# 61st ANNUAL MEETING OF THE AUSTRALIAN MATHEMATICAL SOCIETY
12–15 DECEMBER 2017

MACQUARIE University

# PROGRAM AND ABSTRACTS

Department of Mathematics, Macquarie University

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Aust MS
Australian Mathematical Society Inc.

This ‘Program and Abstracts’ booklet, containing data collected and collated using the *Register!* system, has been prepared in accordance with the PDF/A-3u International Standard for archivability of electronic documents, ISO 19005-3:2012.
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Cover-page photograph of the Macquarie University Library (taken by Paul Wright, 29 July 2011) and other artwork, used in accordance with Macquarie University brand-compliance BC2610.

# Contents

# Foreword

On behalf of the Organising Committee and the Department of Mathematics at Macquarie University, we welcome you to the 61st Annual Meeting of the Australian Mathematical Society. We hope that you will find the program of events varied, interesting and inspiring. Perhaps noteworthy is the inaugural 'AustMS Debate' chaired by Adam Spencer on Wednesday 13 December at 1 pm. We hope too that you will enjoy the various social events that we have organised.

We would like to thank our colleagues on the local organising committee and all the departmental administrative staff who have worked tirelessly in preparation for AustMS 2017. We would also like to take this opportunity to thank our sponsors whose support has made this meeting possible.

We hope that you'll enjoy your time at Macquarie University.

Paul Smith and Xuan Duong
Co-Directors, AustMS 2017

# Conference Organisation

## Program Committee

Julie Clutterbuck — Monash University
Xuan Duong — Macquarie University
Gary Froyland — University of NSW
Vladimir Gaitsgory — Macquarie University
Jan De Gier — The University of Melbourne
Giang Nguyen — The University of Adelaide
Cheryl Praeger — University of Western Australia
Jacqui Ramagge — The University of Sydney
Paul Smith — Macquarie University
Ole Warnaar — University of Queensland

## Local Organising Committee

Paul Smith — Conference co-Director
Xuan Duong — Conference co-Director
Richard Garner — Treasurer
Steve Lack — Secretary
Christine Hale — Administrator
Ross Moore — Website & IT
Carolyn Kennett
Ji Li
Frank Valckenborgh
Elena Vynogradova

Thanks also to John Banks (The University of Melbourne) for use of the *Register!* system, for registration and collection/preparation of abstracts and timetables, and the overall design of this booklet for the Conference 'Program and Abstracts'.

## Conference Information Desk

The information desk for the conference is located in the foyer of the 'Macquarie Theatre'.
This desk will be staffed from 8 am on Tuesday 12 December, and during morning and afternoon teas on other days.

## Lunch

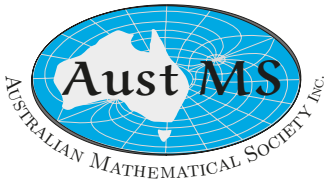
A variety of food outlets is located in the area of the 'Campus Common'. This is located on Central Avenue, east of the Library. Cafés can be found in some other buildings. Further afield, there are a number of restaurants and food courts in the Macquarie Shopping Centre.

Wifi access. The university provides wireless internet access through eduroam.

If you are not part of the eduroam network, or find yourself unable to connect to it, you can instead obtain access via the network 'Macquarie Events'. After connecting, browse to www.mq.edu.au where you will be prompted to enter the passcode: amsam2017.

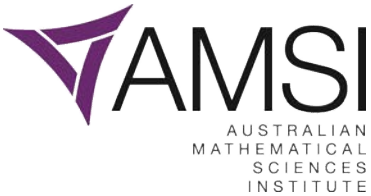
# Conference Sponsors

Australian Mathematical Society Inc.




Macquarie University


Australian Mathematical Sciences Institute




Matri$\chi$, a joint partnership of The University of Melbourne & Monash University


ARC Centre of Excellence for Mathematical and Statistical Frontiers


Special thanks to Professor Nalini Joshi through the Georgina Sweet Fellowship, for supporting the 'Women in Mathematics' dinner, and also to the Department of Mathematics, Macquarie University.

# Practical Information

## Getting to the university

The terminus for domestic and international flights to Sydney is 'Kingsford Smith' airport.
Macquarie University is about 30 km from the airport and can be reached from there by road or rail.
See: http://www.sydneyairport.com.au/.

▷ By train. Take the unique line from the airport to the city; change at 'Central' to the 'Northern Line' (platform 16), and take a train for 'Hornsby via Macquarie Park', disembark at the 'Macquarie University' station. The fare is about $18.

▷ By taxi. There are taxi ranks at each terminal; the fare to Macquarie University is about $100.

▷ By car. Sydney Airport is serviced by most major car rental firms.
See: https://www.sydneyairport.com.au/parking-and-transport/departing/domestic/rental-car.

## Finding the conference

A downloadable PDF map of the university campus is available.
See: https://www.mq.edu.au/__data/assets/pdf_file/0016/108142/Campus-Map.pdf.
An interactive map is at https://www.mq.edu.au/campus-map.

## Events

▷ The 'Women in Mathematics' dinner will take place on Monday 11 December from 6.15 pm for a 6.45 pm start. It will be held in the 'Macquarie Room' of the MGSM (Macquarie Graduate School of Management). There is parking available in the MGSM carpark.
Consult: a detailed map.

▷ The conference commences with an opening ceremony at 9 am on Tuesday 12 December. This, all of the plenary talks, and the lunch-time presentations will take place in the 'Macquarie Theatre'. Morning and afternoon teas will take place in the foyer; we will also be registering participants there.

▷ The opening reception will take place on Tuesday 12 December from 6 pm in the 'E7B Atrium'.

▷ The conference dinner will take place on Thursday 14 December from 6.30 pm in 'Curzon Hall', a short walk from campus. See: http://tinyurl.com/yav6waew, or the map on the next page.

## Getting around Sydney

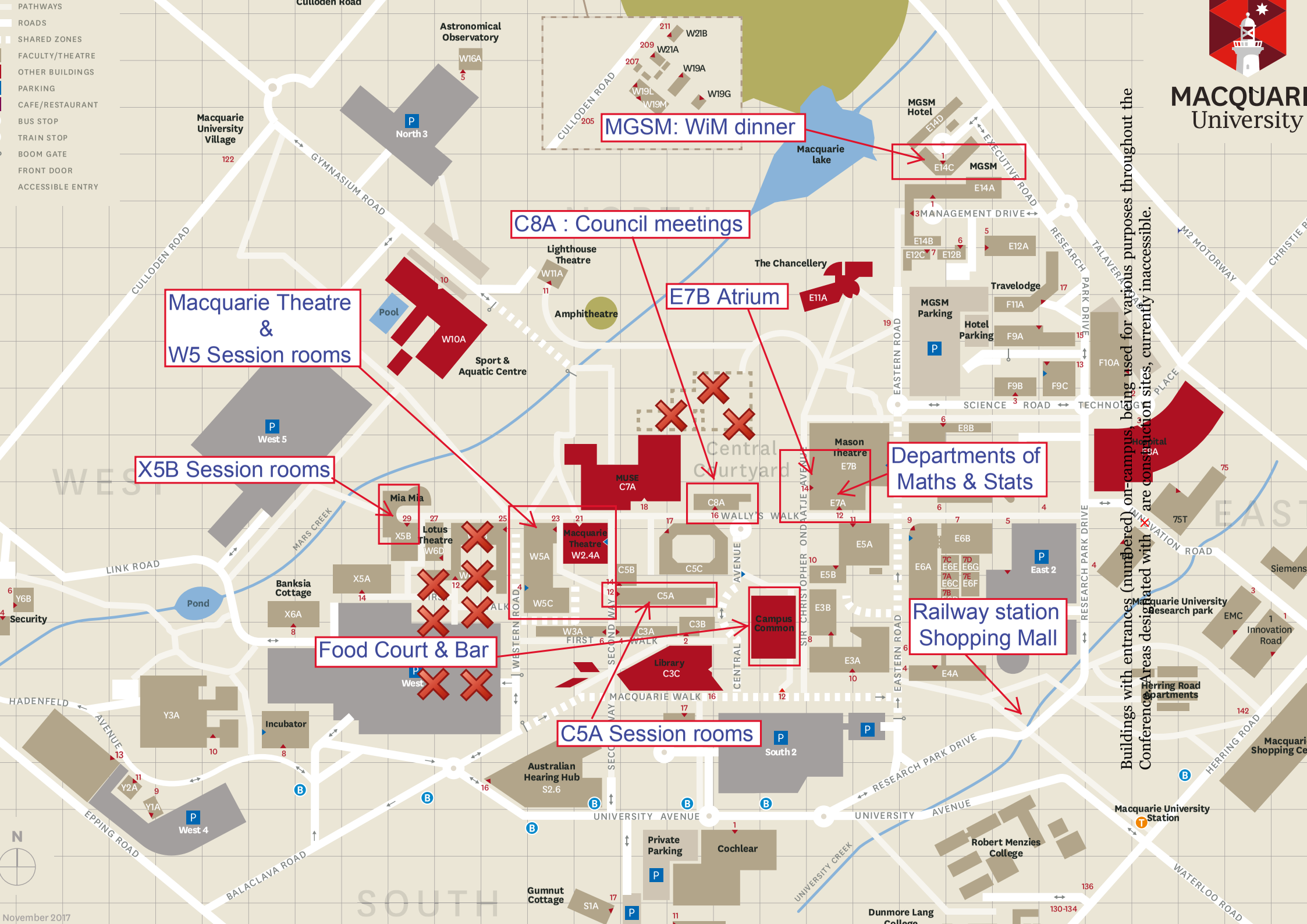
Macquarie University is well-serviced by road, bus and train. The easiest way of getting to and from the city is by train; a one-way trip is around $5, and takes about 35 minutes. You can purchase an 'Opal' card, allowing travel by all forms of public transport, from many newsagents, post offices and convenience stores throughout Sydney. (See: http://www.retailers.opal.com.au/.)
For transport times and ticket information, see https://transportnsw.info/.

