-Ting Chen

The behavior of the optimal exercise price of American puts near expiry has been well studied under the Black-Scholes model as a result of a series of publications. However, the behavior of the optimal exercise price under a stochastic volatility model, such as the Heston (1993) model, has not been reported at all. Adopting the method of matched asymptotic expansions, this paper addresses the asymptotic behavior of American put options on a dividend-paying underlying with stochastic volatility near expiry. Through our analyses, we are able to show that the option price will be quite different from that evaluated under the Black-Scholes model, while the leading order term of optimal exercise price remains almost the same as the constant volatility case if the spot volatility is given the same value as the constant volatility in the Black-Scholes model. Results from numerical experiments also suggest that our analytic formulae derived from the asymptotic analysis are quite reasonable approximations for options with remaining time to expiry in the order of days or weeks.

8.2. Changes of measure for the square-root stochastic volatility process

Daniel Dufresne (The University of Melbourne)

17:30 Tuesday 28 September 2010 – 3-309

Stephen Chin, Daniel Dufresne

In financial mathematics, many have come to consider that the volatility of stocks varies “randomly”. The square-root process is a well-known model for this stochastic volatility. We study this process and its time integral as they occur in pricing options in stochastic volatility models. An explicit measure change formula for the square-root process is used to price European options. Numerical results show that the measure-change approach and Andersen’s quadratic exponential (QE) scheme perform similarly. We also examine the numerical behaviour of the Radon–Nikodym derivative.

8.3. Multiplayer Game Options.

Ivan Guo (University of Sydney)

17:00 Tuesday 28 September 2010 – 3-309

Ivan Guo

A European style multiplayer game option is a contract involving more than two players, where each player has the right to exercise at a fixed time for a predetermined payoff. We present a specific formulation which generalises notions from the two player game option. As a game, a unique solution can be determined by the construction of a Nash equilibrium, expressed as the projection onto the a simplex in a zero-sum coordinate. As a derivative of underlyings (under complete market, arbitrage free assumptions), the equilibrium solution is also the value of the option by super hedging arguments.

8.4. Volatility in the Black–Scholes and other formulae

Kais Hamza (Monash University)

15:30 Tuesday 28 September 2010 – 3-309

Kais Hamza and Fima Klebaner

The Black–Scholes formula has been derived under the assumption of constant volatility in stocks. In spite of evidence that this parameter is not constant, this formula is widely used by the markets. In this paper, we further refine our earlier results on the nonexistence of non-constant volatility models for which the Black–Scholes or similar formulae hold true.

8.5. The constant elasticity of variance model with stochastic volatility

Jeong Hoon Kim (University of Wollongong)

16:30 Tuesday 28 September 2010 – 3-309

Jeong Hoon Kim

In this talks, we consider an option pricing problem based upon the extended CEV model with stochastic volatility. Assuming the stochastic volatility has fast mean reversion, we use asymptotic method to derive the pricing PDEs for both the leading order term and the first correction term of the extended option price. Some calibration results are also shown numerically.

8.6. Real world pricing of long term contracts

Eckhard Platen (University of Technology, Sydney)

14:00 Tuesday 28 September 2010 – 3-309

Eckhard Platen

Long dated contingent claims are relevant in insurance, pension fund management and derivative pricing. This paper proposes a paradigm shift in the valuation of long term contracts, away from classical no-arbitrage pricing towards pricing under the real world probability measure. In contrast to risk neutral pricing, the long term excess return of the equity market, known as the equity premium, is taken into account. Further, instead of the savings account, the numeraire portfolio is used, as the fundamental unit of value in the analysis. The numeraire portfolio is the strictly positive, tradable portfolio that when used as benchmark makes all benchmarked nonnegative portfolios supermartingales, which means intuitively that these are downward trending or at least trendless. Furthermore, the benchmarked real world price of a benchmarked claim is defined to be its real world conditional expectation. This yields the minimal possible price for its hedgable part and minimizes the variance of the benchmarked hedge error. The pooled total benchmarked replication error of a large insurance company or bank essentially vanishes due to diversification. Interestingly, in long term liability and asset valuation, real world pricing can lead to significantly lower prices than suggested by classical no-arbitrage arguments. Moreover, since the existence of some equivalent risk neutral probability measure is no longer required, a wider and more realistic modeling framework is available for exploration. Classical actuarial and risk neutral pricing emerge as special cases of real world pricing.

9. Geometric Analysis

9.1. On the non-commutative Kirillov formula

Anthony Dooley (University of New South Wales)

14:30 Tuesday 28 September 2010 – 14-116

Anthony Dooley

The Kirillov orbit method associates to a coadjoint orbit of a Lie group G an irreducible representation of the group. One can calculate the character of this representation from the Fourier transform of that orbit. However, if one starts not from the character, but from a general matrix entry, the Fourier transform is an interesting distribution on the Lie algebra. We can say a lot about the distributions which arise, their support, singular support and their convolutions. This work is based on the thesis of Raed Raffoul.

9.2. Some properties of wave maps on 2+1-dimensional Minkowski space

Jörg Frauendiener (University of Otago)

15:00 Thursday 30 September 2010 – 14-116

J. Frauendiener

Wave maps are analogues of harmonic maps for Lorentzian manifolds. They provide simple examples for systems of non-linear wave equations and have therefore been studied thoroughly. In this talk the critical case of a wave map on 2 + 1-dimensional Minkowski space will be discussed and some numerical studies will be presented. An application to general relativity will be indicated.

9.3. Projective BGG equations, algebraic sets, and compactifications of Einstein geometries

Rod Gover (The University of Auckland)

15:30 Thursday 30 September 2010 – 14-116

A. Cap, A. R. Gover, M. Hammerl

For curved projective manifolds we introduce a notion of a normal tractor frame field, based around any point. This leads to canonical systems of (redundant) coordinates that generalise the usual homogeneous coordinates on projective space. These give preferred local maps to the model projective space that encode geometric contact with the model to a level that is optimal, in a suitable sense. In terms of the trivialisations arising from the special frames, normal solutions of classes of natural linear PDE (so-called first BGG equations) are shown to be necessarily polynomial in the generalised homogeneous coordinates; the polynomial system is the pull back of a polynomial system that solves the corresponding problem on the model. Thus questions concerning the zero locus of solutions, as well as related finer geometric and smooth data, are reduced to a study of the corresponding polynomial systems and algebraic

sets. We show that a normal solution determines a canonical manifold stratification that reflects an orbit decomposition of the model. Applications include the construction of new structures that are analogues of Poincaré–Einstein manifolds.

9.4. Families of superintegrable systems with higher order symmetries

Jonathan Kress (University of New South Wales)

17:00 Monday 27 September 2010 – 14-116

Jonathan Kress

An integrable n -dimensional Hamiltonian system possessing $2n - 1$ functionally independent constants of the motion is said to be superintegrable. Constants of the motion that are quadratic in the momenta are associated with coordinates that separate the Hamilton–Jacobi equation and have been extensively studied. In this talk I will discuss some recently uncovered families of superintegrable systems possessing higher order constants of the motion. The Jacobi metric formalism relates these systems to manifolds possessing $2n - 1$ independent Killing tensors, including some non-trivial Killing tensors of rank greater than 2. The methods discussed allow the explicit construction of these higher rank Killing tensors.

9.5. Recent developments in Oka theory

Finnur Larusson (University of Adelaide)

15:30 Monday 27 September 2010 – 14-116

Finnur Larusson

Oka theory has its roots in the classical Oka principle in complex analysis and has emerged as a subfield of complex geometry in its own right since the appearance of a seminal paper of M. Gromov in 1989. Oka theory takes place in the recently-defined category of Oka manifolds and Oka maps. I will describe this category. Then I will discuss a few results in Oka theory proved in the past year or two by F. Forstneric, F. Kutzschebauch and B. Ivarsson, and myself.

9.6. The ambient metric for n -dimensional pp -waves

Thomas Leistner (University of Adelaide)

14:30 Thursday 30 September 2010 – 14-116

Thomas Leistner

The ambient metric construction was invented by C. Fefferman and R. Graham as a tool to construct invariants for a manifold equipped with a conformal structure. In the construction, the flat case, in which the conformal sphere is given by the projectivised light cone, is generalised to arbitrary curved conformal classes. Fefferman and Graham

showed that the requirement of the ambient metric being Ricci-flat ensures its uniqueness in the cases where it exists. On the other hand, this requirement impedes the explicit construction and, apart from special cases such as conformally Einstein manifolds, only for very few examples the ambient metric can be constructed explicitly. In the talk we introduce the class of Lorentzian pp -waves as an example that is paradigmatic for the construction but, in general, not conformally Einstein. We derive an explicit formula for the ambient metric of a pp -wave and the obstruction to its existence. The talk is based on joint work with P. Nurowski.

9.7. Quasiregular mappings, curvature and dynamics

Gaven Martin (Massey University)

13:30 Wednesday 29 September 2010 – 14-116

Gaven Martin

We survey recent developments in the area of geometric function theory and nonlinear analysis and in particular those that pertain to recent developments linking these areas to dynamics and rigidity theory in dimension $n \geq 3$. A self mapping (endomorphism) of an n -manifold is rational or uniformly quasiregular if it preserves some bounded measurable conformal structure. Because of Rickmans version of Montels theorem there is a close analogy between the dynamics

9.8. Prolongation of partial differential equations on filtered manifolds

Katharina Neusser (Australian National University)

14:00 Thursday 30 September 2010 – 14-116

Katharina Neusser

A filtered manifold is a smooth manifold M , whose tangent bundle TM is endowed with a filtration by subbundles $TM = T^{-k}M \supset \dots \supset T^{-1}M$, which is compatible with the Lie bracket of vector fields. Studying differential operators on M , it turns out that the notion of order of differential operators should be changed by adjusting it to the filtration of the tangent bundle. This leads to a concept of weighted jet bundles, which provides the convenient formal framework to investigate differential equations on filtered manifolds. In this talk we give a brief introduction to weighted jet bundles and study the problem of prolongation of differential equations on filtered manifolds by working within the setting of weighted jet bundles.

9.9. Conformal relatives of Lie groups

Yuri Nikolayevsky (La Trobe University)

14:00 Tuesday 28 September 2010 – 14-116

Yuri Nikolayevsky

A Riemannian manifold is called *curvature homogeneous*, if its curvature tensor at any two points is “the same”, up to a positive multiple. A curvature homogeneous manifold is *modelled on a homogeneous space* M_0 , if its curvature tensor at every point is “the same” as the curvature tensor of M_0 . In general, even curvature homogeneous manifolds modelled on symmetric spaces can be non-homogeneous. However, a curvature homogeneous manifold modelled on an *irreducible symmetric space* is locally isometric to it (Tricerri, Vanhecke 1986).

Likewise, a Riemannian manifold is called *Weyl homogeneous*, if its Weyl conformal curvature tensor at any two points is “the same”, up to a positive multiple. A Weyl homogeneous manifold is *modelled on a homogeneous space* M_0 , if its Weyl tensor at every point is “the same” as the Weyl tensor of M_0 , up to a positive multiple.

We prove that a Weyl homogeneous manifold M^n , $n \geq 4$, modelled on an irreducible symmetric space M_0 of type II or IV (on a compact simple Lie group with a bi-invariant metric or on its non-compact dual) is conformally equivalent to M_0 .

9.10. Enriched Riemann sphere, Morse stability and equi-singularity in \mathcal{O}_2

Laurentiu Paunescu (University of Sydney)

16:30 Monday 27 September 2010 – 14-116

Tzee-Char Kuo and Laurentiu Paunescu

The *Enriched Riemann Sphere* $\mathbb{C}P_*^1$ is $\mathbb{C}P^1$ plus a set of *infinitesimals*, having coordinates in the Newton-Puiseux field \mathbb{F} . Complex Analysis is extended to the \mathbb{F} -Analysis (*Newton-Puiseux Analysis*). The classical *Morse Stability Theorem* is also extended; the *stability idea* is used to formulate an *equi-singular deformation theorem* in $\mathbb{C}\{x, y\}$ ($= \mathcal{O}_2$).

9.11. Integrating the Vessiot distribution for PDEs

Geoff Prince (AMSI)

16:30 Tuesday 28 September 2010 – 14-116

Geoff Prince

With a PDE comes a Vessiot distribution — a distribution of vector fields on a particular jet bundle. The maximal integrable subdistributions of the Vessiot distribution are tangent to the solution submanifolds. The difficulty is to locate them. I will discuss the interplay of group invariance of PDEs and the integration of the Vessiot distribution.

9.12. Projective to Ricci-flat manifolds

Matthew Randall (Australian National University)
17:00 Tuesday 28 September 2010 – 14-116
Matthew Randall

On a manifold with a fixed projective structure, an overdetermined system of linear partial differential equations determine whether its Ricci tensor vanish in some projective scale. A solution of this projectively invariant Hessian equation is in one-to-one correspondence with a parallel section of the standard co-tractor bundle on the manifold. The speaker shows that the zero locus of this solution determines a totally geodesic hypersurface.

9.13. D-modules and derived loop stacks

John William Rice (University of Sydney)
14:30 Wednesday 29 September 2010 – 14-116
John William Rice

A remarkable analogy has been developed, close and precise, between S^1 -equivariant sheaves on loop spaces and systems of differential equations or D -modules. Applied to geometric representation theory of real and complex lie groups, it reveals a new and more enlightening relationship with the Langlands program and its variants. This talk is a beginning and broad introduction to the ideas behind this analogy, intended to make them less a collection of frightening apparitions from the dark frontiers of algebraic geometry, and more amenable to geometric analysis and representation theory.

9.14. A strong Oka principle for embeddings of Riemann surfaces into $\mathbb{C} \times \mathbb{C}^*$

Tyson Ritter (University of Adelaide)
16:00 Monday 27 September 2010 – 14-116
Tyson Ritter

The *Oka principle* refers to a collection of results in complex analysis which state that there are only topological obstructions to solving certain holomorphically defined problems involving Stein manifolds. For example, a basic version of Gromov's Oka principle states that every continuous map from a Stein manifold into an elliptic manifold is homotopic to a holomorphic map. In this talk I will discuss a new result showing that if we restrict the class of source manifolds to circular domains and fix the target as $\mathbb{C} \times \mathbb{C}^*$ we can obtain a much stronger Oka principle — every continuous map from a circular domain S into $\mathbb{C} \times \mathbb{C}^*$ is homotopic to a proper holomorphic embedding of S into $\mathbb{C} \times \mathbb{C}^*$. This result has close links with the long-standing and difficult problem of finding proper holomorphic embeddings of Riemann surfaces into \mathbb{C}^2 , with additional motivation from other sources.

9.15. Perturbation theorem for joint spectrum of commuting matrices

Jhanjee Sangeeta (Monash University)
15:00 Tuesday 28 September 2010 – 14-116
Jhanjee Sangeeta

The aim of this talk is to present a proof of a perturbation result for joint spectrum of commuting matrices using Elsner's techniques. In fact, it generalizes V.S. Sunder's perturbation result for a single matrix.

9.16. Seiberg–Witten flow

Lorenz Schabrun (The University of Queensland)
17:30 Monday 27 September 2010 – 14-116
Lorenz Schabrun

Computing the Seiberg–Witten invariant for a given 4-manifold involves finding nontrivial solutions to the Seiberg–Witten equations, called monopoles. Therefore, an important problem in Seiberg–Witten theory is the formulation of necessary and/or sufficient conditions for the existence of solutions. One can attempt to elicit information about the moduli space by studying the solutions to the flow equations of the Seiberg–Witten functional.