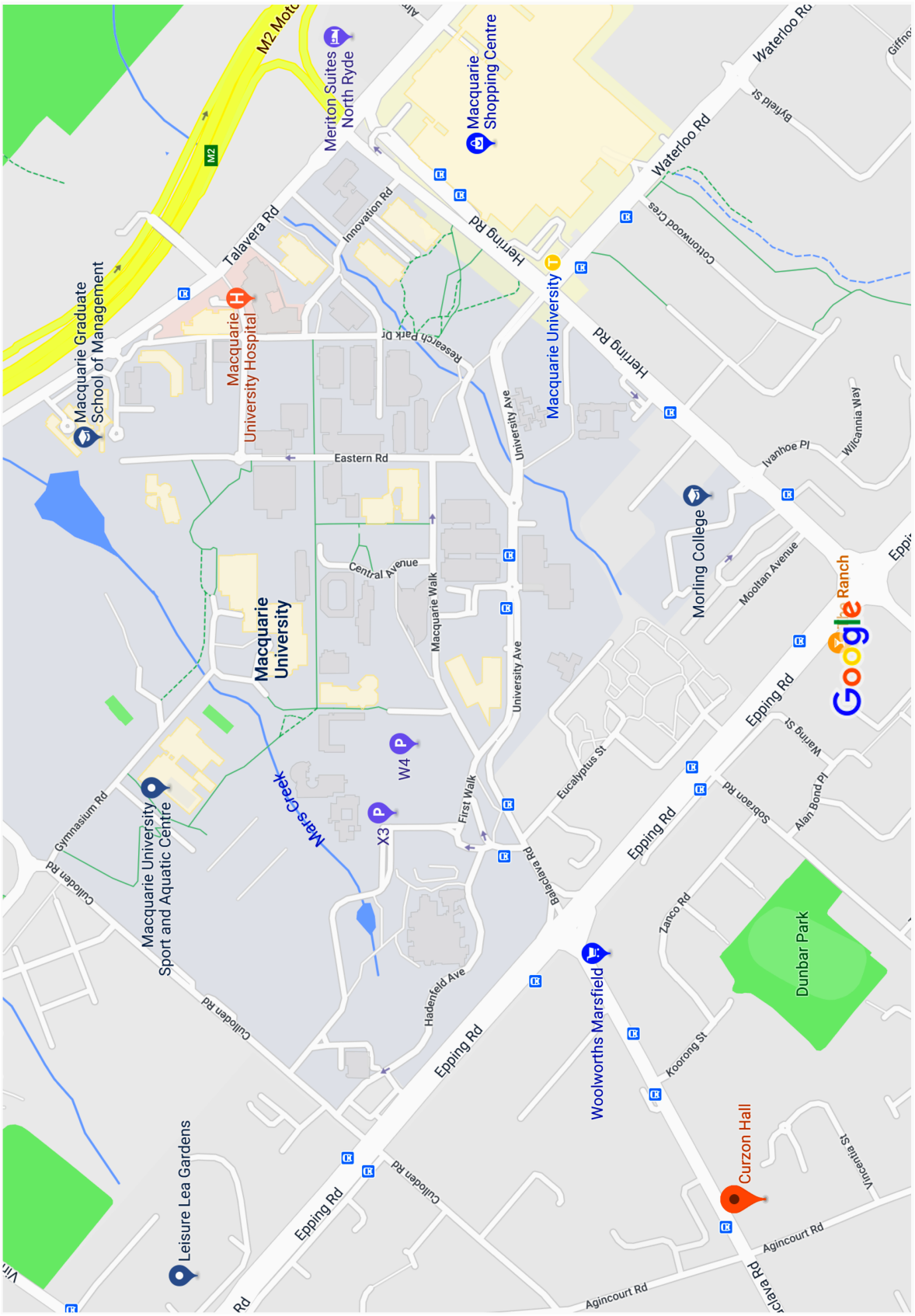
## Registration

Please register on arrival in the foyer of 'Macquarie Theatre'.
We will be opening registrations at 8 am on Tuesday 12 December, and the registration desk will be manned throughout the first day. If you happen to arrive after that, please contact one of the organisers on your arrival and we will see to your registration then.

## Information for speakers

Plenary talks will be 50 minutes long, plus 10 minutes for introduction and questions. These will take place in the 'Macquarie Theatre'. Special session talks will be 20 minutes long plus 5 minutes for questions and discussion; these will be held in various rooms throughout buildings 'C5A', 'W5A', 'W5C' and 'X5B' — see map on facing page. In each case, you may give your talk using data projector or visualizer; some of the special session rooms also have whiteboards (though not the 'Macquarie Theatre'). For those using the data projector, there is a lectern computer (Windows) present in each room; we therefore ask that you bring your talk along to your session in PDF format on a USB stick. Laptops can also be used; please bring your own VGA connection dongle.


MGSM: WiM dinner
C8A : Council meetings
E7B Atrium
Macquarie Theatre & W5 Session rooms
X5B Session rooms
Food Court & Bar
C5A Session rooms
Departments of Maths & Stats
Railway station Shopping Mall
Buildings with entrances (numbered) on-campus, being used for various purposes throughout the Conference. Areas designated with ✕ are construction sites, currently inaccessible.
PATHWAYS
ROADS
SHARED ZONES
FACULTY/THEATRE
OTHER BUILDINGS
PARKING
CAFE/RESTAURANT
BUS STOP
TRAIN STOP
BOOM GATE
FRONT DOOR
ACCESSIBLE ENTRY
Macquarie University
Culloden Road
Astronomical Observatory
Macquarie University Village
North 3
Macquarie lake
MGSM Hotel
MGSM
Lighthouse Theatre
Amphitheatre
Pool
W10A
Sport & Aquatic Centre
The Chancellery
E11A
Travelodge
MGSM Parking
Hotel Parking
Mason Theatre
E7B
E7A
C8A
MUSE
C7A
Central Courtyard
West 5
Mia Mia
X5B
Lotus Theatre
W6D
Macquarie Theatre
W2.4A
W5A
W5C
C5A
C5B
C5C
C3A
C3B
C3C
Campus Common
Library
Pond
Banksia Cottage
X6A
X5A
Y6B
Security
Incubator
Y3A
Y2A
Y1A
West 4
West
Australian Hearing Hub
S2.6
South 2
Private Parking
Cochlear
Gumnut Cottage
S1A
Dunmore Lang College
Robert Menzies College
Macquarie University Station
East 2
E6A
E6B
E5A
E5B
E3B
E3A
E4A
Macquarie University Research park
EMC
Innovation Road
Herring Road Apartments
Siemens
75T
Hospital
Macquarie Shopping Ce
WEST
EAST
SOUTH
CULLODEN ROAD
GYMNASIUM ROAD
LINK ROAD
MARS CREEK
WESTERN ROAD
SECOND AVENUE
FIRST WALK
WALLY'S WALK
MACQUARIE WALK
CENTRAL AVENUE
SIR CHRISTOPHER ONDAATJE AVENUE
EASTERN ROAD
RESEARCH PARK DRIVE
MANAGEMENT DRIVE
EXECUTIVE ROAD
SCIENCE ROAD
TECHNOLOGY PLACE
INNOVATION ROAD
HERRING ROAD
UNIVERSITY AVENUE
HADENFELD AVENUE
EPPING ROAD
BALACLAVA ROAD
WATERLOO ROAD
UNIVERSITY CREEK
TALAVERA ROAD
M2 MOTORWAY
CHRISTIE
N
November 2017




Some venues at, or just beyond, the edge of campus are shown in this map; including the train station, bus stops, Macquarie Centre, Hospital, Macquarie Graduate School of Management and Curzon Hall.

# Conference Program

## Overview of the Academic Program

There are 259 talks, including 13 plenary and featured lectures and 20 special sessions. The Education special sessions include a Forum, and the SIGME organisational session. For the first time at an AustMS annual meeting, there is a special session called 'LaTeX and beyond' discussing uses of LaTeX, primarily in conjunction with other software systems.

▷ Conference Timetable – page 36

Tue 12 December 2017 – page 37
Wed 13 December 2017 – page 42
Thu 14 December 2017 – page 48
Fri 15 December 2017 – page 54

## Plenary Lecturers

Georgia Benkart (University of Wisconsin–Madison, USA)
Young-Ju Choie (Pohang University of Science and Technology, South Korea)
Ivan Corwin (Columbia University, USA)
Michael Cowling (University of New South Wales)
Hans De Sterck (Monash University)
Yihong Du (University of New England)
Hélène Frankowska (CNRS, France)
Catherine Greenhill (University of New South Wales)
Andrei Okounkov (Columbia University, USA)
Philip Keith Pollett (University of Queensland)
Michael Small (The University of Western Australia)
Yvonne Stokes (The University of Adelaide)

▷ Timetable of Plenary Lectures – page 11

## Special Sessions

## Public Lecture

- 6:30–7:30 pm, Wednesday 13 December
  *Michael Small*
  Macquarie Theatre

## Education Events

- 4.30–5.30 pm, Wednesday 13 December
  *Forum: 'Hot Topics'*
  Education Special Session: room W5C 220
- 2.00–2.30 pm, Friday 15 December
  *SIGME organisational meeting*
  Education Special Session: room W5C 220

## Social Program

- 6.15 pm, Monday 11 December
  *Women in Mathematics — dinner*
  Macquarie Graduate School of Management – Building E14C
- 6 pm, Tuesday 12 December
  *Opening Reception*
  E7B Atrium
- 5:45–6:30 pm, Wednesday 13 December
  *Drinks prior to Public Lecture*
  Macquarie Theatre
- 6.30 pm, Thursday 14 December
  *Conference Dinner*
  Curzon Hall

## Additional Presentations

- 1.15–2:00 pm, Tuesday 12 December
  *NCMS Presentation: 'Implementation of the Decadal Plan for the Mathematical Sciences'*
  Macquarie Theatre
- 1.00–2:00 pm, Wednesday 13 December
  *Debate: 'The traditional mathematics blackboard lecture is dead.'*
  Macquarie Theatre

  *Chair*: Adam Spencer
  *Affirmative Team*: Birgit Loch (La Trobe), Dan Mathews (Monash), Marty Ross (Monash)
  *Negative Team*: Adrianne Jenner (Sydney), Heather Lonsdale (Curtin), John Roberts (UNSW)
- 1.00–2:00 pm, Thursday 14 December
  *61st Annual General Meeting of the Australian Mathematical Society*
  Macquarie Theatre

## Annual General Meeting of the Society

- 1.00–2:00 pm, Thursday 14 December
  *61st Annual General Meeting of the Australian Mathematical Society*
  Macquarie Theatre

# Plenary Lectures in Macquarie Theatre

▷ Tue 12 December 2017

11:30 ► Andrei Okounkov (Columbia University, USA)
*Enumerative geometry and geometric representation theory*

17:00 ► Yihong Du (University of New England)
*Propagation, diffusion and free boundaries*

▷ Wed 13 December 2017

09:00 ► Ivan Corwin (Columbia University, USA) – Mahler Lecture
*Integrable probability*

10:00 ► Hans De Sterck (Monash University)
*Scalable PDE solvers on supercomputers: multilevel and parallel-in-time*

11:30 ► Georgia Benkart (University of Wisconsin-Madison, USA) – Hanna Neumann Lecture
*Walking on graphs to Invariant Theory*

18:30 ► Michael Small (The University of Western Australia) – Public Lecture
*Chaos is not random and complexity is not complicated*

▷ Thu 14 December 2017

09:00 ► Hélène Frankowska (CNRS, France)
*Value function and necessary optimality conditions in deterministic optimal control*

10:00 ► Philip Keith Pollett (University of Queensland)
*Metapopulations in evolving landscapes*

14:00 ► YoungJu Choie (POSTECH, South Korea)
*A vital role of automorphic forms in number theory*

16:30 ► Yvonne Stokes (The University of Adelaide) – ANZIAM Lecture
*Can we make that fibre?*

▷ Fri 15 December 2017

09:00 ► Michael Small (The University of Western Australia)
*Reconstructing continuous dynamical systems from time series data with discrete transition graphs*

10:00 ► Catherine Greenhill (University of New South Wales)
*Two threshold problems for random graphs and hypergraphs*

11:30 ► Michael Cowling (University of New South Wales)
*Analysis on product spaces*

# Special Session 2: Algebra

Organisers: James Parkinson, Bregje Pauwels

## Contributed Talks

▷ Tue 12 December 2017

14:00 James East (Western Sydney University)
*Integer polygons with given perimeter*

14:30 Lauren Thornton (University of the Sunshine Coast)
*On base radical operators Part 1: classes of finite associative rings*

15:00 Robert McDougall (University of the Sunshine Coast)
*On base radical operators Part 2: classes of finite Puczylowski algebras*

16:00 Michal Ferov (University of Technology, Sydney)
*Isomorphism problem for virtually-free groups*

16:30 Ainsley Pullen (The University of Queensland)
*Concrete mathematical incompleteness and the Finite Upper Shift Kernel theorem*

▷ Thu 14 December 2017

11:30 John Cannon (The University of Sydney)
*Fact-checking the ATLAS of Finite Groups*

12:00 Hafiz Khusyairi (Australian National University)
*Unexpected new formula for Grothendieck duality*

15:30 Murray Elder (University of Technology, Sydney)
*Permutations sorted by a finite and an infinite stack in series*

16:00 Tim Stokes (University of Waikato, NZ)
*Generalised domain and $E$-inverse semigroups*

# Special Session 3: Applied/Industrial Mathematics

Organiser: Harvinder Sidhu

## Keynote Talks

- ▷ Tue 12 December 2017
  - 14:00 Amie Albrecht (University of South Australia)
    *The two-train separation problem on non-level track*
- ▷ Fri 15 December 2017
  - 16:00 Roslyn Hickson (IBM Research Australia)
    *Dengue fever in Taiwan: an IBM Health Corps adventure*