In this talk, I discuss the global existence of the flow on 4-manifolds, the convergence properties of the flow, and the extension of the global existence result to higher dimensional manifolds.

9.17. Free CR distributions

Gerd Schmalz (University of New England)
13:30 Thursday 30 September 2010 – 14-116
Gerd Schmalz, Jan Slovak

CR manifolds of CR dimension n and codimension n^2 have automatically a uniform geometric structure and therefore possess a canonical Cartan connection. Surprisingly, the underlying CR distribution uniquely determines the CR structure itself, if $n > 1$. This ensures vanishing of most of the curvature. The remaining curvature components are of torsion type and can be interpreted as a partial connection. This is joint work in progress with Jan Slovak (Masaryk University Brno).

9.18. On semi-Hamiltonian systems of hydrodynamic type

Peter Vassiliou (University of Canberra)

15:30 Tuesday 28 September 2010 – 14-116

Peter Vassiliou

Systems of first order quasilinear partial differential equations (PDE) play a central role in continuum physics. They are beginning to play a remarkable role in differential geometry. A special class of such PDE exhibiting interesting geometry, the so called *semi-Hamiltonian systems of hydrodynamic type*, are now being applied to integrable systems theory. The theory of semi-Hamiltonian was discovered by S.P. Tsarev, B.A. Dubrovin and S.P. Novikov and independently by Denis Serre, who called them *Rich systems*. In this talk I will give a brief exposition of semi-Hamiltonian systems and then go on to describe some recent work and outline some open questions.

10. Geometry and Topology

10.1. Homotopy classification of Poincaré duality complexes

Bea Bleile (University of New England)

15:30 Thursday 30 September 2010 – 14-217

Bea Bleile

Using Baues' homotopy systems we show that, up to oriented homotopy, a Poincaré duality complex X of formal dimension n is uniquely determined by its fundamental triple consisting of the $(n-2)$ -type of X , the orientation character and the image of the fundamental class in the homology of the $(n-2)$ -type.

10.2. Is simplifying triangulations as hard as it seems?

Benjamin Burton (The University of Queensland)

14:00 Thursday 30 September 2010 – 14-217

Benjamin A. Burton

Given an arbitrary 3-manifold triangulation, does this triangulation represent the 3-sphere? In theory this problem is difficult to answer: current state-of-the-art algorithms are exponential in the size of the triangulation. However, in practice one can often find a simple answer using fast heuristic techniques.

One such technique is to simplify the triangulation using Pachner moves (also known as bistellar moves): if the triangulation simplifies to a well-known 3-sphere triangulation then the answer is yes. We will discuss algorithmic and combinatorial aspects of simplification, and examine some surprising indications that—contrary to theoretical expectations—simplification may be an extremely effective tool for practical use.

10.3. Constant mean curvature surfaces and Darboux transforms

Emma Carberry (University of Sydney)

13:30 Wednesday 29 September 2010 – 14-217

Emma Carberry, Katrin Leschke and Franz Pedit.

I will discuss constant mean curvature surfaces from several viewpoints, and explain how these different points of view are related. The integrable systems approach stems from considering the classical associated family of constant mean curvature surfaces and leads to a complete description of constant mean curvature tori in terms of a linear flow in an abelian variety. Using a generalisation of the classical Darboux transform, I will give a geometric interpretation of this and explain geometric properties of the transformed surfaces.

10.4. Upper bounds on Reidemeister moves

Alexander Coward (University of California at Davis)

18:00 Monday 27 September 2010 – 14-217

Alexander Coward and Marc Lackenby

Given any two diagrams of the same knot or link, we provide an explicit upper bound on the number of Reidemeister moves required to pass between them in terms of the number of crossings in each diagram. This provides a new and conceptually simple solution to the equivalence problem for knot and links.

10.5. Lattice points in moduli spaces of curves

Norman Do (The University of Melbourne)

14:00 Wednesday 29 September 2010 – 14-217

Norman Do

In how many ways can you obtain a genus g surface by gluing together the edges of a given set of polygons? Norbury interprets this question as counting lattice points in the moduli space of curves and shows that the answer exhibits polynomial behaviour. The top degree and constant terms of these lattice point polynomials are known to store interesting geometric information. On the other hand, the intermediate coefficients remain a complete mystery. In this talk, we'll present some results concerning these polynomials, indicate some interesting connections to other areas, and consider what the intermediate coefficients might mean.

10.6. On free paratopological groups

Ali Elfard (University of Wollongong)

16:30 Monday 27 September 2010 – 14-217

Ali Sayed Elfard and Peter Nickolas

The result often known as Joiner's lemma is fundamental in understanding the topology of the free topological group $F(X)$ on a Tychonoff space X . I will present a detailed proof of Joiner's lemma in case of the free paratopological group $FP(X)$ on a T_1 space X .

10.7. Character formulas

Nora Ganter (The University of Melbourne)
14:00 Tuesday 28 September 2010 – 14-217
Nora Ganter and Arun Ram

Let G be a compact connected Lie group with maximal torus T . The Weyl character formula is the formula describes the character of the induced representation (induced from T to G). For a topologist, the natural point of view on this uses equivariant K-theory. There, the Weyl-formula becomes a well known fixed point formula due to Atiyah and Segal. I will address what happens if one replaces K-theory by elliptic cohomology.

10.8. The linking pairings of orientable Seifert manifolds

Jonathan Hillman (University of Sydney)
14:30 Thursday 30 September 2010 – 14-217
J.A. Hillman

We show that any non-singular linking pairing on a finite abelian group with homogeneous 2-primary summand is the torsion linking pairing of an orientable 3-manifold with a fixed-point free S^1 action. However some pairings on inhomogeneous 2-groups are not realizable by any Seifert fibred 3-manifold.

10.9. Dimensions of totally geodesic subalgebras of filiform nilpotent Lie algebras

Ana Hinić-Galić (La Trobe University)
14:30 Tuesday 28 September 2010 – 14-217
Grant Cairns, Ana Hinić-Galić and Yuri Nikolayevsky

A metric Lie algebra \mathfrak{g} is a Lie algebra equipped with an inner product. A subalgebra \mathfrak{h} of a metric Lie algebra \mathfrak{g} is said to be totally geodesic if the Lie subgroup corresponding to \mathfrak{h} is a totally geodesic submanifold relative to the left-invariant Riemannian metric defined by the inner product, on the simply connected Lie group associated to \mathfrak{g} . A nonzero element of \mathfrak{g} is called a geodesic if it spans a one dimensional totally geodesic subalgebra.

In this talk, we will discuss the possible dimensions of totally geodesic subalgebras of filiform nilpotent Lie algebras.

10.10. On the Kervaire invariant problem

Michael Hopkins (Harvard University)
15:00 Tuesday 28 September 2010 – 14-217
Michael Hopkins

The Kervaire invariant problem is one of the oldest problems in algebraic topology, and originates in the interface of homotopy theory with the theory of manifolds. This is a follow-up of my plenary lecture and will go deeper into the recent solution of the problem by Mike Hill, myself, and Doug Ravenel.

10.11. Blow-analytic equivalence of two variable real analytic function germs

Satoshi Koike (Hyogo University of Teacher Education)
16:00 Monday 27 September 2010 – 14-217
Satoshi Koike and Adam Parusinski

Blow-analytic equivalence is a notion for real analytic function germs, introduced by Tzee-Char Kuo (University of Sydney) in order to develop real analytic equisingularity theory. After he proved some blow-analytic triviality theorem and established a locally finite classification theorem for a family of real analytic function germs with isolated singularities, lots of triviality theorems have been shown and several blow-analytic invariants have been introduced by not only Australian mathematicians but Japanese and European ones. In this talk we give complete characterisations of blow-analytic equivalence in the two dimensional case, in terms of the real tree model for the arrangement of real parts of Newton-Puiseux roots and their Puiseux pairs, and in terms of minimal resolutions. We explain the notions with some concrete examples. These characterisations show that in the two dimensional case the blow-analytic equivalence is a natural analogue of topological equivalence of complex analytic function germs.

10.12. Relatively hyperbolic groups and relatively quasiconvex subgroups

Matthew Kotros (The University of Melbourne)

17:00 Monday 27 September 2010 – 14-217

Matthew Kotros

The notion of a relatively hyperbolic group was originally introduced by Gromov in his 1987 seminal paper ‘Hyperbolic groups’. This paper developed in detail the theory of hyperbolic groups, which are finitely generated groups that exhibit negatively curved (or more precisely, δ -hyperbolic) geometry. Relatively hyperbolic groups are, in a sense, negatively curved away from a collection of peripheral subgroups. They generalise hyperbolic groups and geometrically finite Kleinian groups. Relatively quasiconvex subgroups of relatively hyperbolic groups generalise the notion of quasiconvex subgroups of hyperbolic groups, the theory of which plays a central role in the theory of hyperbolic groups. In this talk, I will introduce relatively hyperbolic groups and the notion of relative quasiconvexity of their subgroups. I will also discuss results that exist for relatively quasiconvex subgroups that are analogous to those that exist for quasiconvex subgroups in the non-relative setting. In particular, I will discuss the existence of a Cannon–Thurston map that arises when considering such subgroups.

10.13. Affine simplices in Oka manifolds

Finnur Larusson (University of Adelaide)

17:30 Tuesday 28 September 2010 – 14-217

Finnur Larusson

I will describe a result that I proved last year, saying that the homotopy type of a complex Lie group or a homogeneous space of a complex Lie group is captured by holomorphic maps into it from the affine spaces \mathbb{C}^n , $n \geq 0$. The result holds more generally for so-called Oka manifolds and is proved using a version of the Oka principle. Finally, I will mention similar results for mapping spaces.

10.14. Half flat structures and special holonomy

Thomas Leistner (University of Adelaide)

17:30 Monday 27 September 2010 – 14-217

V. Cortés, T. Leistner, L. Schäfer, and F. Schulte-Hengesbach

Manifolds with a half flat structure $SU(3)$ -structure are a natural generalisation of three-dimensional Calabi–Yau-manifolds. Of particular interest is their relation to parallel G_2 structures. It was proven by Hitchin that any solution of his evolution equations for a half-flat $SU(3)$ -structure on a compact six-dimensional manifold M defines an extension to a seven-dimensional manifold with holonomy in the exceptional group G_2 . We give

a new proof of this result that does not require the compactness of M . Based on this we obtain a generalisation of Hitchin’s result to half flat and G_2 structures for indefinite metrics corresponding to the non-compact real forms of the groups. We present several examples that are obtained by this method.

10.15. Local quasi-isomorphisms between topological buildings

Rupert McCallum (Australian Catholic University)

15:00 Thursday 30 September 2010 – 14-217

Dr Rupert McCallum

Associated to any absolutely almost simple algebraic group over a field k is a Tits building. Jacques Tits gave a description of the isomorphisms between the building of one such group and another. We can modify this slightly, defining a notion of “quasi-isomorphism”, and generalise Tits’ result slightly to give a description of the quasi-isomorphisms. If k is a Hausdorff topological field, then the associated building becomes a topological Tits building. I investigate conditions under which one can guarantee that a local quasi-isomorphism from one such topological building to another will extend to a global quasi-isomorphism.

10.16. Directional properties of sets definable in o-minimal structures

Laurentiu Paunescu (University of Sydney)

15:30 Monday 27 September 2010 – 14-217

Satoshi Koike, Ta Lê Loim, Laurentiu Paunescu and Masahiro Shiota

In a previous work I introduced the notion of direction set for a subset of \mathbb{R}^n , and showed that the dimension of the common direction set of two subanalytic subsets, called *directional dimension*, is preserved by a bi-Lipschitz homeomorphism, provided that their images are also subanalytic. In this talk I will describe a generalisation of the above result to sets definable in an o-minimal structure on an arbitrary real closed field.

10.17. Pseudo-developing maps for ideal triangulations

Stephan Tillmann (The University of Queensland)

13:30 Thursday 30 September 2010 – 14-217

Stephan Tillmann

Given the topologically finite 3-manifold M , I’ll talk about some facts about pseudo-developing maps for ideal triangulations of M , and how they are useful in the study of representations of the fundamental group of M , and in the study of geometric structures on M .

10.18. Geometric quantisation commutes with reduction

Mathai Varghese (University of Adelaide)

16:30 Tuesday 28 September 2010 – 14-217

Mathai Varghese and Weiping Zhang

I will report on a recent proof of, geometric quantisation commutes with reduction, for proper actions of noncompact groups, as proposed by Hochs–Landsman.

10.19. The caloron correspondence and string classes for loop group bundles

Raymond Vozzo (University of Adelaide)

17:00 Tuesday 28 September 2010 – 14-217

Michael Murray and Raymond Vozzo

Suppose G is a compact Lie group, LG its (free) loop group and $\Omega G \subseteq LG$ its based loop group. Let $P \rightarrow M$ be a principal bundle with structure group one of these loop groups. In this talk I will explain a correspondence between such bundles and certain G -bundles. This so-called *caloron correspondence* allows us to translate problems on the (infinite dimensional) bundle P into ones on a (finite dimensional) G -bundle. As an application, I shall present some new results on characteristic classes for loop group bundles, using the caloron correspondence to demonstrate how to construct certain classes—which we call *string classes*—for such bundles.

10.20. The stable topology of Hurwitz spaces

Craig Westerland (The University of Melbourne)

14:30 Wednesday 29 September 2010 – 14-217

Jordan Ellenberg, Akshay Venkatesh, and Craig Westerland

We study the homology of moduli spaces of branched covers of curves, and its limiting behaviour as the number of branch points grows. Time permitting, we will describe applications to arithmetic, in particular, to function field analogues of the Cohen–Lenstra conjectures.

11. Lie Groups and Harmonic Analysis

11.1. Quadratic estimates for perturbed Dirac type operators on doubling measure metric spaces

Menaka Lashitha Bandara (Australian National University)

14:30 Tuesday 28 September 2010 – 32-214

Menaka Lashitha Bandara

I will discuss quadratic estimates for perturbations of Dirac type operators on doubling measure metric spaces using ideas originating from the proof of the Kato Square Root problem. I will also highlight consequences to boundary value problems and the Kato Square Root problem on doubling manifolds.

11.2. Mappings preserving cosets of subgroups and the Fourier–Stieltjes algebra

Michael Cowling (University of New South Wales)

15:00 Tuesday 28 September 2010 – 32-214

Michael Cowling

I will outline a two parallel families of results. Suppose that G_1 and G_2 are connected Lie groups, and that $\phi : G_1 \rightarrow G_2$ is a bijection. In many cases it is possible to prove that, if ϕ sends cosets of subgroups to cosets of subgroups, or if composition with ϕ maps the Fourier–Stieltjes algebra $B(G_2)$ to $B(G_1)$, then ϕ is composed of some or all of the following: a group isomorphism; a translation, and reflection. Curiously, nilpotent Lie groups are the hardest to deal with.

11.3. Levy–Kintchine formulae on symmetric spaces

Anthony Dooley (University of New South Wales)

15:30 Tuesday 28 September 2010 – 32-214

Anthony Dooley

In the 1970’s, Gangolli proved a Levy–Kintchine formula for K -invariant processes on a Riemannian symmetric space G/K . In recent work with David Applebaum, we have obtained an analogue of this formula without the assumption of K -invariance.

11.4. The Clifford Fourier transform

Jeff Hogan (University of Newcastle)

17:00 Tuesday 28 September 2010 – 32-214

Jeff Hogan

The Clifford Fourier transform is a generalisation of the usual Fourier transform which treats multi-channel signals as an algebraic whole rather than as an ensemble of one-dimensional signals. In this talk we present the basic theory of the Clifford Fourier transform and some applications to the processing of multichannel signals, especially in

the two-dimensional case where the underlying algebra is that of the quaternions. Some Cliffordised versions of well-known theorems of harmonic analysis will be presented.

11.5. Invariant complementation and related properties for the group algebra of a locally compact group

Anthony Lau (University of Alberta)

13:30 Wednesday 29 September 2010 – 32-214

Anthony T.-M. Lau

A classical result of H. Rosenthal (1966) asserts that if X is a weak*-closed completed translation invariant subspace of the C^* -algebra of essentially bounded Borel measurable functions on a locally compact abelian group, then X admits a translation invariant complement. In my talk, I shall discuss a similar property for the group von Neumann algebra of a locally compact group G and its relation to the Hahn Banach separation and extension properties of continuous positive definite functions on G .

11.6. Unitary representations of semisimple Lie groups

Christopher Meaney (Macquarie University)

17:30 Wednesday 29 September 2010 – 32-214

Christopher Meaney

We will talk about methods for assigning a unitary structure to some subquotients of principal series representations of a semisimple Lie group. These include derived-intertwining norms and Midorikawa’s invariant seminorms on some function spaces on G/K . This touches on work of Ankaabout, Donley, Delorme and Souaifi.

11.7. Computing fundamental domains of Kac–Moody groups

Scott Murray (University of Canberra)

16:30 Tuesday 28 September 2010 – 32-214

Lisa Carbone, Leigh Cobbs, and Scott H. Murray

The Bass–Serre theory of groups acting on trees is vital to the structure theory of certain infinite groups. In this talk, we consider the action of the affine Kac–Moody group $SL_2(F_q((t)))$ on their Bruhat–Tits graph (or building). By quotienting out the action of congruence subgroups, we get a class of graphs called fundamental domains.

We used Magma to construct a large number of such graphs. These constructions allowed us to make new conjectures on the structure of expanders, some of which we have been able to prove. I will also discuss possible extensions of these techniques to larger Kac–Moody groups.

11.8. Operator-Lipschitz functions in Schatten–von Neumann classes

Fedor Sukochev (University of New South Wales)

14:00 Tuesday 28 September 2010 – 32-214

Denis Potapov and Fedor Sukochev

We resolve a number of problems in the perturbation theory of linear operators, linked with the 45 years old conjecture of M. G. Krein. In particular, we prove that every Lipschitz function is operator Lipschitz in the Schatten–von Neumann ideals S_p , $1 < p < \infty$.

11.9. Geometric-arithmetic averaging of dyadic weights

Lesley Ward (University of South Australia)

14:30 Wednesday 29 September 2010 – 32-214

J. Pipher, L.A. Ward, X. Xiao

The theory of Muckenhoupt weights arises in many areas of analysis, for example in connection with bounds for singular integrals and maximal functions on weighted spaces. We show that a certain averaging process gives a method for constructing A_p weights from a measurably varying family of dyadic A_p weights. This averaging process is suggested by the exponential/logarithmic relationship between the A_p weight class and the space BMO of functions of bounded mean oscillation. The same averaging process also constructs weights satisfying the reverse Hölder (RH_p) condition from families of dyadic RH_p weights. Moreover, it applies to the multiparameter weight classes A_p and RH_p on the polydisc as well.

11.10. Contraction subgroups in locally compact groups

George Willis (University of Newcastle)

18:00 Wednesday 29 September 2010 – 32-214

George Willis

For each automorphism, α , of the locally compact group G there is a corresponding *contraction subgroup*, which is the set of $x \in G$ such that $\alpha^n(x)$ converges to the identity as $n \rightarrow \infty$. Contraction subgroups are important in representation theory, through the Mautner phenomenon, and in the study of convolution semigroups.

The property of possessing a contractive automorphism has strong structural implications for a group. A connected contraction group must be nilpotent. Totally disconnected contraction groups have a more complicated structure which has been completely worked out only recently. The talk will present these recent results.

12. Mathematics in Biology, Medicine and Conservation

12.1. Mathematical aspects of fluorescence recovery after photo-bleaching (FRAP) in SC

Yuri Anissimov (Griffith University)

14:30 Thursday 30 September 2010 – 3-329

Y G Anissimov

The value of diffusion coefficients in different phases of the heterogeneous Stratum Corneum (SC) is very difficult to obtain in classical skin penetration experiments due to difficulties associated with assessing the true pathlength of solute transport in the SC. In this work we used the technique of Fluorescence Recovery After Photo-bleaching (FRAP) to assess diffusion coefficient of Rhodamine B in SC lipids.

FRAP was conducted in the SC lipid phase using a fluorescence multiphoton microscope. Two simplified mathematical models were used to fit the fluorescence intensity data, yielding the value of the diffusion coefficient of Rh:B in SC lipids. The value was then compared to the diffusion coefficient for similar molecular weight fluorophore. The feasibility of simplified mathematical models for analysis of FRAP in SC was discussed.

12.2. Modelling influenza mutation and dynamics

Steven Barry (Australian National University)

17:30 Wednesday 29 September 2010 – 3-329

Steven I. Barry, Geoff Mercer

The 2009 influenza pandemic illustrates the need for understanding the mutation of influenza, and its effect on both the human population and on existing strains. For example, in Victoria 98% of influenza cases in 2009 were pandemic H1N1. Yet in other states it was 68%. In this paper we consider some of the latest models of influenza strain interaction, and mutation, showing how these models can help predict the behaviour of influenza epidemics/pandemics, as well as helping with the choice of vaccination strains. This has direct implications on the governmental policy with respect to managing influenza. The models overlap the areas of SIR differential equation dynamics [compartmental models], phylogenetics [the mutation tree structure] and antigenic cartography [mapping the mutation using multidimensional scaling].

The results use international and national data from the 2009 pandemic to show how the model effectively represents the pandemics complex behaviour.

12.3. Bone implant scaffold prototypes designed via topology optimisation and manufactured by solid freeform fabrication

Vivien Challis (The University of Queensland)

14:00 Thursday 30 September 2010 – 3-329

V.J. Challis, A. P. Roberts, J. F. Grotowski, L.C. Zhang, T.B. Sercombe

The linking of computational design with precision solid freeform fabrication has tremendous potential for producing tissue scaffolds with tailored properties. I'll discuss the need for porous bone implant scaffolds and our new approach to designing their architecture, which is based on jointly maximising scaffold stiffness and diffusive transport in the interconnected pores. The stiffness of the scaffold can be matched to that of bone by choosing a suitable scaffold porosity. I will discuss the significant benefits of our designs and the manufacture and mechanical testing of the resulting prototype scaffolds. Our excellent agreement between theory and experiment confirms the viability of this route to scaffold design and fabrication.

12.4. Matrix models for tick-borne disease and other vector-borne pathogens

Stephen Davis (Royal Melbourne Institute of Technology)

14:30 Wednesday 29 September 2010 – 3-329

Stephen A. Davis

Next-generation matrices (NGMs) are used in epidemiological modelling to characterise growth in numbers of infected hosts (R_0). The approach is appropriate for multi-host pathogens and has proved highly suitable for complex disease systems such as Lyme disease, which is carried by ticks. The dynamics of such pathogens are complicated by the curious life cycle of ticks and the multiple routes of transmission that are possible. The matrix approach allows the modeller to use perturbation techniques such as composite elasticities and loop analysis that were developed by theoretical ecologists for projection matrices for plants and animals. We show how the approach has given insights into the pathogens of the black-legged tick in northeastern United States.

12.5. Mathematical modelling of the impact of tourism on dengue fever

Glenn Fulford (Queensland University of Technology)

13:30 Wednesday 29 September 2010 – 3-329

Glenn Fulford

Dengue fever is an infectious disease that is spread from mosquito to human and from human to mosquito. Dengue fever outbreaks have recently occurred in the city of Cairns in northern Queensland and this is thought to have happened due to the influx of tourists from the international airport. This talk presents a preliminary mathematical model that incorporates the impact of tourism on the prevalence of Dengue fever in Cairns. The talk will outline the model, how parameters were estimated and provide some preliminary analysis of effectiveness of different intervention measure aimed at reducing the size of future outbreaks.

12.6. A mathematical model of diffusional shunting of oxygen from arteries to veins in the kidney

Bruce Gardiner (The University of Western Australia)

17:00 Monday 27 September 2010 – 3-329

Bruce S. Gardiner, David W. Smith, Paul M. OConnor and Roger G. Evans

Despite receiving a large supply of well-oxygenated blood, kidney are surprisingly prone to hypoxia. Tissue hypoxia is a hallmark of the pathogenesis of both acute and chronic kidney diseases. I will present a model we have constructed to understand how mammalian kidney tissue oxygen levels are regulated, and I will focus on the interplay between oxygen delivery, oxygen consumption and arterial-to-venous oxygen shunting. The model consists of a multiscale hierarchy of eleven counter-current systems, representing the various branch levels of the cortical arterial-venous parallel vasculature architecture. At each level equations describing the reactive-advection-diffusion of oxygen are solved. The model is able to reproduce many key experimental observations and can show how tissue oxygen levels can be maintain in the event of changing oxygen delivery.

12.7. Nerve fibre chemotaxis

Geoffrey Goodhill (The University of Queensland)

15:30 Monday 27 September 2010 – 3-329

Geoffrey J. Goodhill

Chemotaxis—detecting and following chemical gradients—plays a crucial role in the function of many biological systems. In particular, gradient-following by neuronal growth cones is important

for the correct wiring of the nervous system. However, there is little quantitative information available on how small chemotacting devices such as neuronal growth cones respond to gradients. At the most fundamental level such devices are constrained by unavoidable noise due to the limited number of ligand and receptor molecules involved. I will discuss our recent work on (1) a Bayesian analysis of how such devices might optimally combine noisy receptor binding measurements in order to determine gradient direction, and (2) experimental measurements of nerve fiber chemotaxis which are quantitatively consistent with the predictions of the analysis.

12.8. Non-local models for the formation of hepatocyte - stellate cell aggregates

Edward Green (The University of Western Australia)

17:00 Tuesday 28 September 2010 – 3-329

J. E. F. Green

Hepatocytes and stellate cells are two types of liver cell, which, when cultured together, form aggregates more rapidly, and which remain viable and functional for longer, than when hepatocytes are cultured alone. We have developed a new mathematical model to investigate two alternative hypotheses concerning the role of stellate cells in promoting aggregate formation. Under Hypothesis 1, each population produces a chemical signal which affects the other, and enhanced aggregation is due to chemotaxis. Hypothesis 2 asserts that the interaction between the two cell types is by direct physical contact: the stellates extend long cellular processes which pull the hepatocytes into the aggregates. Our nonlocal model consists of integro-partial differential equations to describe the densities of cells, which are coupled to reaction-diffusion equations for the chemical concentrations. The behaviour of the model under each hypothesis is studied using a combination of linear stability analysis and numerical simulations. The results show how the initial rate of aggregation depends upon the cell seeding ratio, and how the distribution of cells within aggregates depends on the relative strengths of attraction and repulsion between the cell types. Although the currently available experimental data does not allow us to distinguish between the two hypotheses, we can use our model to suggest experiments which might enable us to do so.

12.9. Dengue in Queensland, Australia

Roslyn Hickson (Australian National University)
 14:00 Wednesday 29 September 2010 – 3-329
 Roslyn Hickson, Geoff Mercer, Glenn Fulford

I will explore the effect of vector seasonality on Dengue incidence in Queensland, Australia. The long term goal is consideration of the effect of climate change on Dengue epidemics in Australia. Furthermore, I will investigate how Wolbachia bacterium affects the dynamics of Dengue transmission.

12.10. A non-dimensional study of the passive bidomain equation

Peter Johnston (Griffith University)
 17:30 Monday 27 September 2010 – 3-329
 Peter R. Johnston

Simulation studies of ST depression arising from subendocardial ischaemia show a marked difference in the resulting epicardial potential distributions depending on which of the three common experimentally determined bidomain conductivity data sets is chosen. Here, the governing equation is non-dimensionalised by dividing by the difference in normal and ischaemic transmembrane potentials during the ST segment and by the sum of the intra and extracellular conductivities in the transverse direction, yielding the ratio of the sum of the intra and extracellular longitudinal conductivities divided by the sum of the intra and extracellular transverse conductivities as a dimensionless group. Averaging this ratio over the three sets of experimentally determined data gives the value of 3.21 ± 0.08 . The effect of this narrow range means that the left hand side of the governing equation can be considered, as a good approximation, to be equal for all these sets of conductivity data. Hence, the right hand of the non-dimensional differential equation contains all the necessary information to compare the effect different conductivity data sets have on the epicardial potential distribution. As an example, an explanation is given as to why values from one data set gives rise to epicardial distributions which are markedly different from those obtained from the other two data sets.

12.11. Modelling within-host chlamydial infection

Dann Mallet (Queensland University of Technology)
 18:00 Wednesday 29 September 2010 – 3-329
 Dann G. Mallet, Kelly-Jean Heymer, Masoumeh Bagher-Oskouei

I will discuss recent approaches to modelling within-host chlamydial infection dynamics and related findings.

12.12. ZSS says relax: A mathematical investigation of the contraction of fibroblast-populated collagen lattices

Shakti Narayanan Menon (Queensland University of Technology)

13:30 Thursday 30 September 2010 – 3-329
 Shakti N. Menon, Cameron L. Hall, Scott W. McCue, D. L. Sean McElwain

Fibroblast-populated collagen lattices (FPCLs) are commonly used in *in vitro* experiments to study the mechanical interactions between fibroblast cells and their environment, as well as to provide a model of contraction as it occurs during the process of dermal wound healing. These collagen lattices are observed to contract significantly, in some cases to as little as 10% of their original size in around one day. It has also been observed that the removal of fibroblast cells can result in the partial re-expansion of such gels. I will present an overview of the different types of FPCLs, and the proposed mechanisms by which they contract. I shall also discuss a one-dimensional morphoelastic model, which uses the concept of an evolving zero-stress state (ZSS) to describe the deformation of a continually changing biological tissue. I will present analytical results for this model in the case where the cells are killed, as well as the asymptotic behaviours of the system in the large and small time limits. Finally, I shall compare our numerical and theoretical results with previously obtained experimental data for a relaxed FPCL.

12.13. Pattern formation in E. coli colonies

Thomas Mollee (The University of Queensland)
 17:30 Tuesday 28 September 2010 – 3-329
 Thomas R. Mollee and Masayasu Mimura

Colonies of mutant *E. coli* strains, when inoculated in the centre of a plate, form highly symmetric, stable spot patterns. These spot patterns are only observed in chemotactic *E. coli* strains, i.e. strains that bias their motion so that cell populations move up gradients of a chemical in the cells' local environment. It is an important question whether these patterns are due to genetic control or self-organization. I will present a macroscopic continuum model of *E. coli* pattern formation that reproduces the observed spot patterns as the initial nutrient is varied. This supports the view that these patterns are indeed a result of self-organization.