## Contributed Talks

- ▷ Tue 12 December 2017
  - 15:00 Lele (Joyce) Zhang (The University of Melbourne)
    *A study of optimizing courier routes in CBD areas*
  - 16:00 Mark Nelson (University of Wollongong)
    *Analysis of nitrogen removal in the activated sludge process*
  - 16:30 Martin Sagradian (Macquarie University)
    *Potential theory problems for arbitrary rotationally symmetric double-connected conductors: rigorous approach*
- ▷ Wed 13 December 2017
  - 14:00 Zlatko Jovanoski (University of New South Wales Canberra)
    *A stochastic differential equation approach to modelling the growth phase of fire spread*
  - 14:30 Paul Smith (Macquarie University)
    *Quantifying the change in the far-field pattern induced by rounding the corners of a scatterer illuminated by a plane-wave electromagnetic field*
  - 15:00 Turker Topal (Macquarie University)
    *Accurate calculation of complex eigenvalues for TM-modes in 2D arbitrary cavities with longitudinal slit*
- ▷ Fri 15 December 2017
  - 14:00 Song-Ping Zhu (University of Wollongong)
    *Pricing American-style Parisian options*
  - 14:30 Ilknur Tulunay (University of Technology, Sydney)
    *ST-metric method in Finance*
  - 15:00 Elena Vinogradova (Macquarie University)
    *Regularization of the first-kind surface integral equations arising in the wave diffraction on 2D arbitrary cavities with longitudinal slit*

# Special Session 4: Category Theory, Algebraic Topology, K-Theory

Organiser: Philip Hackney

## Contributed Talks

▷ Tue 12 December 2017

- 14:00 Ross Howard Street (Macquarie University)
  *Real sets*
- 14:30 Charles Walker (Macquarie University)
  *Universal properties of polynomials via doctrinal Yoneda structures*
- 15:00 Mircea Voineagu (University of New South Wales)
  *Computations in Bredon motivic cohomology*
- 16:00 Diarmuid Crowley (The University of Melbourne)
  *Functors to categories of manifolds*
- 16:30 Csaba Nagy (The University of Melbourne)
  *A functorial approach to classifying manifolds*

▷ Wed 13 December 2017

- 14:00 Michael Alexander Hallam (The University of Adelaide)
  *End-periodic $K$-homology and positive scalar curvature*
- 14:30 Marcy Robertson (The University of Melbourne)
  *Presheaf models for infinity modular operads*
- 15:00 Edoardo Lanari (Macquarie University)
  *$\infty$-groupoids and the Homotopy Hypothesis*
- 16:00 Matthew James Spong (The University of Melbourne)
  *The $K$-theory of loop spaces and elliptic cohomology*
- 16:30 Chi-Kwong Fok (The University of Adelaide)
  *Real K-theory of compact Lie groups*
- 17:00 Daniel Lin (Macquarie University)
  *Presheaves over join restriction categories*
- 17:30 Yaping Yang (The University of Melbourne)
  *Algebraic elliptic cohomology and flops*

▷ Thu 14 December 2017

- 11:30 Yuki Maehara (Macquarie University)
  *Mahavier limits*
- 12:00 Stephen Lack (Macquarie University)
  *Parity for nestohedra*
- 16:00 John Bourke (Macquarie University)
  *Braidings for skew monoidal categories*

▷ Fri 15 December 2017

- 14:00 Jesse Burke (Australian National University)
  *Transferring $A$-infinity structures along quasi-isomorphisms*
- 14:30 Richard Garner (Macquarie University)
  *Ultrafilters*

15:00 Huanhuan Li (Western Sydney University)
*Graded Steinberg algebras and their representations*

16:00 Dominic Verity (Macquarie University)
*Generator notions in ∞-cosmology*

16:30 Alexander Campbell (Macquarie University)
*Enriched algebraic weak factorisation systems*

# Special Session 5: Complex Analysis, Geometry

Organisers: Adam Harris, Gerd Schmalz

## Contributed Talks

▷ Tue 12 December 2017

14:00 Lesley Ward (University of South Australia)
*Using the Schottky–Klein prime function to compute the harmonic measure distribution function of a doubly connected planar domain*

14:30 Christopher Green (Macquarie University)
*Using the Schottky–Klein prime function to compute harmonic measure distribution functions of a class of multiply connected planar domains*

15:00 Marielle Ong (University of Queensland)
*The Donaldson–Narasimhan–Seshadri Theorem*

16:00 Matthew Randall (None)
*Flat* $(2,3,5)$*-distributions and Chazy's equations*

▷ Wed 13 December 2017

14:00 Rod Gover (University of Auckland, NZ)
*The projective geometry of Sasaki–Einstein structures and their compactification*

15:00 Gerd Schmalz (University of New England)
*Homogeneous tube domains in higher dimensions*

16:00 Masoud Ganji (University of New England)
*A criterion for the embedding of a* 3*-dimensional CR structure*

▷ Thu 14 December 2017

11:30 Emma Carberry (The University of Sydney)
*Toroidal soap bubbles: constant mean curvature tori in* $\mathbb{S}^3$ *and* $\mathbb{R}^3$

12:00 David Brander (Technical University of Denmark)
*Cauchy problems for surfaces related to harmonic maps*

15:30 Alessandro Ottazzi (University of New South Wales)
*Lie groups contacto-morphic to nilpotent Lie groups*

16:00 Wolfgang Globke (The University of Adelaide)
*Affinely flat algebraic groups and a conjecture of Popov*

# Special Session 6: Computational Mathematics

Organisers: Bishnu Lamichhane, Quoc Thong Le Gia

## Keynote Talks

▷ Wed 13 December 2017

14:00 Hans De Sterck (Monash University)
*Nonlinearly preconditioned optimisation methods for tensor decompositions and recommendation*

## Contributed Talks

▷ Tue 12 December 2017

14:00 Jerome Droniou (Monash University)
*Designing high-order schemes for diffusion problems on generic polytopal cells*

14:30 Hanz Martin Cheng (Monash University)
*Convergence analysis of a family of ELLAM schemes for a fully coupled model of miscible displacement in porous media*

15:00 Bishnu Lamichhane (The University of Newcastle)
*A new minimisation principle for the Poisson equation leading to a flexible finite-element approach*

16:00 Martin Ehler (University of Vienna, Austria)
*Optimal Monte Carlo integration*

16:30 Quoc Thong Le Gia (University of New South Wales)
*Sparse isotropic regularisation for spherical harmonic representations of random fields on the sphere*

▷ Wed 13 December 2017

15:00 Ian Sloan (University of New South Wales)
*On the generation of random fields*

16:00 Markus Hegland (Australian National University)
*Fractals and numerical linear algebra*

16:30 Michael Assis (The University of Newcastle)
*Systematic analysis of OEIS generating functions*

# Special Session 7: Dynamical Systems/Ergodic Theory

Organisers: Gary Froyland, Georg Gottwald, John Roberts

## Contributed Talks

▷ Wed 13 December 2017

- 14:00 Tanja Schindler (Australian National University)
  *Trimmed sums for observables on the doubling map*
- 14:30 Holger Dullin (The University of Sydney)
  *Stability of doubly periodic shear flow of the Euler equations*
- 15:00 Sanjeeva Balasuriya (The University of Adelaide)
  *Stochastic sensitivity: a computable measure for uncertainty of deterministic trajectories*
- 16:00 John Wormell (The University of Sydney)
  *Spectral Galerkin methods for transfer operators in uniformly expanding dynamics*
- 16:30 Harry Crimmins (University of New South Wales)
  *Stability of Statistical Properties for some Dynamical Systems*
- 17:00 Fadi Antown (University of New South Wales)
  *Optimal linear response for Markov chains*
- 17:30 Timothy Siu (University of New South Wales)
  *Combinatorial model for the dynamics of birational maps over finite fields*

▷ Thu 14 December 2017

- 11:30 Milena Radnovic (The University of Sydney)
  *Short trajectories of integrable billiards*
- 12:00 Bojan Crnkovic (University of Rijeka, Croatia)
  *Lattice structure detection and refinement DMD algorithm*