12.14. Biological and therapeutic predictions from a morphoelastic representation of dermal repair

Kelly Murphy (Queensland University of Technology)

16:30 Tuesday 28 September 2010 – 3-329
 K.E. Murphy, C.L. Hall, S.W. McCue and D.L.S. McElwain

Dermal repair is an intricate process in which cells, chemicals and mechanics all play vital roles in effecting wound closure. Recent experimental results have showcased the importance of transforming growth factor- β (TGF β), especially in conjunction with mechanical stimuli to invoke differentiation of fibroblasts to their active contractile phenotype, the myofibroblast. We have developed a mathematical representation of wound repair that involves the interactions between TGF β , cells and wound mechanics, incorporating the combined mechanical and chemical stimulation of fibroblasts. Furthermore, our model considers a morphoelastic mechanical framework, which enables us to simulate the three contractile phases of closure, retraction, rapid contraction and the permanence of wound contraction. Using this model, we predict that the combined action of TGF β and myofibroblasts is the primary factor behind the poor healing observed in contractures. Therefore, we have used this model to investigate intervention strategies that target myofibroblast apoptosis of fibroblast differentiation as possible therapeutic approaches. In each scenario trialled, early elimination of myofibroblasts was shown to significantly reduce wound contraction, improving scar quality.

12.15. Modelling the development of resistance to HIV gene therapy

John Murray (University of New South Wales)
 16:30 Monday 27 September 2010 – 3-329
 John Murray

Gene therapy has recently been shown to produce lower viral loads compared to placebo in chronically HIV-infected individuals. Gene therapy for HIV has the potential to counter problems that still hamper standard antiretroviral therapy (ART), including toxicity, patient adherence and the development of resistance.

As has been observed with ART, gene therapy against a single viral target can result in the development of resistance due to the quasi-species nature of the infection and its fast mutation. Therefore gene therapy against multiple HIV targets will be required for long-term viral suppression. One gene therapeutic involves RNA interference which can suppress HIV replication via expressed short hairpin RNAs (shRNAs).

We developed the first biologically relevant stochastic agent-based model in which multiple shRNAs are introduced into hematopoietic stem cells. This model has been used to track the production of gene-containing CD4+ T cells, the degree of HIV infection and the development of resistance in lymphoid tissue for 13 years.

We found that more than two active shRNAs were required to suppress HIV infection/replication ef-

fectively and prevent the development of resistance. The inhibition of incoming virus was shown to be critical for effective treatment. The low potential for resistance development that we found is largely due to a pool of replicating wild-type HIV that is maintained in non-gene containing CD4+ T cells. The presence of a group of cells that lack the gene therapeutic and are available for infection by wild-type virus appears to mitigate the development of resistance observed with systemic antiretroviral therapy.

12.16. Prioritizing conservation actions for a population that is declining due to multiple threats

Chooi Fei Ng (The University of Queensland)
 15:00 Tuesday 28 September 2010 – 3-329
 Chooi Fei Ng, Hugh P. Possingham, Deidré L. de Villiers, Harriet J. Preece, Clive A. McAlpine and Jonathan R. Rhodes

Finding cost-effective management strategies for the recovery of species that are declining due to multiple threats is a major challenge for conservation biologists and decision makers. Conservation managers are often encumbered by a restricted budget that needs to be allocated among a range of different actions aimed at mitigating multiple threats. A decision theory framework was used to determine the optimal allocation of resources among management actions to mitigate multiple threats for a rapidly declining koala (*Phascolarctos cinereus*) population in eastern Australia. This population is threatened by habitat loss, car collisions on roads, domestic dog attacks and disease. By integrating an age-structured matrix population model with return on investment curves, we found the most cost-effective allocation of resources among three management actions: (1) reduce car collisions; (2) reduce domestic dog attacks; and (3) restore habitat. The results show that the optimal strategy depends on the management objective. If the objective is to slow the rate of population decline, then the optimal strategy is to invest predominantly in reducing car collisions and dog attacks. However, if the management objective is to achieve a non-negative population growth rate, then a substantial investment in habitat restoration is required. This decision theoretic approach provides a powerful framework for planning the recovery of declining species exposed to multiple threats; a situation that is becoming critically important for many species.

12.17. The regulation of epidermal morphology: insight from in-vitro culture and in-silico modelling
Graeme Pettet (Queensland University of Technology)

15:00 Thursday 30 September 2010 – 3-329
Graeme J Pettet, Colin P Please, Jos Malda

Epidermal wound healing is a complex physiological process, requiring restoration of the barrier function of skin. It remains unclear however, exactly how proliferation and terminal differentiation of the keratinocytes are regulated in order to regenerate the organised structure of the epidermis. Here we consider two different generic processes as potential sources of the restoration and regulation of the epidermal layer: (i) signalling from the basement layer and (ii) signalling from the cornified layer.

In assessing these we identify that both can create stable thicknesses for the epidermis. However we also use evidence gained from human skin equivalent models (HSEs) to see if either process can explain the more complex dynamic behaviour that is observed. These HSE experiments reveal that the layers do not grow uniformly but have a transient behaviour where the viable layer initially grows rapidly but then shrinks back as the cornified layer grows. Our comparison indicates that such behaviour is not possible by a simple diffusive signal from the basement layer but that signalling from the cornified layer can reproduce these observations.

12.18. Clinical trials

William Probert (The University of Queensland)

15:30 Tuesday 28 September 2010 – 3-329
W. Probert, P. Baxter, H. Possingham

We draw a range of methods from the clinical trial and decision theory literature and apply them to the allocation of endangered species to conservation sites. We are particularly interested in two-armed bandit problems (two treatments to choose between) over a finite horizon with a binary response (success/fail). We assume that at each decision horizon there be a constant probability of a superior treatment being found and the experiment stops. Applying methods from the clinical trial literature to non-human subjects also provides new perspectives on ethical considerations in allocating treatments. We illustrate the methods with an example based on an endangered Australian species, the bilby, and conservation efforts in Western Australia to protect it.

12.19. A cross-species avian-human influenza model: disease spread and controls

Wuryatmo Sidik (Flinders University)

14:30 Tuesday 28 September 2010 – 3-329
Wuryatmo Sidik

I will present a cross-species avian-human influenza epidemic model,

$$\begin{aligned} \dot{x}_i &= a_i - (c_i + \sum_{j \neq i} \theta_{ij})x_i - \alpha_i \kappa_i y_i x_i + r_i y_i \\ &+ \sum_{j \neq i} \theta_{ji} x_j (1 - (1 - \sigma_j) \alpha_{ji} \kappa_{ji} y_j), \end{aligned}$$

$$\begin{aligned} \dot{y}_i &= \alpha_i \kappa_i y_i x_i - (c_i + m_i + r_i + \sum_{j \neq i} (1 - \sigma_i) \theta_{ij}) y_i \\ &+ \sum_{j \neq i} (1 - 2\sigma_i) (1 - \sigma_j) \theta_{ji} y_j \\ &+ \sum_{j \neq i} (1 - 2\sigma_i) (1 - \sigma_j) \theta_{ji} \alpha_{ji} \kappa_{ji} y_j x_j, \end{aligned}$$

$$\begin{aligned} \dot{s}_i &= \lambda_i - (d_i + \sum_{j \neq i} \vartheta_{ij}) s_i - (\beta_i \delta_i y_i + \gamma_i \varkappa_i h_i) s_i \\ &+ \sum_{j \neq i} \vartheta_{ji} s_j (1 - (1 - \zeta_j) \gamma_{ji} \varkappa_{ji} h_j) \\ &+ \varsigma_i b_i + \eta_i h_i + (\rho_i + \tau_i) q_i, \end{aligned}$$

$$\begin{aligned} \dot{b}_i &= \beta_i \delta_i y_i s_i - (d_i + \mu_i + \varsigma_i + \epsilon_i + \xi_i) b_i \\ &+ \sum_{j \neq i} (1 - \xi_i) \vartheta_{ij} b_j + \sum_{j \neq i} (1 - \xi_i) (1 - \xi_j) \vartheta_{ji} b_j, \end{aligned}$$

$$\begin{aligned} \dot{h}_i &= \gamma_i \varkappa_i h_i s_i + \epsilon_i b_i - (d_i + \nu_i + \eta_i + \zeta_i) h_i \\ &+ \sum_{j \neq i} (1 - \zeta_i) \vartheta_{ij} h_j + \sum_{j \neq i} (1 - \zeta_i) (1 - \zeta_j) \vartheta_{ji} h_j \\ &+ \sum_{j \neq i} (1 - \zeta_i) (1 - \zeta_j) \vartheta_{ji} \gamma_{ji} \varkappa_{ji} h_j s_j, \end{aligned}$$

$$\begin{aligned} \dot{q}_i &= \xi_i b_i + \sum_{j \neq i} \xi_i (1 - \xi_j) \vartheta_{ji} b_j + \zeta_i h_i \\ &+ \sum_{j \neq i} (1 - \zeta_i) \vartheta_{ji} h_j + \sum_{j \neq i} \zeta_i (1 - \zeta_j) \vartheta_{ji} \gamma_{ji} \varkappa_{ji} h_j s_j \\ &- (d_i + \mu_i + \nu_i + \rho_i + \tau_i) q_i \end{aligned}$$

for $i, j = 1, 2, \dots, n$. Where $x_i, y_i, s_i, b_i, h_i, q_i$ are the proportions of susceptible birds, infected birds, susceptible humans, infected humans with *H5N1* virus, infected humans with *MA* (mutant avian) virus and quarantined infectious humans of *H5N1* and *MA* viruses in region i , respectively. Virus mutation and transport processes are taken into account in the model. I will present some analytical results on: the existence and uniqueness of a solution to the system, reproduction numbers and stability of equilibrium points. I will also present some numerical study results which show some indications that: an endemic may triggered by an infected bird or human from other region therefore a screening policy may help for disease prevention, but cannot eradicate the disease. in term of the number of infected humans, the *MA* epidemic has a greater impact compare to that of *H5N1*.

12.20. Cell invasion with proliferation mechanisms motivated by time-lapse data

Matthew Simpson (Queensland University of Technology)

18:00 Monday 27 September 2010 – 3-329

Matthew Simpson

Cell invasion involves a population of cells which are motile and proliferative. Traditional discrete models of proliferation involve agents depositing daughter agents on nearest-neighbor lattice sites. Motivated by time-lapse images of cell invasion, we propose and analyze two new discrete proliferation models in the context of an exclusion process with an undirected motility mechanism. These discrete models are related to a family of reaction-diffusion equations and can be used to make predictions over a range of scales appropriate for interpreting experimental data. The new proliferation mechanisms are biologically relevant and mathematically convenient as the continuum-discrete relationship is more robust for the new proliferation mechanisms relative to traditional approaches.

12.21. Mathematical model of the interaction between a growing tumour and cells of the innate and specific immune system

Trisilowati Trisilowati (Queensland University of Technology)

14:00 Tuesday 28 September 2010 – 3-329

Trisilowati and Dann G. Mallet

In this paper, we present a new mathematical model of the interaction between a growing tumour and cells of the innate and specific immune system. Some tumours present dendritic cells and the presence of such cells has a potential role in tumour control. In this model, we assume that both natural killer and dendritic cells as the innate immune system can kill the tumour. We analyse the stability of the model as well as the bifurcation behaviour. Numerical simulation of the model is also provided and from these simulations, it is found that some parameters such as the tumour growth rate, the rate of dendritic cell initiated tumour cell death, influx of dendritic cells and the rate of natural killer cell initiated dendritic cell actions play an important role in the final tumour size.

13. Mathematics Education

13.1. Experiences from the mathematics in schools program

Steven Barry (Australian National University)

14:00 Wednesday 29 September 2010 – 1-E302

Steven I. Barry

In 2010 I began working with two schools on formulating projects for their students. This was part of the mathematics in schools program organised by CSIRO. It soon became apparent that the teachers in these schools were in desperate need of realistic projects and examples that demonstrate the *uses and applications* of applied mathematics, not by using the ‘toy’ examples that proliferate in text books, but the actual mathematics skills used by engineers, scientists, doctors etc. The are not concerned with the latest mathematical theories, or our research interests, but in how they might use mathematics in the careers they will go into (which almost certainly will not involve doing research mathematics).

I will describe the projects I developed and am developing for these schools. These projects include modelling epidemics, salmonella poisoning, diabetes, and solving a maritime surveillance problem. The projects use SciLab and available materials from the web.

13.2. Have eight colleagues watch me lecture? Why would I agree to that?

Bill Barton (The University of Auckland)

13:30 Wednesday 29 September 2010 – 1-E302

Bill Barton

At Auckland we have begun a project aimed at lecture development using videos of ourselves lecturing. We (a group of four mathematics educators and four mathematicians, all of whom lecture undergraduate mathematics) watch the videos together as a group and talk about what is going on and why. We also video the same lecture during a later semester. There is, understandably, some anxiousness about this process—even for an old school master like myself who was first videoed in 1972 during pre-service teacher training. I will talk about the project, the theory behind it, how we try to manage the sensitive issues, what it has raised on the emotional level, and the insights it has given us on our practice. We have contracted to evaluate both the effectiveness of this practice as professional development, and the effectiveness of the lectures. Both of these create some practical problems.

13.3. A mathematics learning community in North Queensland

Shaun Belward (James Cook University of North Queensland)

17:00 Monday 27 September 2010 – 1-E302

Shaun Belward and Jo Balatti

There is considerable concern amongst the mathematics community regarding the quality of mathematics teaching in the secondary school system in Australia. This situation seems to be worsening. Reasons for this include the lack of students studying mathematics at university level and the lack of esteem associated with education as a career path. At James Cook University in 2010 we will produce at most three graduates with qualifications suitable to teach year 12 mathematics.

Here we detail a mathematics learning community that has been established in North Queensland. The aim of the community is to provide a forum so that all concerned who are involved in mathematics education in the region can look after the needs of the trainee mathematics teachers.

13.4. Computer aided assessment in a CAS immersed vector calculus course

Bill Blyth (The University of Melbourne)

17:30 Monday 27 September 2010 – 1-E302

Bill Blyth

The two most powerful and widely used CAS are Maple and Mathematica: both are suitable for use in CAS immersion courses with CAS-immersed Computer Aided Assessment, CAA. Examples using Maple in a Vector Calculus subject at RMIT University will be discussed. By CAS ‘immersion mode’, we mean that all presentation is with the CAS files (that the students have in advance of the class) and student work is done using CAS in a computer lab. Assignments and examinations are CAS files downloaded from the web, and submitted via the web.

Recently, CAA packages, such as AiM, STACK and MapleTA use a CAS to provide automatic marking of numerical and symbolic answers. In these packages the work is done elsewhere and the answers are typed into the CAA package. In our Vector Calculus course, students directly work with, and submit, Maple files so we don’t require an external CAA package: we utilize Maple directly to implement the CAS-immersed CAA. Since we wish to assess how and what we wish to assess (not just what some assessment package allows), we automatically have numeric and symbolic answers marked but student comments and plots are marked (within Maple) by the tutor. The tutor allocates marks in an efficient and

structured way: these marks are automatically added to the auto-generated marks, the full marking report is automatically generated from Maple in a separate text file and returned to the student. A student cumulative Marks List is also auto-generated.

13.5. Statistical microarray analysis in a virtual environment

Michael Bulmer (The University of Queensland)

18:00 Wednesday 29 September 2010 – 1-E302

Michael Bulmer and Rebecca Yaun

We have developed a virtual population for use in teaching and learning epidemiology, experimental design and data analysis. Underlying the simulation that generates this population is a genetic sequence for each individual. This sequence is used to determine various characteristics of the individuals, including their susceptibility to diseases. We have now given students access to this sequence through a virtual microarray tool and this has been very useful in introduction statistical issues in microarray analysis, such as how to deal with the multiple comparisons. In this talk we give an overview of the virtual sequences and discuss a particular student project that looked for a diabetes gene in the population.

13.6. Diagnostic testing in mathematics and its use across the disciplines

Carmel Coady (University of Western Sydney)

14:30 Wednesday 29 September 2010 – 1-E302

Carmel Coady, University of Western Sydney; Mary Coupland, University of Technology, Sydney; Mark Nelson; University of Wollongong and Maureen Townley-Jones, University of Newcastle

Diagnostic testing in mathematics is becoming commonplace in many tertiary institutions across Australia, not only in the traditional disciplines of Engineering and Science, but increasingly in the disciplines of Business and Education. In this presentation we will report on the diagnostic testing carried out in three tertiary institutions at the first-year level for use in the disciplines of Engineering, Science and Business, how the results of this testing are used, and the success of this method at identifying students at risk.

13.7. Mathematics confidence, that essential but sometimes elusive ingredient: What is it, and what can we do about it?

Patricia Cretchley (Queensland University of Technology)

16:30 Monday 27 September 2010 – 1-E302

Patricia Cretchley

This talk aims to generate discussion on the nature and role of mathematics confidence in learning, and what we academics can do to raise confidence levels among our students. Because people use the term differently, I examine claims about the nature of mathematics confidence, compare ways in which researchers are measuring it, and offer findings about its role in learning. To stimulate discussion on what we can do to build students' mathematics confidence, I will include empirical data on the confidence levels in first and second year Australian Science and Engineering students in a particular university tracked over a number of years, and consider their relationship with performance to raise points for debate.

13.8. First-year students' mathematical understanding

Michael Jennings (The University of Queensland)

17:30 Wednesday 29 September 2010 – 1-E302

Michael Jennings

In recent years there has been a noticeable increase in the diversity of backgrounds, abilities and aspirations of students entering bridging and first-year mathematics courses at The University of Queensland. Much research has been undertaken into primary and secondary mathematics education but little in comparison has been done into tertiary mathematics and students' transition from secondary to tertiary mathematics. With the number of students entering Australian universities increasing, it is important to know what level of mathematical understanding they bring with them.

Diagnostic testing of first-year engineering and science students at The University of Queensland has been conducted at the beginning of first semester for the past four years. The data from the competency tests were analysed to decide the best way to improve students' mathematical knowledge and understanding. Results from the tests and subsequent outcomes will be presented.

**13.9. Toward a formal thinking in linear algebra:
The case of eigenvalues and eigenvectors**

Sepideh Stewart (The University of Auckland)

15:30 Monday 27 September 2010 – 1-E302

Sepideh Stewart

Many first year undergraduate students get confronted with a highly formal approach to mathematics in linear algebra courses. Unlike the formal definitions of concepts such as function, limit and continuity in calculus which may interfere with students previous experiences, students have no intuition for linear algebra terms such as span or eigenvectors, which are often taught formally and symbolically. Students may cope with the procedural aspects of the course, solving linear systems and manipulating matrices (as part of the requirement for examinations), but often are not aware that they have not grasped the crucial conceptual ideas underpinning them. This talk reveals the complexities that students find in learning about eigenvalues and eigenvectors. We use the theoretical framework of Talls three worlds of mathematics, along with perspectives from APOS theory to describe thinking about these concepts by several groups of first and second year university students. In particular we will highlight the obstacles they faced, and the emerging links some were constructing between parts of their concept images formed from the embodied, symbolic and formal worlds.

**13.10. Exploring the fundamental theorem of
arithmetic in a spreadsheet**

Steve Sugden (Bond University)

18:00 Monday 27 September 2010 – 1-E302

Steve Sugden

The unique factorization theorem states that any integer after 1 may be expressed in just one way as a product of primes. This basic result has been known for centuries. Despite this, the inability of even supercomputers to factorize large integers forms the basis of the RSA public-key cryptosystem which is widely used in ecommerce. This talk will outline some of the basics of number theory, including an efficient Excel model to fully factorize modest-sized integers and recursively produce the three basic functions of number theory (divisor, totient and Möbius) as a by-product using very simple spreadsheet formulas. The aim is to introduce students to essential concepts of number theory. Attendees may be asked to do some arithmetic.

**13.11. Is learning mathematics about learning
concepts?**

Susan Worsley (The University of Queensland)

16:00 Monday 27 September 2010 – 1-E302

Susan R Worsley

In mathematical philosophy, mathematical concepts are historical constructs that allow us to understand the concepts in mathematics as accurate, possibly complicated, ideas or theories that have been established (or constructed) from other simpler parts of mathematics. In mathematics education literature, how the concept is seen by the student is described as concept image and how it is seen by the discipline is described as concept definition. The term concept usage is used to explain how the concept is applied. From the theory of threshold concepts we are introduced to the idea that some concepts have the additional feature of transforming the way the student thinks. Can this terminology incorporate all that we are teaching students in mathematics courses?

I interviewed eight lecturers from first and second level mathematics and statistics courses to determine the key concepts they were teaching students and to find out how this related to the literature on mathematical concepts and threshold concepts. In this talk I will present my findings, showing the key concepts identified in each course and also looking at those things that are taught that may not be considered concepts.

14. Mathematical Physics

14.1. Bosons and fermions: from mathematical toy models into the lab

Murray Batchelor (Australian National University)

15:30 Monday 27 September 2010 – 32-215

Murray T. Batchelor

For several decades integrable models of one-dimensional bosons and fermions were considered as mathematical toy models by physicists. Nevertheless such models inspired significant developments in mathematics. Recently models of this kind have been realised in ingenious experiments with cold atoms. I will discuss these developments.

14.2. A tree-decomposed transfer matrix for computing exact partition functions for arbitrary graphs

Andrea Bedini (The University of Melbourne)

13:30 Thursday 30 September 2010 – 32-215

Andrea Bedini

Combining tree decomposition and transfer matrix techniques provides a very general algorithm for computing exact partition functions of statistical models defined on arbitrary graphs. The algorithm is particularly efficient in the case of planar graphs. We illustrate it by computing the Potts model partition functions and chromatic polynomials (the number of proper vertex colourings using Q colours) for large samples of random planar graphs with up to $N = 100$ vertexes.

14.3. Algebraic varieties for nondegenerate second-order superintegrable systems on the complex three-sphere

Joshua Capel (University of New South Wales)

14:30 Tuesday 28 September 2010 – 32-215

Joshua Capel

There has been a lot of recent activity in the classification of superintegrable systems on conformally flat manifolds. Of particular interest is the work of Kalnins et al. in which algebraic varieties are used to determine all nondegenerate potentials (i.e. maximum parameter potentials) on complex-Euclidean three space $E(3, \mathbb{C})$. In this talk I will discuss analogous results for nondegenerate potentials on the complex three-sphere.

14.4. The fifth virial coefficient for hard discs

Nathan Clisby (MASCOS/The University of Melbourne)

17:30 Monday 27 September 2010 – 32-215

Nathan Clisby

We dramatically improve the numerical accuracy of the fifth virial coefficient for hard discs, by employing some straightforward tricks to simplify integrals and exploiting improvements in computer hardware and numerical integration algorithms. We hope that this will enable us to make a conjecture for the exact value in terms of known mathematical constants via the PSLQ algorithm.

14.5. Exact spin quantum Hall current between boundaries of a lattice strip

Jan de Gier (The University of Melbourne)

18:00 Wednesday 29 September 2010 – 32-215

Jan de Gier

Employing an inhomogeneous solvable lattice model for classical bond percolation, we derive an exact expression for a boundary-to-boundary correlation function on a lattice of finite width. This correlator is the same as the spin current at the spin quantum Hall transition in a model introduced by Chalker and Coddington, and generalized by Gruzberg, Ludwig and Read. Our result is derived from a solution of the q -deformed Knizhnik Zamolodchikov equation, and is expressed in terms of a symplectic Toda-lattice wave-function.

14.6. The resolvent algebra of the canonical commutation relations

Hendrik Grundling (University of New South Wales)

14:00 Thursday 30 September 2010 – 32-215

Detlev Buchholz and Hendrik Grundling

The standard C^* -algebraic version of the algebra of canonical commutation relations, the Weyl algebra, frequently causes difficulties in applications since it neither admits the formulation of physically interesting dynamical laws nor does it incorporate pertinent physical observables such as (bounded functions of) the Hamiltonian. We will discuss a novel C^* -algebra of the canonical commutation relations which does not suffer from such problems. It is based on the resolvents of the canonical operators and their algebraic relations. The resulting C^* -algebra, the resolvent algebra, is shown to have many desirable analytic properties and the regularity structure of its representations is surprisingly simple. The resolvent algebra is also a more convenient framework for applications to interacting and to constrained quantum systems.

14.7. Lattice Green functions in all dimensions

Tony Guttmann (MASCOS/The University of Melbourne)

13:30 Wednesday 29 September 2010 – 32-215

Anthony J Guttmann

We give a systematic treatment of lattice Green functions (LGF) on the d -dimensional diamond, simple cubic, body-centred cubic and face-centred cubic lattices for arbitrary dimensionality $d \geq 2$ for the first three lattices, and for $2 \leq d \leq 5$ for the hyper-fcc lattice. We show that there is a close connection between the LGF of the d -dimensional hypercubic lattice and that of the $(d - 1)$ -dimensional diamond lattice. We give constant-term formulations of LGFs for all lattices and dimensions. Through a still under-developed connection with Mahler measures, we point out an unexpected connection between the coefficients of the s.c., b.c.c. and diamond LGFs and some Ramanujan-type formulae for $1/\pi$.

14.8. Calculus structure on the variational complex

Pedram Hekmati (University of Adelaide)

15:30 Tuesday 28 September 2010 – 32-215

Pedram Hekmati

A basic operation in calculus of variations is the Euler-Lagrange variational derivative, whose kernel determines the extremals of functionals. There exists a natural resolution of this operator, called the variational complex. In this talk, I shall explain how to use tools from the theory of Lie conformal algebras to explicitly construct the variational complex and endow it with a calculus structure. This also provides a very convenient framework for classifying and constructing integrable hierarchies.

14.9. Remarks on singularity theorems in general relativity

Ecaterina Howard (Macquarie University)

16:30 Monday 27 September 2010 – 32-215

Katie Howard

I present a brief overview of the acclaimed singularity theorems in Mathematical Relativity and propose a new definition of the concept of singularity. I review the traditional picture of singularities defined as geodesic incompleteness and attempt a rigorous analysis of the sufficient conditions for the existence of singularities. Furthermore, I bring several open questions and weak points in singularity theory, including the relation between geodesic incompleteness and curvature problems, the analytical extension of the spacetime as well as the boundary conditions in metric spaces.

14.10. Copolymer adsorption on striped surfaces: A directed walk model

Gary Iliev (MASCOS/The University of Melbourne)

15:30 Thursday 30 September 2010 – 32-215

Gary Iliev

We will consider a three-dimensional directed walk model of copolymer adsorption at an impenetrable surface. The interacting surface will be patterned with an alternating ‘colouring’ commensurate to the copolymer colouring and compared to the cases of a homopolymer interacting with a striped surface and a copolymer interacting with a homogeneous surface.

14.11. Integrable BEC-BCS crossover with $p+ip$ pairing symmetry

Phillip Isaac (The University of Queensland)

18:00 Monday 27 September 2010 – 32-215

Phillip Isaac, Clare Dunning, Jon Links, Shao-You Zhao

We analyse a $p + ip$ -wave pairing BCS Hamiltonian, coupled to a single bosonic degree of freedom representing a molecular condensate, and investigate the BEC-BCS crossover for this system. For a restriction on the coupling parameters, we show that the model is integrable and we derive the exact solution by the algebraic Bethe ansatz. We also obtain explicit formulae for correlation functions.

14.12. Super parafermions: The $osp(2|2)_k/u^2(1)$ case

Sam Kault (The University of Queensland)

14:00 Tuesday 28 September 2010 – 32-215

Sam Kault, Yao-Zhong Zhang

The technique of bosonisation allows complex affine Lie (super) algebras to be expressed as a composite of more elemental operators. We discuss the bosonisation of the $osp(2|2)_k/u^2(1)$ algebra, and its extension outside the root lattice to form the surprisingly general double indexed $\psi_{r,s} osp(2|2)_k/u^2(1)$ parafermion. We explore both the positive, and associated negative modes in full. We demonstrate the utility of this approach to finding conformal dimensions and structure constants of other, possibly more general affine Lie (super) coset algebras.

14.13. Exact solutions of a family of spin boson models

Yuan-Harng Lee (The University of Queensland)
 16:30 Tuesday 28 September 2010 – 32-215
 Yuan-Harng Lee

We derive the dynamical symmetry algebras and obtain the exact Bethe ansatz solutions of a wide class of Spin Boson Hamiltonians that appears in the field of atomic, molecular, nuclear and optical physics. In particular, this class of Hamiltonians include some well known models such as the Bose Hubbard model, the Lipkin–Meshkov–Glick model, the molecular asymmetric rigid rotor and the Tavis–Cummings model.

14.14. Chiral phases in an interacting anyon system

Jon Links (The University of Queensland)
 17:30 Wednesday 29 September 2010 – 32-215
 Peter Finch, Holger Frahm, Jon Links

A model will be introduced which describes interacting anyons on a one-dimensional lattice. An exact solution provided by Bethe ansatz methods allows for the calculation of the ground-state energy and momentum. These results point towards a phase diagram which includes chiral phases.

14.15. Kauffman knot polynomials in classical abelian Chern–Simons field

Xin Liu (University of Sydney)
 15:00 Thursday 30 September 2010 – 32-215
 Xin Liu

Kauffman knot polynomial invariants are discovered in classical abelian Chern–Simons field theory. A topological invariant $t^{I(\mathcal{L})}$ is constructed for a link \mathcal{L} , where I is the abelian Chern–Simons action and t a formal constant. For oriented knotted vortex lines, t^I satisfies the skein relations of the Kauffman R-polynomial; for un-oriented knotted lines, t^I satisfies the skein relations of the Kauffman bracket polynomial. As an example the bracket polynomials of trefoil knots are computed, and the Jones polynomial is constructed from the bracket polynomial. This theory has found applications in topological fluid mechanics, where an important topological invariant, the so-called helicity, is the abelian Chern–Simons action. Our analysis for classical Chern–Simons theory is useful in the study of reconnection of vortex lines and other phenomena in fluid flows.

14.16. Numerical simulations of the Ising model on the Union Jack lattice

Vincent Mellor (The University of Queensland)
 17:00 Monday 27 September 2010 – 32-215
 Vincent Mellor

In this talk I will briefly recall the results of Wu and Lin (J. Phys. A: Math. Gen. **20**, 5737 (1987)) for the magnetisation of the Ising model on a Union Jack lattice, and their classification of phases at zero temperature. In the second part of the talk I will present numerical simulation results. These simulations will be performed using a Monte Carlo method, specifically the Metropolis–Hastings algorithm, to simulate a Markov chain. Simulation results will be presented for ferromagnetic, antiferromagnetic and metamagnetic systems. Finally I will analyse these findings and discuss how the simulation results differ from the predictions of Wu and Lin.