# Special Session 8: Education

Organisers: Carolyn Kennett, Deborah King

## Contributed Talks

- Tue 12 December 2017
  - 14:00 Yucang Wang (Central Queensland University)
    *Linking mathematical theories to computation and modelling for engineering applications*
  - 14:30 Deborah Jackson (La Trobe University)
    *Impact and sustainability of a cross-disciplinary mathematics support program*
  - 15:00 Rebecca Smith (The University of Newcastle)
    *Engagement-focused learning in large service-level courses*
  - 16:00 Chris Tisdell (University of New South Wales)
    *No, Professor: you don't need to reverse the order of integration!*
  - 16:30 Terence Mills (Deakin University)
    *Lessons from problem solving in ancient China*
- Wed 13 December 2017
  - 14:00 Roland Dodd (Central Queensland University)
    *Bridging the gap for inclusive transition*
  - 14:30 Birgit Loch (La Trobe University)
    *Teaching wirelessly with a pen-enabled tablet*
  - 15:00 William Guo (Central Queensland University)
    *Improving retention and progression by rescheduling engineering mathematics units*
  - 16:00 Harkirat Dhindsa (Macquarie University)
    *Tertiary students' perceptions of assessments of, and attitudes to, Mathematics*
- Thu 14 December 2017
  - 11:30 Dilshara Hill (Macquarie University)
    *Assessment: a multi-pronged tool to motivate and engage*
  - 12:00 Deborah King (The University of Melbourne)
    *Investigating students' perceptions of graduate learning outcomes in mathematics*
  - 15:30 Gizem Intepe (Western Sydney University)
    *Examining students' interaction with mathematics consultation using Text Mining*
  - 16:00 Heather Lonsdale (Curtin University)
    *Third-year undergraduate projects in mathematics education: analysing student attitudes, student reflections, and predicting student performance*
- Fri 15 December 2017
  - 14:30 Judy-anne Osborn (The University of Newcastle)
    *Communities of practice across pre-undergraduate and undergraduate mathematics*
  - 15:00 Thomas Wong (The University of Melbourne)
    *LaTeX + First Year Calculus = ???*

16:00 Lyn Armstrong (Western Sydney University)
*From where do our students come?*

16:30 Collin Grant Phillips (The University of Sydney)
*Employing cultural plasticity in STEM workshops for prospective indigenous Engineering and Information Technology students*

# Special Session 9: Functional Analysis, Operator Algebra, Non-commutative Geometry

Organisers: Zahra Afsar, Hang Wang

## Keynote Talks

▷ Tue 12 December 2017

14:00 Fedor Sukochev (University of New South Wales)
*Conformal trace theorem for Julia sets*

▷ Wed 13 December 2017

14:00 Jacqui Ramagge (The University of Sydney)
*C*-algebras from self-similar actions and their states*

## Contributed Talks

▷ Tue 12 December 2017

15:00 Jinghao Huang (University of New South Wales)
*Derivations into ideals of semifinite von Neumann algebras*

16:00 Shaymaa Shawkat Kadhim Al-shakarchi (University of New South Wales)
*Isomorphisms of $AC(\sigma)$ spaces*

16:30 Michael Arthur Mampusti (University of Wollongong)
*Mauldin–Williams graphs and their KMS states*

▷ Wed 13 December 2017

15:00 Aidan Sims (University of Wollongong)
*Rigidity for dynamics via operator algebras*

16:00 Becky Armstrong (The University of Sydney)
*Twisted $C^*$-algebras of topological higher-rank graphs: keeping things simple!*

16:30 Kevin Aguyar Brix (University of Copenhagen, Denmark)
*Investigating symbolic dynamics using C*-algebras*

17:00 Thomas Pedersen (University of Wollongong)
*On the $C^*$-algebras of a graph of groups*

17:30 Elizabeth Bradford (University of South Australia)
*Recursive algorithms for inversion of linear operator pencils*

▷ Thu 14 December 2017

11:30 Peter Hochs (The University of Adelaide)
*K-theory and characters*

12:00 Guo Chuan Thiang (The University of Adelaide)
*Hyperbolic and crystalline topological matter via Baum–Connes isomorphisms*

15:30 Silvestru Sever Dragomir (Victoria University)
*Recent inequalities of Young type for positive operators in Hilbert spaces*

16:00 Geetika Verma (University of South Australia)
*The fundamental equations for the generalized resolvent of an elementary pencil in a unital Banach algebra*

▷ Fri 15 December 2017

14:00 Hang Wang (The University of Adelaide)
*Positive scalar curvature for proper actions*

14:30 Nathan Brownlowe (The University of Sydney)
*On Baumslag–Solitar monoids and their $C^*$-algebras*

15:00 Adam Sierakowski (University of Wollongong)
*Unbounded quasitraces, stable finiteness and pure infiniteness*

16:00 Zahra Afsar (University of Wollongong)
*KMS states on the $C^*$-algebras of Fell bundles over groupoids*

# Special Session 10: Geometric Analysis

Organisers: Haotian Wu, Bernard Yann

## Keynote Talks

▷ Wed 13 December 2017

16:00 Jim Isenberg (University of Oregon, USA)
*Non-Kaehler Ricci flows that converge to Kaehler–Ricci solitons*

## Contributed Talks

▷ Wed 13 December 2017

16:00 Zhou Zhang (The University of Sydney)
*Mean curvature flows of closed hypersurfaces in warped product manifolds*

14:00 Artem Pulemotov (The University of Queensland)
*Metrics with prescribed curvature on homogeneous spaces with intermediate subgroups*

14:30 Jonathan Julian Zhu (Harvard University, USA)
*Min–max theory for constant mean curvature hypersurfaces*

15:00 Alexander Majchrowski (The University of Sydney)
*Neck detection for the fully nonlinear flow $G$*

17:00 Erchuan Zhang (The University of Western Australia)
*Riemannian cubics in the manifold* $\mathrm{SPD}(n)$ *of all* $n \times n$ *symmetric positive-definite matrices*

17:30 Qirui Li (Australian National University)
*The planar dual Minkowski problem*

▷ Thu 14 December 2017

11:30 Ross Ogilvie (The University of Sydney)
*The space of harmonic tori in the 3-sphere*

12:00 Paul Bryan (The University of Queensland)
*Distance comparison for curve shortening of networks*

15:30 Changwei Xiong (Australian National University)
*Convexity of non-negatively curved hypersurfaces with free boundary on a sphere*

16:00 Yong Wei (Australian National University)
*Volume preserving flow in hyperbolic space*

# Special Session 11: Harmonic Analysis

Organisers: Zihua Guo, Ji Li

## Contributed Talks

▷ Tue 12 December 2017

14:00 Adam Sikora (Macquarie University)
*Riesz transform and harmonic functions*

14:30 Alessandro Ottazzi (University of New South Wales)
*Spectral multipliers for sub-Laplacians on $NA$ groups*

15:00 Jan Rozendaal (Australian National University)
*Operator-valued $(L^p, L^q)$ Fourier multipliers*

16:00 Zihua Guo (Monash University)
*Generalized Strichartz estimates for Schrödinger equation*

16:30 Dorothee Frey (Delft University of Technology, The Netherlands)
*Sparse dominations and sharp weighted estimates for singular integral operators*

▷ Wed 13 December 2017

14:00 Maolin Zhou (University of New England)
*A principal eigenvalue problem with large degenerate advection*

14:30 Daniel Hauer (The University of Sydney)
*A generalised Gagliardo–Nirenberg type inequality with application to the $p(x)$-Laplacian*

▷ Thu 14 December 2017

11:30 Anh Bui (Macquarie University)
*On the flows associated to self-adjoint operators on metric measure spaces*

12:00 Fu Ken Ly (The University of Sydney)
*An embedding result for Hermite distribution spaces*

# Special Session 12: Mathematical Biology

Organisers: Peter Kim, Frank Valckenborgh

## Contributed Talks

▷ Tue 12 December 2017

14:00 Aaron Jordan Kaw (University of New South Wales)
*Delivery and diffusion in membranes*

14:30 Catheryn Gray (University of New South Wales)
*Akt translocation as a harmonic oscillator*

15:00 Michael Hendriksen (Western Sydney University)
*Non-binary unrooted tree-based networks*

▷ Wed 13 December 2017

14:00 Pantea Pooladvand (The University of Sydney)
*Do T-cells compete for antigen?*

14:30 Adarsh Kumbhari (The University of Sydney)
*Modelling the impact of T-cell avidity on cancer vaccines*

15:00 Adrianne Jenner (The University of Sydney)
*Modelling heterogeneity in biology: how do cancer-killing viruses interact with tumour cells?*

16:00 Maia Nikolova Angelova (Deakin University)
*Mathematical model of glucose–insulin regulation with diabetically impaired ultradian oscillations*

16:30 Mark Nelson (University of Wollongong)
*Modelling the spread of smoking as an infectious disease*

▷ Thu 14 December 2017

11:30 Robyn Patrice Araujo (Queensland University of Technology)
*The simple complexity of robust networks*

12:00 John Murray (University of New South Wales)
*Smoking prevalence and related death rates for Australian birth cohorts over the last century*

15:30 Danya Rose (The University of Sydney)
*Who gets the girl? On the operational sex ratio as an index for male strategy*

16:00 Michael Greg Watson (The University of Sydney)
*Multi-phase modelling of early fibrous cap formation in atherosclerosis*

▷ Fri 15 December 2017

14:00 Peter Kim (The University of Sydney)
*Modelling evolution of post-menopausal human longevity: the Grandmother Hypothesis*

# Special Session 13: Mathematical Optimization

Organisers: Guoyin Li, Vera Roshchina

## Keynote Talks

▷ Tue 12 December 2017

14:00 Vladimir Gaitsgory (Macquarie University)
*Averaging in singularly perturbed deterministic and stochastic optimal control problems and dynamic games*

## Contributed Talks

▷ Tue 12 December 2017

15:00 Andrew Eberhard (RMIT University)
*Radius theorems for monotone mappings*

16:00 Chuong Thai Doan (University of New South Wales)
*Optimality conditions for non-smooth, multi-objective, bilevel optimization problems*

16:30 Guillermo Pineda-Villavicencio (Federation University Australia)
*On the reconstruction of polytopes*

▷ Wed 13 December 2017

14:00 Alex Parkinson (Macquarie University)
*Averaging of discrete-time singularly perturbed optimal control problems*

14:30 Scott Lindstrom (The University of Newcastle)
*Strong convergence for relaxed iterated approximate projection methods for convex feasibility problems*

15:00 Ali Eshragh (The University of Newcastle)
*A new approach to select the best subset of predictors in linear regression modeling*

16:00 Sogol Mohammadian (The University of Newcastle)
*Investigating Hamilton cycles through extreme points of a certain polytope*

16:30 Kieran Clancy (Flinders University)
*Extending a linear programming formulation for TSP*

17:00 Minh N. Dao (The University of Newcastle)
*On the generalized Douglas–Rachford algorithm for feasibility problems*

▷ Thu 14 December 2017

11:30 Vera Roshchina (RMIT University)
*Multipoint Voronoi cells*

12:00 Guoyin Li (University of New South Wales)
*Computing radius of robust feasibility of uncertain linear conic programs via semidefinite programs*

# Special Session 14: Mathematical Physics

Organiser: Thomas Quella

## Contributed Talks

▷ Tue 12 December 2017

14:00 Vladimir Mangazeev (Australian National University)
*Integrable structure of products of complex random matrices*

14:30 Xin Zhang (The University of Melbourne)
*Quantum integrable models and the off-diagonal Bethe ansatz method*

15:00 Maia Nikolova Angelova (Deakin University)
*Squeezed coherent states of one-dimensional anharmonic quantum oscillators*

16:00 Zeying Chen (AMSI/University of Melbourne)
*Duality in mASEP and tKZ equation*

16:30 Alexandr Garbali (The University of Melbourne)
*Lattice integrable stochastic processes*

▷ Wed 13 December 2017

17:30 Michael Assis (The University of Newcastle)
*Exactly-solved origami statistical mechanics*

▷ Thu 14 December 2017

11:30 Zongzheng Zhou (Monash University)
*Unified correlation function behaviours on high-dimensional tori*

12:00 Abrahim Steve Nasrawi (Monash University)
*Lifted worm process for the Ising model*

15:30 Guo Chuan Thiang (The University of Adelaide)
*Duality methods for topological matter*

16:00 Thomas Quella (The University of Melbourne)
*Protection of topological phases in quantum spin systems by quantum deformed symmetries*

# Special Session 15: Number Theory

Organiser: David Harvey

## Contributed Talks

▷ Tue 12 December 2017

- 14:30 Mumtaz Hussain (La Trobe University)
  *The Hausdorff measure version of Gallagher's theorem — closing the gap and beyond*
- 15:00 Jeffrey Lay (Australian National University)
  *An explicit bound for the divisor function*
- 16:00 Dzmitry Badziahin (The University of Sydney)
  *p-adic Littlewood conjecture: what can potential counter-examples look like?*
- 16:30 Liangyi Zhao (University of New South Wales)
  *Mean-value results of Hecke L-functions with fixed-order characters*

▷ Wed 13 December 2017

- 14:30 Peter Forrester (The University of Melbourne)
  *Octonions in random matrix theory*
- 15:00 Kam Hung Yau (University of New South Wales)
  *Distribution of $\alpha n + \beta$ modulo 1 over some arithmetic set*
- 16:00 Timothy Trudgian (University of New South Wales Canberra)
  *Primes and squares — in less than two pages!*
- 16:30 Stephen Meagher (University of New South Wales)
  *Chebotarev's density theorem over finite fields*

▷ Thu 14 December 2017

- 11:30 Simon Macourt (University of New South Wales)
  *Visible points on exponential curves*
- 12:00 Yinan Zhang (Australian National University)
  *Computing p-adic regulators*
- 15:30 Jessica Fintzen (Institute for Advanced Study, Princeton, USA)
  *Families of p-adic automorphic forms on unitary groups*
- 16:00 Min Sha (Macquarie University)
  *On the irregular primes with respect to Euler polynomials*

# Special Session 16: Partial Differential Equations

Organisers: Paul Bryan, James McCoy, Adam Sikora

## Contributed Talks

- Tue 12 December 2017
  - 14:00 Daniel Daners (The University of Sydney)
    *Global dynamics of generalized logistic equations*
  - 14:30 Yingying Sun (The University of Sydney)
    *The Sylvester equation and the elliptic Korteweg–de Vries system*
  - 15:00 Philip Broadbridge (La Trobe University)
    *Non-classical symmetry solution of nonlinear reaction–diffusion: soil–water with plant roots*
  - 16:00 Shengguo Zhu (Monash University)
    *Recent progress on classical solutions for compressible isentropic Navier–Stokes equations with degenerate viscosities and vacuum*
  - 16:30 Jean-Jerome Casanova (Monash University)
    *Fluid structure system with boundary conditions involving the pressure*
- Wed 13 December 2017
  - 16:00 Qirui Li (Australian National University)
    *A class of optimal transportation problems on the sphere*
  - 16:30 Daniel Hauer (The University of Sydney)
    *A strong maximum principle on cones*
- Thu 14 December 2017
  - 15:30 Yong Wei (Australian National University)
    *Volume preserving flow by powers of k-th mean curvature*
  - 16:00 Geoffrey Prince (Australian Mathematical Sciences Institute)
    *Variationality of PDEs*
- Fri 15 December 2017
  - 14:00 Jiakun Liu (University of Wollongong)
    *Bergman–Toeplitz operators on weakly pseudoconvex domains*
  - 14:30 Jan Rozendaal (Australian National University)
    *Stability theory for semigroups using $(L^p, L^q)$ Fourier multipliers*
  - 15:00 Nalini Joshi (The University of Sydney)
    *Geometric asymptotics*

# Special Session 17: Probability Theory and Stochastic Processes

Organisers: Andrea Collevecchio, Kais Hamza, Giang Nguyen

## Keynote Talks

▷ Tue 12 December 2017

14:00 Fima Klebaner (Monash University)
*Random initial conditions in differential equations*

## Contributed Talks

▷ Tue 12 December 2017

15:00 Petru A. Cioica-Licht (University of Otago, NZ)
*Stochastic integration in quasi-Banach spaces*

16:00 Zdravko Botev (University of New South Wales)
*Sampling via regenerative chain Monte Carlo*

16:30 Liam S. Hodgkinson (University of Queensland)
*The long-term behaviour of an occupancy process*

▷ Wed 13 December 2017

14:00 Meng Shi (Monash University)
*Bootstrap random walk*

14:30 Yunxuan Liu (Monash University)
*Invariance principle for biased bootstrap random walks*