14.17. The lattice structure of Connection preserving deformations

Christopher Ormerod (La Trobe University)
 17:30 Tuesday 28 September 2010 – 32-215
 Christopher M. Ormerod

When considering systems of linear q -difference equations, we may deduce a special connection matrix. We prescribe a method of deforming the system of linear q -difference that gives rise to a very nice lattice structure. Fixing a connection matrix defines a variety, each translation is equivalent to a rational automorphism of the variety. We will present the third and fourth q -Painlevé equations as examples of such automorphisms.

14.18. Separation of variables for the symplectic character using Sklyanin’s Q -operator approach

Anita Ponsaing (The University of Melbourne)
 17:00 Tuesday 28 September 2010 – 32-215
 Anita Ponsaing

We present a separation of variables method for the character of the symplectic group, which is the Schur function for the type C root system. We closely follow the method of Kuznetsov, Mangazeev and Sklyanin, who used the Q -operator approach to separate the variables of Jack polynomials associated to the root system of type A. We thus transform the multivariate Hamiltonian spectral problem associated with the symplectic character into a set of single-variable differential equations.

14.19. Indecomposable representations in physics

David Ridout (Australian National University)

14:30 Wednesday 29 September 2010 – 32-215

David Ridout

A significant fraction of modern mathematical physics boils down to studying the representation theory of certain groups and/or algebras. Historically, the emphasis has been on studying irreducible representations, in particular, those which are unitarisable. However, sometimes it is necessary to consider representations which are merely indecomposable, rather than irreducible. This talk will briefly survey indecomposability and highlight various areas of theoretical physics where their appearance is unavoidable, before turning to classification results for a particular class of representations relevant to logarithmic conformal field theory.

This talk discusses joint work with Thomas Creutzig, Kalle Kytölä, Pierre Mathieu, Yvan Saint-Aubin and Jörg Teschner.

14.20. Topological T-duality in homotopy theory

Craig Westerland (The University of Melbourne)

15:00 Tuesday 28 September 2010 – 32-215

Craig Westerland

We review the topological T-duality of Bouwknegt-Evslin-Mathai and others, and reinterpret their result in the language of stable homotopy theory. This duality may be considered as an exotic non-degenerate pairing in the category of modules over the K-theory spectrum.

14.21. On Wakimoto free field realizations of current algebras and superalgebras

Yao-Zhong Zhang (The University of Queensland)

14:30 Thursday 30 September 2010 – 32-215

Yao-Zhong Zhang

Obtaining explicit Wakimoto free field representations of higher-rank current (super)algebras had been mathematically challenging and had been achieved only for some isolated cases. In a series of papers, we have given a complete solution to the problem for all classical current algebras and superalgebras. In this talk, I will outline the techniques we used to solve the problem.

15. Noncommutative Geometry and Operator Algebras

15.1. Spectral flow inside essential spectrum

Nurulla Azamov (Flinders University)

13:30 Thursday 30 September 2010 – 32-213

Nurulla Azamov

As is known, spectral flow of eigenvalues is defined for self-adjoint operators with compact resolvent, which ensures that the spectrum is discrete. More generally, if spectra of a path of self-adjoint operators have gaps in the essential spectrum, then it is still possible to define spectral flow in these gaps.

In this talk I shall discuss definition of spectral flow which allows to generalize this notion to the case of "spectral flow of eigenvalues" (more generally, singular spectrum) everywhere on the spectral line, including essential spectrum. Proofs of properties of this generalized spectral flow are based on a new approach to abstract scattering theory.

15.2. Modular non-commutative geometries and quantum gravity

Paolo Bertozzini (Thammasat University)

14:30 Wednesday 29 September 2010 – 32-213

Paolo Bertozzini, Roberto Conti, Wicharn

Lewkeeratiyutkul

Making use of Tomita–Takesaki modular theory, we associate spectral non-commutative geometries to states over (categories of) C^* -algebras of partial observables in a covariant quantum theory and we describe some possible relations with current research work in (modular) non-commutative geometry and (loop) quantum gravity.

15.3. Boundary quotients of the Toeplitz algebra of the affine semigroup over the natural numbers

Nathan Brownlowe (University of Wollongong)

15:00 Tuesday 28 September 2010 – 32-213

Nathan Brownlowe

Laca and Raeburn have recently studied the Toeplitz algebra $\mathcal{T}(\mathbb{N} \rtimes \mathbb{N}^\times)$ of the affine semigroup over the natural numbers $\mathbb{N} \rtimes \mathbb{N}^\times$. They proved that the boundary quotient of $\mathcal{T}(\mathbb{N} \rtimes \mathbb{N}^\times)$ in the sense of Crisp and Laca corresponds to Cuntz's simple purely infinite C^* -algebra $\mathcal{Q}_\mathbb{N}$.

We present further work on the boundary quotient of $\mathcal{T}(\mathbb{N} \rtimes \mathbb{N}^\times)$, as well as work on two other quotients which we call the additive and multiplicative boundary quotients of $\mathcal{T}(\mathbb{N} \rtimes \mathbb{N}^\times)$. In particular, we examine the connections between these quotients and some Exel crossed products by endomorphic actions of the semigroup \mathbb{N}^\times .

If time permits, we will give a description of the KMS states on the boundary quotients of $\mathcal{T}(\mathbb{N} \rtimes \mathbb{N}^\times)$. This description follows from Laca and Raeburn's computation of the KMS states on $\mathcal{T}(\mathbb{N} \rtimes \mathbb{N}^\times)$.

15.4. Index theory on noncompact manifolds from a noncommutative perspective

Alan Carey (Australian National University)

13:30 Wednesday 29 September 2010 – 32-213

Alan Carey

There is no systematic approach to index theorems for Dirac-type operators on noncompact manifolds. I will explain some work in progress with Victor Gayral, Adam Rennie and Fedor Sukochev in which we aim to rectify this defect using cyclic cohomology and noncommutative analysis.

15.5. The Yang–Mills functional and Laplace's equation on quantum Heisenberg manifolds

Sooran Kang (University of Wollongong)

14:00 Wednesday 29 September 2010 – 32-213

Sooran Kang

In this talk, we discuss the Yang–Mills functional and a certain family of its critical points on quantum Heisenberg manifolds using noncommutative geometrical methods developed by A. Connes and M. Rieffel. In the main result, we construct a certain family of connections on a projective module over a quantum Heisenberg manifold that give rise to critical points of the Yang–Mills functional. Moreover, we show that this set of critical points can be described as a set of solutions to Laplace's equation on quantum Heisenberg manifolds.

15.6. Singular traces and applications to Connes' noncommutative integral

Steven Lord (University of New South Wales)

14:30 Tuesday 28 September 2010 – 32-213

Steven Lord, Fedor Sukochev (UNSW), Nigel Kalton (MU), Denis Potapov (UNSW)

I present a new characterisation of the formula $\phi(AT)$ where ϕ is any trace on a (two sided) ideal of compact operators \mathcal{I} , $T \in \mathcal{I}$, and $A \in \mathcal{L}(H)$. A primary application of the characterisation is a Dominated Convergence Theorem for Connes' noncommutative integral.

15.7. Constructions of Cuntz–Pimsner algebras for iterated function systems

Jahne Meyer (Australian National University)

17:00 Tuesday 28 September 2010 – 32-213

Jahne V. Meyer

A hyperbolic iterated function system (IFS) is a finite set of proper contractions on a complete metric space X . It has an *attractor*, $\mathbb{A} \subset X$. For general IFS, we can construct a Cuntz–Pimsner algebra $\mathcal{O}_{\mathcal{E}}$ associated to a C^* –correspondence \mathcal{E} over $C(\mathbb{A})$. We shall look at examples of such C^* –correspondences and explore whether $\mathcal{O}_{\mathcal{E}}$ has desired features: such as being simple, purely infinite and not isomorphic to \mathcal{O}_N . We shall discover when $\mathcal{O}_{\mathcal{E}}$ falls short of these properties and how *critical points* of \mathbb{A} play an important role in our construction.

15.8. Poincaré duality for hyperbolic dynamical systems

Whittaker Michael (University of Wollongong)

17:00 Monday 27 September 2010 – 32-213

J. Kaminker and I. Putnam and M. Whittaker

Noncommutative Poincaré duality for a pair of C^* -algebras was formulated by Kasparov to generalize the notion of Poincaré duality for topological spaces. Hyperbolic dynamical systems, known as Smale spaces, will be introduced along with two C^* -algebras associated with a Smale space. I will show that these C^* -algebras are Poincaré dual and discuss some consequences.

15.9. Primitive ideals of k-graph algebras

David Pask (University of Wollongong)

16:30 Tuesday 28 September 2010 – 32-213

David A. Pask and Sooran Kang

We describe the gauge invariant primitive ideals of a k-graph C^* -algebra and give some examples.

15.10. Classification of noncommutative torus bundles

Rishni Ratnam (Australian National University)

16:30 Monday 27 September 2010 – 32-213

Rishni Ratnam

In 2005 Bouwknegt, Hannabuss and Mathai proposed that the curvature classes of noncommutative torus bundles arising as T-duals of commutative torus bundles should be classified by a group arising as the target of an “integration over the fibres” map in a dimensionally reduced Gysin sequence. Their paper however was restricted to the image of integer cohomology in de Rham cohomology, and therefore omitted torsion.

Somewhat earlier, Packer, Raeburn and Williams, using the theory of group actions on continuous trace C^* -algebras, had written a version of the

Gysin sequence that includes torsion, but was restricted to the case where the Mackey obstruction for the action was trivial.

Using the groupoid cohomology of Tu we construct an integer cohomology version of the Gysin sequence that agrees with both of these results and extends to the case where the Mackey obstruction for the action is nontrivial. This sequence consequently provides a group that classifies noncommutative torus bundles that are T-dual to commutative ones.

15.11. Riemannian manifolds in noncommutative geometry

Adam Rennie (Australian National University)

14:00 Thursday 30 September 2010 – 32-213

Steven Lord, Adam Rennie, Joe Varilly

I will describe joint work with Steven Lord (Adelaide) and Joe Varilly (Costa Rica) showing how Riemannian manifolds can be described in NCG. Previous axiomatic descriptions of manifolds have been restricted to generalisations of manifolds which are spin or spin-c. We show how the two notions relate to each other. The key tools are Tomita-Takesaki theory, a new understanding of connections on bimodules, and a streamlined picture of certain Kasparov products.

15.12. Towards a modular spectral triple for $SU_q(2)$

Roger Senior (Australian National University)

17:30 Tuesday 28 September 2010 – 32-213

Roger Senior

I will present recent results on the development of a modular spectral triple for the quantum group $SU_q(2)$ and demonstrate why the concept of a modular spectral triple is necessary in this context.

15.13. Renault’s equivalence theorem for reduced groupoid C^* -algebras

Aidan Sims (University of Wollongong)

14:30 Thursday 30 September 2010 – 32-213

Aidan Sims and Dana P. Williams

Renault’s Equivalence Theorem says that if two groupoids are equivalent in the sense that they both act freely and properly on a common space, then their full C^* -algebras are Morita equivalent. The proof depends on Renault’s deep Disintegration Theorem.

We indicate how Renault’s equivalence theorem may be proved for reduced groupoid C^* -algebras using linking groupoid techniques. In particular, our proof does not use the equivalent theorem for full algebras and does not depend on the Disintegration Theorem.

15.14. Purely infinite simple real C^* -algebras

Peter Stacey (La Trobe University)

15:30 Tuesday 28 September 2010 – 32-213

Peter Stacey

The classification by Kirchberg and Phillips of purely infinite, simple, separable, nuclear C^* -algebras was a spectacular contribution to Elliott's program to classify a large class of nuclear, separable, simple C^* -algebras in terms of K -theory. I will talk about the corresponding result for real C^* -algebras. Although the proof closely follows the complex case, there are some significant differences. My aim is to provide an overview without technical details.

show that the embedding of $C^*(\Lambda)$ in $C^*(\Gamma)$ restricts to an embedding of their diagonals which implements π via the homeomorphism between the spectrum and the boundary paths.

15.15. Lidskii formula for Dixmier traces

Fedor Sukochev (University of New South Wales)

14:00 Tuesday 28 September 2010 – 32-213

A. Sedaev, F. Sukochev, D. Zanin

We establish several analogues of the classical Lidskii Theorem for some special classes of singular traces (Dixmier traces and Connes-Dixmier traces) used in noncommutative geometry.

15.16. Parametrised strict deformation quantisation of C^* -algebras and modules and T-duality

Mathai Varghese (University of Adelaide)

15:30 Monday 27 September 2010 – 32-213

Mathai Varghese

I will talk about a generalization of Rieffel's theory of strict deformation quantisation, to the parametrised case, and give various applications, to T-duality and also to the construction of new noncommutative manifolds and bundles over these.

15.17. The spectrum of the diagonal C^* -algebra of a k -graph

Samuel Webster (University of Wollongong)

17:30 Monday 27 September 2010 – 32-213

Samuel B. G. Webster

A k -graph is a k -dimensional analogue of a directed graph. To each path in row-finite k -graph Λ we can associate a partial isometry, then $C^*(\Lambda)$ is the C^* -algebra generated by these partial isometries subject to a set of Cuntz-Krieger relations. Given a row-finite k -graph Λ , we restrict our attention to the diagonal C^* -subalgebra D_Λ of $C^*(\Lambda)$. We endow the path space of Λ with a locally-compact Hausdorff topology, and identify the spectrum of D_Λ with the space of boundary-paths of Λ . We outline a process which constructs from Λ a row-finite k -graph Γ with no sources such that the resulting C^* -algebras are Morita equivalent. We then identify the boundary paths of Λ with a subset of those of Γ via a map π , and

16. Optimization and Applications

16.1. Rail scheduling on a single track network: Heuristic and exact approaches

Siti Amirah Abd Rahman (University of New South Wales)

15:30 Tuesday 28 September 2010 – 1-E215

Siti Amirah Abd Rahman

The majority of the world's freight rail network consists of single track lines with sidings where interactions between trains occur (meet, pass, overtake). Typically, the problem is to generate a schedule for which the trains spend as little time as possible traversing between loading and unloading stations whilst ensuring that the interactions happen safely. In this talk I will briefly discuss the problem model and integer program formulation.

16.2. On a sufficient condition for equality of two maximal monotone operators

Regina Burachik (University of South Australia)

14:30 Thursday 30 September 2010 – 1-E215

Regina S. Burachik (UniSA), Juan Enrique Martinez-Legaz (Universitat Autònoma de Barcelona), Marco Rocco (Università degli Studi di Bergamo)

We establish minimal conditions under which two maximal monotone operators coincide. Our first result is inspired by an analogous result for subdifferentials of convex functions. In particular, we prove that two maximal monotone operators T, S which share the same convex-like domain D coincide whenever $T(x) \cap S(x)$ not empty for every $x \in D$. We extend our result to the setting of enlargements of maximal monotone operators. More precisely, we prove that two operators coincide as long as the enlargements have nonempty intersection at each point of their common domain, assumed to be convex-like and open. We then use this to obtain new facts for convex functions: we show that the difference of two convex functions whose subdifferentials have a common open convex-like domain is constant if and only if their epsilon-subdifferentials intersect at every point of that domain.