15:00 Kais Hamza (Monash University)
*General bootstrap random walks*

16:00 Thomas Taimre (University of Queensland)
*Exploiting asymptotic structure for efficient rare-event estimation for sums of random variables*

16:30 Azam Asanjarani (AMSI/University of Melbourne)
*Bursty Markovian arrival processes*

▷ Thu 14 December 2017

11:30 Jie Yen Fan (Monash University)
*Measure-valued population processes and their asymptotics*

12:00 Oscar Peralta (Technical University of Denmark)
*On a class of bivariate phase-type distributions and its applications in risk theory*

15:30 Andrea Collevecchio (Monash University)
*The branching-ruin number and the critical parameter of once-reinforced random walk on trees*

16:00 Laurence Field (Australian National University)
*Spatial decomposition for Brownian motion and SLE curves*

▷ Fri 15 December 2017

14:00 Tanja Schindler (Australian National University)
*Convergence to extremal processes for Lévy processes with slowly varying canonical measure*

14:30 Zongzheng Zhou (Monash University)
*Green's function of a random length random walk on the torus*

15:00 Yan Dolinsky (Monash University)
*Duality and convergence for binomial markets with friction*

# Special Session 18: Representation Theory

Organiser: Vinoth Nandakumar

## Keynote Talks

▷ Wed 13 December 2017

14:00 Ben Webster (University of Waterloo, Canada)
*The representation theory of symplectic singularities*

## Contributed Talks

▷ Tue 12 December 2017

14:00 Kevin Coulembier (The University of Sydney)
*Auslander–Dlab–Ringel algebras and Ringel duality*

14:30 Bregje Pauwels (Australian National University)
*Gerstenhaber structure of a class of special biserial algebras*

15:00 Jessica Fintzen (Institute for Advanced Study, Princeton, USA)
*On the Moy–Prasad filtration and super-cuspidal representations*

16:00 Peter Hochs (The University of Adelaide)
*Blattner's conjecture as an index theorem*

16:30 Yaping Yang (The University of Melbourne)
*Towards a construction of higher dimensional loop Grassmannians*

▷ Wed 13 December 2017

15:00 Kari Vilonen (The University of Melbourne)
*Langlands duality for real groups*

16:00 Duy Ho (University of Canterbury, NZ)
*On the classification of toroidal circle planes*

16:30 Jon Xu (The University of Melbourne)
*Chevalley groups and finite geometry*

17:00 Yang Zhang (The University of Sydney)
*The second fundamental theorem of invariant theory for the orthosymplectic supergroup*

▷ Thu 14 December 2017

11:30 Arik Wilbert (University of Bonn/MPI Bonn, Germany)
*Two-block Springer fibers and Springer representations in type D*

12:00 Sinead Wilson (The University of Queensland)
*Stabilisers of eigenvectors in complex reflection groups*

15:30 Masoud Kamgarpour (University of Queensland)
*Examples of mesopelagic Langlands correspondence*

16:00 Anthony Licata (Australian National University)
*Linear braids*

# Special Session 19: Stochastic Models and Applications

Organisers: Thomas Fung, Georgy Sofronov

## Contributed Talks

▷ Wed 13 December 2017

14:30 Michael Stewart (The University of Sydney)
*More sensitive mixture detection using the empirical moment-generating function*

15:00 Justin Wishart (Macquarie University)
*Homogeneous wavelet expansions of some fractional Gaussian fields*

16:00 Thanakorn Nitithumbundit (The University of Sydney)
*Modelling multivariate financial time series with variance gamma innovations*

16:30 Andrew Grant (Macquarie University)
*Comparing multivariate spectral densities*

17:00 Lijing Ma (Macquarie University)
*Multiple change-point detection in an AR(1) Process: comparison of different methods*

17:30 Nishanthi Raveendran (Macquarie University)
*Binary segmentation methods for spatial clustering*

# Special Session 20: Topology

Organiser: Zsuzsanna Dancso

## Keynote Talks

▷ Tue 12 December 2017

14:00 Diarmuid Crowley (The University of Melbourne)
*The topological period–index conjecture for almost complex 6-manifolds*

## Contributed Talks

▷ Tue 12 December 2017

15:00 Csaba Nagy (The University of Melbourne)
*Classifying 8-dimensional E-manifolds*

16:00 Daniel Mathews (Monash University)
*Knot invariants and cluster algebras*

16:30 Sophie Ham (Monash University)
*Geometric triangulations of knot complements*

▷ Wed 13 December 2017

14:00 Joan Licata (Australian National University)
*Contact manifolds with boundary*

14:30 Dominic Tate (The University of Sydney)
*Higher Teichmüller theory on closed and finite-area surfaces using techniques of Fock and Goncharov*

15:00 Alex Casella (The University of Sydney)
*Representations of fibered 3-manifolds using flags*

16:00 Michael Batanin (Macquarie University)
*$E_3$-algebra structure on the Davydov–Yetter deformation complex*

16:30 Florian Martin Laurent De Leger (Macquarie University)
*Contractibility of nerve of classifiers and application to the Turchin–Dwyer–Hess theorem (with Michael Batanin)*

▷ Thu 14 December 2017

11:30 Marcy Robertson (The University of Melbourne)
*An action of the Grothendieck–Teichmüller group*

12:00 Artem Pulemotov (The University of Queensland)
*Metrics with prescribed curvature on generalised flag manifolds*

15:30 Hang Wang (The University of Adelaide)
*Twisted Donaldson invariants*

16:00 Paul Norbury (The University of Melbourne)
*A new cohomology class in the moduli space of stable curves*

# Special Session 21: LaTeX and beyond

Organiser: Ross Moore

## Contributed Talks

▷ Thu 14 December 2017

11:30 Ross Moore (Macquarie University)
*Authoring 'Tagged PDF' documents with LaTeX*

12:00 John Banks (The University of Melbourne)
*The Register! conference registration system*

15:30 Dmitry Demskoi (Charles Sturt University)
*Automated assessment by means of computer algebra, LaTeX and PDF forms*

# Conference Timetable Summary

| | Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|---|
| 8:00 | | | | | |
| 8:30 | | Registrations | | | |
| 9:00 | | | | | |
| 9:30 | AustMS editors meeting *C8A 310 Senate* | Opening Session & Prize Winners | Mahler Lecture *Ivan Corwin* | Plenary talk *Hélène Frankowska* | Plenary talk *Michael Small* |
| 10:00 | | | | | |
| 10:30 | | | Plenary talk *Hans De Sterck* | Plenary talk *Philip Pollett* | Plenary talk *Catherine Greenhill* |
| 11:00 | AMPAI & AustMS Council meeting *C8A 310 Senate* | Morning Tea | Morning Tea | Morning Tea | Morning Tea |
| 11:30 | | | | | |
| 12:00 | | Plenary talk *Andrei Okounkov* | Hanna Neumann Lecture *Georgia Benkart* | Special Sessions | Plenary talk *Michael Cowling* |
| 12:30 | | | | | |
| 13:00 | | Lunch | Lunch | Lunch | Lunch |
| 13:30 | | Decadal Plan *NCMS* | Debate | AustMS annual general meeting | |
| 14:00 | | Special Sessions | Special Sessions | Plenary talk *YoungJu Choie* | Special Sessions (SIGME) |
| 14:30 | | | | | |
| 15:00 | | | | Coffee Break | |
| 15:30 | | Coffee Break | Coffee Break | Special Sessions | Coffee Break |
| 16:00 | | Special Sessions | Special Sessions (Edu'n Forum) | | Special Sessions |
| 16:30 | | | | ANZIAM Lecture *Yvonne Stokes* | |
| 17:00 | WiMSIG Executive Meeting *E7B 263* | Plenary talk *Yihong Du* | | | |
| 17:30 | | | Drinks *MQ Theatre foyer* | | |
| 18:00 | | Reception *E7B Atrium* | | | |
| 18:30 | Women in Mathematics Dinner *MGSM* | | Public Lecture *Michael Small* | Conference Dinner *Curzon Hall* | |
| 19:00 | | | | | |
| 19:30 | | | | | |
| 20:00 | | | | | |