16.3. An exact model for the k -connected wireless survivable network problem

Christina Burt (MASCOS/The University of Melbourne)

13:30 Thursday 30 September 2010 – 1-E215

Christina Burt

Survivable wired networks have been extensively studied up to 2-connected. More recently, 1-connected wireless networks have been addressed,

but k -connected networks remain an open problem. We prove that, in contrast to the wired case, the minimum transmission k -connected optimisation problem is NP-hard even for $k = 1$. We construct a multi-commodity flow model, extend preprocessing and valid inequalities from the literature; and develop a new warm start heuristic to achieve results for small networks. We anticipate that we will be able to use these results to help derive local heuristics for real-time use as future research.

16.4. Equilibrium and learning in traffic network games

Roberto Cominetti (Universidad de Chile)

13:30 Wednesday 29 September 2010 – 1-E215

Roberto Cominetti

Congestion is a common characteristic in modern telecommunication networks as well as in transportation systems of large urban areas. In this talk we review some recent developments in modeling traffic equilibrium in congested networks. Starting from the classical models of Wardrop Equilibrium and Stochastic User Equilibrium, we will present in more detail the notion of Markovian Traffic Equilibrium as well as numerical methods for computing it. We will show how all these equilibrium models admit a unified reformulation in terms of a strictly convex mathematical program. From these static equilibrium notions we move on to present a recent attempt to model the dynamic behavior of travelers by using a stochastic adaptive-learning process, and describe its asymptotic convergence towards equilibrium.

16.5. Robust airline scheduling: Minimising propagated delay in an integrated routing and crewing framework

Michelle Dunbar (University of New South Wales)

14:30 Tuesday 28 September 2010 – 1-E215

Michelle Dunbar

To retain a degree of tractability, the airline scheduling problem has traditionally been sequentially decomposed into various stages (e.g. schedule generation, fleet assignment, aircraft routing, and crew pairing), with the decisions from one stage imposed upon the decision making process in subsequent stages. Whilst this approach greatly simplifies the solution process, it unfortunately fails to capture the many dependencies between the various stages, most notably between those of aircraft routing and crew pairing, and how these dependencies affect the propagation of delays through the flight network. As delays are

commonly transferred between late running aircraft and crew, it is important that aircraft routing and crew pairing decisions are made together. The propagated delay may then be accurately estimated to minimise the overall propagated delay for the network and produce a robust solution for both aircraft and crew. In this presentation we outline a new approach to accurately calculate and minimise the cost of propagated delay, in a framework that integrates aircraft routing and crew pairing.

16.6. A new approach to the feasibility pump

Andrew Eberhard (Royal Melbourne Institute of Technology)

17:30 Tuesday 28 September 2010 – 1-E215

A. Eberhard, N. Boland and A. Tsoukalas

In the talk we discuss how the feasibility pump (FP) heuristic can be interpreted as a multi-start, global optimization algorithm that utilizes a fast local minimizer that in many respects resembles a discrete version of the proximal point algorithm. In effect the proximal point iterates calculates an integrality-gap measure which is then attempted to be driven to zero. This gap-measure has many local minima, some of which correspond to feasible integral solutions. This interpretation suggests alternative ways of incorporating restarts when the basic iterates of the FP cycle, one of which is novel application of cutting planes. Numerical experiments show encouraging results on standard test libraries.

16.7. Multi-stage integer stochastic programming under endogenous uncertainty with an application to open pit mining

Gary Froyland (University of New South Wales)

16:30 Tuesday 28 September 2010 – 1-E215

Natashia Boland, Irina Dumitrescu, Gary Froyland

We consider the difficult case of multi-stage integer stochastic programming under endogenous uncertainty (release of uncertainty depends upon decisions taken). We show that this uncertainty can be modelled naturally using integer variables. The resulting models have a large number of constraints which can be reduced using the scenario structure. These concepts are illustrated with an application in open pit mine scheduling, utilising multiple stochastic geological estimates. Our model allows mining and processing decisions to flexibly adapt over time, in response to observation of the geology of the material mined. We discuss a number of model reductions to decrease computational effort.

16.8. Error bounds: necessary and sufficient conditions

Alexander Kruger (University of Ballarat)

17:00 Tuesday 28 September 2010 – 1-E215

Alexander Kruger

I am going to present a classification scheme of necessary and sufficient criteria for the error bound property incorporating the existing conditions.

Several derivative-like objects both from the primal as well as from the dual space are used to characterize the error bound property of extended-real-valued functions.

16.9. Strong duality for monotropic programming in infinite dimensions

Saba Majeed (University of South Australia)

14:00 Tuesday 28 September 2010 – 1-E215

Regina S. Burachik and Saba Majeed

We introduce the problem of monotropic programming and its dual in reflexive Banach spaces. We obtain strong duality by considering a new constraint qualification based on the closedness of the sum of the epigraphs of convex functions. We ensure that our assumption is weaker than those in the literature.

16.10. Regularity conditions in multiobjective optimization problems for strong Karush–Kuhn–Tucker conditions

Mohammed Mustafa Rizvi (University of South Australia)

15:00 Tuesday 28 September 2010 – 1-E215

Regina S. Burachik and M. M. Rizvi

In this paper, we consider multiobjective optimization problems with inequality constraints where objective and constraint functions are differentiable. We establish strong Karush–Kuhn–Tucker necessary optimality conditions under the new regularity conditions. We are able to show that our regularity condition is weaker than Maeda (J. Optim. Theory Appl. 80: 483–500, 1994) and therefore it is the weakest available condition in the literature.

16.11. Optimization and Feasibility Problems Related to Proton Therapy

Reinhard Schulte (Loma Linda University)

14:00 Thursday 30 September 2010 – 1-E215

Reinhard Schulte, Scott Penfold, Yair Censor

Proton therapy has evolved over the last 50 years and with the establishment of an increasing number of treatment centers worldwide is now on the verge of becoming a mainstream radiation therapy modality. Due to the fact that protons can be directed and focused with magnetic fields and their range can be predetermined by adjusting proton energy, it is possible to optimize radiotherapy to a degree that is unprecedented in radiation oncology, even with modern techniques such as IMRT. To make this goal reality, optimization and feasibility solving are important tools, and these areas where mathematicians can provide support and expertise working as part of an interdisciplinary group comprised of physicists, computer scientists, and physicians. In this talk, I will give real-life examples on where optimization feasibility methods can be applied to solving problems in proton therapy. The examples presented will include feasibility seeking algorithms for solving very large linear systems encountered in the reconstruction of proton computed tomography and optimization of proton fluence distributions for intensity-modulated proton therapy.

16.12. Analysis in CAT(0) spaces

Brailey Sims (University of Newcastle)

14:30 Wednesday 29 September 2010 – 1-E215

Brailey Sims

In many situations there is no natural linear structure present, instances include:

- *State spaces*, where it often makes sense to measure how near one state is to another, but adding or scaling states may make no sense. The special states in which a Robot may find itself provides an example (see work by Robert Grist and his group at the University of Illinois).
- *Cognitive models of recognition* in which the genus of an object is identified with that of its nearest prototype; Voronoi cells/tessellations.

Convex metric spaces and in particular those of negative curvature, the so called CAT(0) spaces, provide an ambient setting for such situations. Hilbert spaces are archetypical and much of their rich geometry is retained by all CAT(0) spaces. This allows for the development in CAT(0) spaces of analogues to convex and more generally nonlinear analysis in normed spaces. One possible impediment is the seeming absence of duality and hence of a weak topology, however, this too can be overcome.

We will briefly survey these developments.

17. Probability and Statistics

17.1. Rare-event simulation using Markov chain Monte Carlo

Zdravko Botev (The University of Queensland)

15:00 Tuesday 28 September 2010 – 32-211

Zdravko Botev

Markov Chain Monte Carlo (MCMC) is a valuable computational tool in applied statistics with major applications in the area of Bayesian inference. However, attempts to use MCMC for the estimation of rare-event probabilities has so far been unsuccessful. The ergodic estimators constructed using traditional MCMC algorithms typically have high variance and bias, making them inefficient and unreliable. In this talk we present a new MCMC approach to rare-event probability estimation that results in reliable estimators. The approach combines ideas from MCMC, nonparametric importance sampling, and Rao–Blackwellization.

17.2. Estimating differential equations from real data

Jiguo Cao (Simon Fraser University)

16:30 Tuesday 28 September 2010 – 32-211

Jiguo Cao

Differential equations describe the rate of change of a process. They are widely used in medicine, engineering, ecology and a host of other applications. One central and difficult problem is how to estimate DE parameters from noisy data. We have developed the generalized profiling method to solve this problem. DE solutions are approximated by nonparametric functions, which are estimated by penalized smoothing with DE-defined penalty. The computation is much faster than other methods. I will demonstrate our method by some applications in ecology, genetics, and pharmacokinetics.

17.3. Consistency of Markov chain quasi-Monte Carlo on continuous state spaces

Josef Dick (University of New South Wales)

14:30 Tuesday 28 September 2010 – 32-211

S. Chen, J. Dick, A. Owen

The random numbers driving Markov chain Monte Carlo (MCMC) simulation are usually modeled as independent uniform $U(0, 1)$ random variables. Tribble reports substantial improvements when those random numbers are replaced by carefully balanced inputs from completely uniformly distributed sequences.

The previous theoretical justification for using anything other than IID $U(0, 1)$ points showed consistency for estimated means, but only applies

for discrete stationary distributions. We extend those results to some MCMC algorithms for continuous stationary distributions. The main motivation is the search for quasi-Monte Carlo versions of MCMC. As a side benefit, the results also establish consistency for the usual method of using pseudo-random numbers in place of random ones.

17.4. Estimating change-points in biological sequences via the cross-entropy method

Gareth Evans (The University of Queensland)

14:30 Wednesday 29 September 2010 – 32-211

Gareth Evans, George Sofronov, Jonathan Keith, Dirk Kroese

The genomes of complex organisms, including the human genome, are known to vary in GC content along their length. That is, they vary in the local proportion of the nucleotides G and C, as opposed to the nucleotides A and T. Changes in the GC content are often abrupt, producing well-defined regions.

We model DNA sequences as a multiple change-point process in which the sequence is separated into segments by an unknown number of change-points, with each segment supposed to have been generated by a different process. Multiple change-point problems are important in many biological applications, particularly in the analysis of DNA sequences. Multiple change-point problems also arise in segmentation of protein sequences according to hydrophobicity.

We use the Cross-Entropy method to estimate the positions of the change-points and use an information criterion to determine the optimal number of change-points. Parameters of the process for each segment are approximated with maximum likelihood estimates. We will show examples to illustrate the effectiveness of the approach.

17.5. The Clustering of High-Dimensional Data

Geoffrey McLachlan (The University of Queensland)

13:30 Thursday 30 September 2010 – 32-211

Geoff McLachlan

We consider the clustering of high-dimensional data where the number n of observations is quite small relative to the dimension p of the observation vector. In such situations (the big p , small n problem), it is common to reduce first the number of variables (features) before undertaking the clustering of the data set and/or to adopt some method of regularization. In this talk we consider the latter approach in the context of applications of normal mixture models to cluster

high-dimensional data. The focus is on the use of mixtures of factor analyzers in order to reduce the number of parameters in the component-covariance matrices of the mixture model for the underlying density. Examples are presented on the clustering of microarray gene-expression data.

17.6. Adaptive optimal scaling of Metropolis–Hastings algorithms

Scott Sisson (University of New South Wales)
15:00 Thursday 30 September 2010 – 32-211
Scott Sisson, Paul Garthwaite and Yanan Fan

In Metropolis-Hastings algorithms it is common to manually adjust the scaling parameter of the proposal distribution so that the sampler achieves a reasonable overall acceptance probability. Some theoretical results suggest that the overall acceptance probability should be around 0.44 for univariate and 0.234 for multivariate proposal distributions. However, manually tuning the scaling parameter(s) to obtain this can be time-consuming, and impractical in high dimensions.

I will present an adaptive method for the automatic scaling of Random-Walk Metropolis-Hastings algorithms. This method will adaptively update the scaling parameter of the proposal distribution to achieve a pre-specified overall acceptance probability. Our approach relies on the use of the Robbins–Monro search process, whose performance is determined by an unknown steplength constant, for which we give a very simple estimator. I will demonstrate how to incorporate the Robbins–Monro process into Metropolis–Hastings algorithms and demonstrate its effectiveness

through simulated and real data examples. The algorithm is a quick robust method for finding the scaling parameter that yields a specified acceptance probability.

17.7. Differential gene expression analyses of data from deep-sequencing technologies

Gordon Smyth (Walter and Eliza Hall Institute)
14:00 Thursday 30 September 2010 – 32-211
Gordon Smyth

Modern technologies such as microarrays and Next-Generation deep-sequencing platforms are able to measure the transcriptional level of every gene in the genome given a sample of RNA from a cell or tissue. This gives a snapshot of the activity level of every gene in a particular cell type at a particular time. These activity snapshots can then be related to various predictors such as disease status or genotype. In this way, we can study which genes are associated with different conditions, and hence learn much about gene function and inter-gene networks. This is an exciting playground for a statistician, not just because of the

access to cutting-edge science, but also because of the opportunity to apply and develop a wealth of interesting statistical ideas. Genomic data is hugely high-dimensional with tiny sample sizes, so the familiar rules of univariate inference are often radically changed. This talk will describe some of our work using a variety of multivariate and empirical Bayes techniques to analyze transcriptional profiles, focusing particularly on RNA sequencing data from the latest technologies. We have developed some novel empirical Bayesian approaches, with automatic generation of appropriate prior distributions, to deal with such data.

17.8. A Python package for Bayesian estimation using Markov chain Monte Carlo

Chris Strickland (Queensland University of Technology)

17:00 Tuesday 28 September 2010 – 32-211

Chris Strickland, Robert Denham, Clair Alston and Kerrie Mengersen

Abstract Markov chain Monte Carlo (MCMC) estimation provides a solution to the complex integration problems that are faced in the Bayesian analysis of statistical problems. The implementation of MCMC algorithms is, however, code intensive and extremely time consuming. We have developed a Python package, which is called PyMCMC, that aids in the construction of MCMC samplers and helps significantly reduce the likelihood of coding error, as well as aid in the minimisation of repetitive code. PyMCMC contains classes for the Gibbs sampler, Metropolis Hastings, independent Metropolis Hastings, random walk Metropolis Hastings, orientational bias Monte Carlo, Slice Sampler and a module for Bayesian Regression analysis. PyMCMC is straightforward to optimise, taking advantage of the Python libraries Numpy and Scipy, as well as being readily extensible with C or Fortran. PyMCMC eases the construction of complex algorithms, as well as providing a code efficient interface for the user.

17.9. Random sequential adsorption on random trees

Aidan Sudbury (Monash University)

13:30 Wednesday 29 September 2010 – 32-211

Aidan Sudbury

When gas molecules bind to a surface they may do so in such a way that the adsorption of one molecule inhibits the arrival of others. Two models which have frequently been studied are the “dimer” model and the “blocking” model. Rather complete solutions of these have been obtained on fixed trees or Bethe lattices. In this talk comparisons are made between the occupation probabilities for vertices between fixed and random trees.

17.10. Unifying methods for species distribution modelling using presence-only data in ecology

David Warton (University of New South Wales)

14:30 Thursday 30 September 2010 – 32-211

David I. Warton

Technology has enabled rapid advances in data analysis across multiple disciplines with the collection of new types of data posing new challenges, and with the development of new methods for analysing data rapidly increasing our analytical capacity. An important example is species distribution modelling using presence-only data; geographic information systems (GIS) enable the study of environmental variables at a spatial resolution far higher than previously possible, and new methods of data analysis are rapidly being developed for studying how such environmental variables relate to species occurrence (or “presence-only”) records.

I will show that three different methods of analysis, from the ecology, machine learning and statistical literatures, are all equivalent. This advance offers new insights on how to overcome the methodological weaknesses of the two most widely used methods for species distribution modelling using presence-only data—pseudo-absence regression and MAXENT—via the use of a point process model specification. An example of how this result offers new insight is in understanding the role of spatial resolution in species distribution modelling. The increased functionality available via point process models will be discussed, and finally, a new method for accounting for observer bias proposed.

17.11. A Functional Limit Theorem for the Empirical Process associated with Spatial Causal ARMA Models

Neville Weber (University of Sydney)

14:00 Wednesday 29 September 2010 – 32-211

Neville C. Weber and B. Gail Ivanoff

Let $(X_{i,j} : i, j \in \mathbf{Z})$ be a stationary random field on the lattice. Let F be the distribution function of $X_{i,j}$. We are interested in the behaviour of the empirical distribution function

$$H_{m,n}(x) := \frac{1}{mn} \sum_{i=1}^m \sum_{j=1}^n I(X_{i,j} \leq x).$$

As with stationary stochastic processes the random field is said to have short memory if and only if its covariance function is absolutely summable, otherwise it is said to have long memory. While there are many results for the empirical process associated with long memory, stationary random fields the results for short memory fields typically

assume mixing or association. For short memory, stationary, stochastic processes these assumptions can be avoided by using martingale methods. In general the martingale techniques do not extend to spatial processes due to the lack of a total order on the lattice.

An exception is provided by the short memory, causal, autoregressive moving average (ARMA) process

$$X_{s,t} = \sum_{i \geq 0} \sum_{j \geq 0} a_{ij} \xi_{s-i,t-j}, \quad s, t \in \mathbf{Z},$$

where $\{\xi_{u,v} : u, v \in \mathbf{Z}\}$ is an array of independent and identically distributed random variables with mean 0 and variance 1 and $\{a_{i,j}\}$ is an array of constants with $\sum_{i=0}^{\infty} \sum_{j=0}^{\infty} |a_{i,j}| < \infty$. By judicious choice of σ -fields and element enumeration, the structure of this process allows us to exploit one-dimensional martingale arguments, similar to those of Doukhan and Surgailis (1998) for short memory linear processes, to establish a functional limit theorem for the empirical process.

17.12. Non-monotonicity of the generalized score statistic

Alan Welsh (Australian National University)

14:00 Tuesday 28 September 2010 – 32-211

C. A. Field, Zhen Pang and A. H. Welsh

We show in the context of the linear regression model fitted by Gaussian quasi-likelihood estimation that the generalized score statistics of Boos (1992, Amer. Statist.) and Hu and Kalbfleisch (2000, Canad. J. Statist.) for individual parameters can be non-monotone in the parameter, making it difficult to make inferences from the generalized score statistic. The phenomenon is due to the form of the functional dependence of the estimators on the parameter being held fixed and the way this affects the score function and/or the estimator of the asymptotic variance.

17.13. Bayes' factor computation for hierarchical hidden Markov models

Nicole White (Queensland University of Technology)

15:30 Tuesday 28 September 2010 – 32-211

Nicole White, Helen Johnson, Peter Silburn, Judith Rousseau, Sophie Donnet, Kerrie Mengersen

When comparing goodness of fit for competing models within a Bayesian framework, a popular criterion is the Bayes' factor, representing evidence in favour of one model over another in the form of a ratio of marginal likelihoods. When these models involve a latent variable, s , Chib (1995) provides a novel computational approach for approximating the marginal likelihood based

on MCMC output. However, for models with a hierarchical latent structure, this approach is complicated by the presence of multiple latent variables.

In this work, we consider extending Chib's approach to approximate the marginal likelihood of a model with two latent variables, s and z , where z is conditional on s . In particular, we focus on hierarchical hidden Markov models with an application to spike identification and sorting for extracellular recordings. Results for both simulated and real datasets are presented, the latter being extracellular recordings of the brain taken during Deep Brain Stimulation, a popular treatment for advanced Parkinson's disease.

18. Stochastic Processes and Modelling

18.1. On random graphs, random walks and the Hamiltonian cycle problem

Ali Eshragh (University of South Australia)

16:00 Monday 27 September 2010 – 32-207

Ali Eshragh and Jerzy Filar

In this talk, we introduce a certain polytope, H , induced by a particular discounted Markov decision process corresponding to a given graph G . It has been proved that if the graph G is Hamiltonian, then corresponding to each Hamiltonian cycle in graph G , there exists an extreme point in polytope H , namely, Hamiltonian extreme point. We concentrate on random graph $G_{n,p}$, where n is the total number of nodes and p is the probability of having an arc between any pair of nodes. We show that the set of all extreme points of polytope H corresponding to a random graph $G_{n,p}$ can be partitioned into four subsets and derive the expected cardinality of each of them. These results indicate that the ratio of expected number of Hamiltonian extreme points to all extreme points decays rapidly as it is of the order $\frac{O(n!)}{O(n^n)}$. However, an adaptation of the polytope H , will be shown to have much more favourable ratios of this type. In particular, we constrain H by appropriately designed, efficient linear constraints, to obtain a new polytope WH that is a subset of H . Numerical results suggest the following two conjectures on WH : (i) Extreme points of polytope WH can be generated, uniformly, in polynomial time; (ii) The expected number of Hamiltonian extreme points in WH is bounded below by a rational function of n .

In order to prove (i), one may try to design a random walk on extreme points of WH which has the property that the underlying Markov chain is rapidly mixing. To prove (ii), a good approach might be to extract certain geometric properties of extreme points of WH and try to use the same notion as utilized in H . We support our conjectures by numerical results.

18.2. Copulas of maximum entropy

Phil Howlett (University of South Australia)

17:30 Wednesday 29 September 2010 – 32-207

Phil Howlett, Julia Piantadosi, Jon Borwein

We find a multi-dimensional checkerboard copula of maximum entropy that matches an observed set of grade correlation coefficients. The problem is formulated as the maximization of a concave function on a convex polytope. Under reasonable constraint qualifications we show that a unique solution exists in the core of the feasible region.

The theory of Fenchel duality is used to reformulate the problem as an unconstrained minimization which is solved numerically using a Newton iteration. We discuss the numerical calculations for some hypothetical examples and describe how this work can be applied to the modelling and simulation of monthly rainfall.

18.3. Multifractal spectra for random self-similar measures via branching processes

Owen Jones (The University of Melbourne)

17:30 Monday 27 September 2010 – 32-207

J.D. Biggins, B.M. Hambly, and O.D. Jones

Random self-similar (or fractal, or recursive) measures can be split into a number of component measures each of which is, after a suitable transformation, a copy of the original measure and these copies are independent given the transformations. Here measures on R^d are considered and the allowed transformations combine a rescaling of the total weight of the measure and the application of a similitude to the set being measured. By drawing on connections with the general branching random walk we obtain a full multifractal spectrum for such measures. Our main contribution is dealing with the geometry of realisations in R^d and our principle aim is to generalise results of Arbeiter and Patzschke (1996) and Patzschke (1997) to allow an unbounded, random, number of components and arbitrarily small rescalings.

18.4. The limits of a mainland-island metapopulation model.

Ross McVinish (The University of Queensland)

17:00 Monday 27 September 2010 – 32-207

Ross McVinish

Stochastic patch occupancy models (SPOMs) are a class of discrete time Markov chains used to model the presence/absence of a population in a collection of habitat patches. This class of model is popular with ecologists due to its ability to incorporate important factors of the habitat patch network such as connectivity and distance between patches as well as heterogeneity in patch characteristics. However, the flexibility of this class of model also makes it difficult to analyse. Properties of the model are typically investigated on a case by case basis using simulation studies or other numerical methods.

We present an asymptotic examination of a simple type of SPOM called the mainland-island model. In this model a single patch called the mainland is connected to a large number of smaller patches called islands. Each island is only connected to the mainland. We discuss the limiting behaviour

of the SPOM as the number of islands increases and the size of the islands decrease relative to the mainland. We demonstrate that a variety of limiting behaviours is possible depending on the scaling of the island size and on the heterogeneity of habitat quality.

18.5. Limit theorems for random fields with cyclical long memory

Andriy Olenko (La Trobe University)

14:00 Wednesday 29 September 2010 – 32-207

Andriy Olenko

There has recently been great interest in time series with long memory, namely series whose dependence decays slowly in the sense that autocovariances are not summable and the spectral density is unbounded. The non-central limit theorem for functionals of such Gaussian process was the object of studies by Rosenblatt, Dobrushin, Major, Gordeckii, Taqqu, Giraitis and others. This concept has been extended to Seasonal/Cyclical Long Memory where the dependence between seasonal or cyclic observations decays similarly slowly. However among the extensive literature about long-range dependence, relatively only few papers are devoted to seasonal long-memory.

We study the asymptotic behavior of weighted functionals of random fields when the underlying data are Gaussian and exhibit cyclical long-memory. Our functionals generalize the Donsker-Prokhorov scheme.

We show that

- (1) the limit is not affected by seasonality for a wide class of functionals, which includes the Donsker-Prokhorov scheme;
- (2) for general schemes, in contrast to the Donsker line, the seasonal effects play a role even for the linear case.

18.6. Limits of large metapopulations with patch dependent extinction probabilities

Philip Pollett (The University of Queensland)

16:30 Monday 27 September 2010 – 32-207

Philip K. Pollett

We propose a model for the presence/absence of a population occupying a collection of habitat patches. The model assumes that colonisation and extinction of the patches occur as distinct phases. Importantly, the local extinction probabilities are allowed to vary between patches. This permits an investigation of the effect of habitat degradation on the persistence of the population. The limiting behaviour of the model is examined as the number of habitat patches increases to infinity. This is done in the case where the number of patches and the initial number of occupied patches increase at the same rate and for the case where the initial

number of occupied patches remains fixed. [This is joint work with Ross McVinish.]

18.7. Evaluating the distribution of generalised hitting times

Joshua Ross (University of Adelaide)

15:30 Monday 27 September 2010 – 32-207

Joshua Ross

We are often interested in the time until a certain event occurs. For example, for HIV we might be interested in the first time a viral load, or cell count, reaches a certain level; for relapsing-remitting diseases such as multiple sclerosis, we might be interested in the time until sustained progression, corresponding to the first time of entering a status of moderate-to-severe disability and remaining in that status for at least Δ time units; or, for conservation biology, we might be interested in the time until a population is at sustained risk of extinction, corresponding to the first time a population drops and remains below a certain threshold for Δ time units. Here we show that the distribution of these random variables may be evaluated as the (maximal) solution to systems of linear equations when the system is modelled as a time-homogeneous Markov chain.

18.8. Waiting-time distributions for queues in which customers accumulate priority as a linear function of their time in the system

Peter Taylor (The University of Melbourne)

13:30 Wednesday 29 September 2010 – 32-207

David Stanford and Peter Taylor

Motivated by a proposed method for managing elective surgery queues, we consider a model for a single-server queue in which customers of class i who arrive at a queue at time a accumulate a priority $b_i(t-a)$ by time t . When the server becomes free, it chooses the customer with the highest current value of the priority, provided that at least one customer is present in the queue. Thus the priority of class i customers is controlled by the rate b_i at which they accumulate priority.

In his classical books on queueing systems, Kleinrock showed how to derive the mean waiting time of customers of class i . For a system with just two customer classes, we consider the more difficult problem of deriving the waiting time distributions of high and low priority customers. Knowledge of these distributions can be used to tune the rates b_i in order to achieve desired performance targets specified in terms of the tails of the waiting time distributions.

18.9. Clubbed binomial approximation for the lightbulb process

Aihua Xia (The University of Melbourne)

18:00 Wednesday 29 September 2010 – 32-207

Aihua Xia

The lightbulb process was motivated by a pharmaceutical study of the effect of dermal patches designed to activate/deactivate targeted receptors [see Rao, Rao and Zhang (2007)] and it evolves as follows. On days $r = 1, \dots, n$, out of n lightbulbs, all initially off, exactly r bulbs selected uniformly and independent of the past have their status changed from off to on, or vice versa and our interest is on the distribution of the number W_n of bulbs on at the terminal time n . We demonstrate that, with C_n a suitable clubbed binomial distribution,

$$d_{\text{TV}}(W_n, C_n) \leq 2.7314\sqrt{ne}^{-(n+1)/3} \quad \text{for all } n \geq 1.$$

The talk is based on joint work with L. Goldstein.

19. Education Afternoon

19.1. The Klein Project

Bill Barton (The University of Auckland)

14:00 Tuesday 28 September 2010 – 7-222

Bill Barton

Over a century ago, in 1908, Felix Klein's lectures on mathematics for secondary teachers were first published (in German). This comprehensive view of the field challenged both teachers and mathematicians to consider the relationship between mathematics as a school subject, and mathematics as a scientific discipline. IMU and ICMI have commissioned a project to revisit Klein's intent, and produce a book and related materials that will help senior secondary teachers understand the links between what they teach and research mathematics. We have witnessed many changes in mathematics in 100 years: the crises in Foundations, the advent of computing, emergence of new fields, and resolutions of some major mathematical challenges. It has become more and more difficult for teachers to have a sense of the divergent but linked discipline of mathematics in all its manifestations. The project seeks to produce a stimulating book that will engage teachers in the living and exciting field of mathematics. The Klein Project is also a forum for mathematics teachers and mathematicians to come together. I will report on how it is progressing, give some examples of new ideas for teachers, and seek your involvement in the project.

19.2. How Maths is saving species

Hugh Possingham (The University of Queensland)

14:45 Tuesday 28 September 2010 – 7-222

Hugh Possingham

Mathematical thinking and tools eventually imposes itself on almost all areas of human endeavour. My group uses mathematics in the most unlikely of places—biodiversity conservation research. I will outline a few of the problems where we use optimization tools and thinking to pose and solve biodiversity conservation issues. Some of the work is being used to build the world's marine reserve systems—changing the face of about 10% of the world's surface. Recently we have formulated the problem of allocating conservation funds to countries to advise non-government organizations about where they can save as much biodiversity as possible for their hard-earned green dollar.

19.3. The Improving Mathematics Education in Schools (TIMES) Project

Michael Evans and Ms Janine McIntosh

(Australian Mathematical Sciences Institute (AMSI))

15:45 Tuesday 28 September 2010 – 7-222

Michael Evans and Ms Janine McIntosh

The Australian Mathematical Sciences Institute works with teachers to enhance their mathematics programs. The development of the ICE-EM mathematics textbooks for Years 5 to 10 has been central in our schools program. In this session, we will outline the development and use of new careers materials and modules covering the mathematics required in the school curriculum up to and including year 10. The modules are being written to support the introduction of the new Australian Curriculum – Mathematics.

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