# Tue 12 December 2017

□ *Registration – Macquarie Theatre Foyer 08:00 – 11:00*

□ *Opening Session – Macquarie Theatre 09:00 – 11:00*

□ *Morning Tea – Macquarie Theatre Foyer 11:00 – 11:30*

■ Plenary Lecture – Macquarie Theatre

11:30 ► Andrei Okounkov (Columbia University, USA)
*Enumerative geometry and geometric representation theory*

□ *Lunch 12:30 – 14:00*

□ *NCMS Presentation: 'Implementation of the Decadal Plan for the Mathematical Sciences' – Macquarie Theatre 13:15 – 14:00*

■ Afternoon Special Sessions 14:00 – 15:30

□ *Afternoon tea – Macquarie Theatre Foyer 15:30 – 16:00*

■ Afternoon Special Sessions 16:00 – 17:00

■ Plenary Lecture – Macquarie Theatre

17:00 ► Yihong Du (University of New England)
*Propagation, diffusion and free boundaries*

□ *Reception E7B Atrium 18:00 – 20:00*

## ▪ Afternoon Special Sessions – list of speakers

2. Algebra

   W5A 105

   14:00 James East (Western Sydney University)
   *Integer polygons with given perimeter*

   14:30 Lauren Thornton (University of the Sunshine Coast)
   *On base radical operators Part 1: classes of finite associative rings*

   15:00 Robert McDougall (University of the Sunshine Coast)
   *On base radical operators Part 2: classes of finite Puczylowski algebras*

   16:00 Michal Ferov (University of Technology, Sydney)
   *Isomorphism problem for virtually-free groups*

   16:30 Ainsley Pullen (The University of Queensland)
   *Concrete mathematical incompleteness and the Finite Upper Shift Kernel theorem*

3. Applied/Industrial Mathematics

   W5C 221

   14:00 Amie Albrecht (University of South Australia)
   *The two-train separation problem on non-level track*

   15:00 Lele (Joyce) Zhang (The University of Melbourne)
   *A study of optimizing courier routes in CBD areas*

   16:00 Mark Nelson (University of Wollongong)
   *Analysis of nitrogen removal in the activated sludge process*

   16:30 Martin Sagradian (Macquarie University)
   *Potential theory problems for arbitrary rotationally symmetric double-connected conductors: rigorous approach*

4. Category Theory, Algebraic Topology, K-Theory

   W5A 101

   14:00 Ross Howard Street (Macquarie University)
   *Real sets*

   14:30 Charles Walker (Macquarie University)
   *Universal properties of polynomials via doctrinal Yoneda structures*

   15:00 Mircea Voineagu (University of New South Wales)
   *Computations in Bredon motivic cohomology*

   16:00 Diarmuid Crowley (The University of Melbourne)
   *Functors to categories of manifolds*

   16:30 Csaba Nagy (The University of Melbourne)
   *A functorial approach to classifying manifolds*

5. Complex Analysis, Geometry

   X5B 039

   14:00 Lesley Ward (University of South Australia)
   *Using the Schottky–Klein prime function to compute the harmonic measure distribution function of a doubly connected planar domain*

   14:30 Christopher Green (Macquarie University)
   *Using the Schottky–Klein prime function to compute harmonic measure distribution functions of a class of multiply connected planar domains*

   15:00 Marielle Ong (University of Queensland)
   *The Donaldson–Narasimhan–Seshadri Theorem*

   16:00 Matthew Randall ()
   *Flat* $(2,3,5)$*-distributions and Chazy's equations*

6. Computational Mathematics

X5B 138

14:00 Jerome Droniou (Monash University)
*Designing high-order schemes for diffusion problems on generic polytopal cells*

14:30 Hanz Martin Cheng (Monash University)
*Convergence analysis of a family of ELLAM schemes for a fully coupled model of miscible displacement in porous media*

15:00 Bishnu Lamichhane (The University of Newcastle)
*A new minimisation principle for the Poisson equation leading to a flexible finite-element approach*

16:00 Martin Ehler (University of Vienna, Austria)
*Optimal Monte Carlo integration*

16:30 Quoc Thong Le Gia (University of New South Wales)
*Sparse isotropic regularisation for spherical harmonic representations of random fields on the sphere*

8. Education

W5C 220

14:00 Yucang Wang (Central Queensland University)
*Linking mathematical theories to computation and modelling for engineering applications*

14:30 Deborah Jackson (La Trobe University)
*Impact and sustainability of a cross-disciplinary mathematics support program*

15:00 Rebecca Smith (The University of Newcastle)
*Engagement-focused learning in large service-level courses*

16:00 Chris Tisdell (University of New South Wales)
*No, Professor: you don't need to reverse the order of integration!*

16:30 Terence Mills (Deakin University)
*Lessons from problem solving in ancient China*

9. Functional Analysis, Operator Algebra, Non-commutative Geometry

C5A 226

14:00 Fedor Sukochev (University of New South Wales)
*Conformal trace theorem for Julia sets*

15:00 Jinghao Huang (University of New South Wales)
*Derivations into ideals of semifinite von Neumann algebras*

16:00 Shaymaa Shawkat Kadhim Al-shakarchi (University of New South Wales)
*Isomorphisms of $AC(\sigma)$ spaces*

16:30 Michael Arthur Mampusti (University of Wollongong)
*Mauldin–Williams graphs and their KMS states*

11. Harmonic Analysis

C5A 225

14:00 Adam Sikora (Macquarie University)
*Riesz transform and harmonic functions*

14:30 Alessandro Ottazzi (University of New South Wales)
*Spectral multipliers for sub-Laplacians on $NA$ groups*

15:00 Jan Rozendaal (Australian National University)
*Operator-valued $(L^p, L^q)$ Fourier multipliers*

16:00 Zihua Guo (Monash University)
*Generalized Strichartz estimates for Schrödinger equation*

16:30 Dorothee Frey (Delft University of Technology, The Netherlands)
*Sparse dominations and sharp weighted estimates for singular integral operators*

12. Mathematical Biology

    W5C 213

    14:00 Aaron Jordan Kaw (University of New South Wales)
    *Delivery and diffusion in membranes*

    14:30 Catheryn Gray (University of New South Wales)
    *Akt translocation as a harmonic oscillator*

    15:00 Michael Hendriksen (Western Sydney University)
    *Non-binary unrooted tree-based networks*

13. Mathematical Optimization

    X5B 136

    14:00 Vladimir Gaitsgory (Macquarie University)
    *Averaging in singularly perturbed deterministic and stochastic optimal control problems and dynamic games*

    15:00 Andrew Eberhard (RMIT University)
    *Radius theorems for monotone mappings*

    16:00 Chuong Thai Doan (University of New South Wales)
    *Optimality conditions for non-smooth, multi-objective, bilevel optimization problems*

    16:30 Guillermo Pineda-Villavicencio (Federation University Australia)
    *On the reconstruction of polytopes*

14. Mathematical Physics

    W5A 202

    14:00 Vladimir Mangazeev (Australian National University)
    *Integrable structure of products of complex random matrices*

    14:30 Xin Zhang (The University of Melbourne)
    *Quantum integrable models and the off-diagonal Bethe ansatz method*

    15:00 Maia Nikolova Angelova (Deakin University)
    *Squeezed coherent states of one-dimensional anharmonic quantum oscillators*

    16:00 Zeying Chen (AMSI/University of Melbourne)
    *Duality in mASEP and tKZ equation*

    16:30 Alexandr Garbali (The University of Melbourne)
    *Lattice integrable stochastic processes*

15. Number Theory

    W5C 211

    14:30 Mumtaz Hussain (La Trobe University)
    *The Hausdorff measure version of Gallagher's theorem — closing the gap and beyond*

    15:00 Jeffrey Lay (Australian National University)
    *An explicit bound for the divisor function*

    16:00 Dzmitry Badziahin (The University of Sydney)
    *p-adic Littlewood conjecture: what can potential counter-examples look like?*

    16:30 Liangyi Zhao (University of New South Wales)
    *Mean-value results of Hecke L-functions with fixed-order characters*

16. Partial Differential Equations

    C5A 229

    14:00 Daniel Daners (The University of Sydney)
    *Global dynamics of generalized logistic equations*

    14:30 Yingying Sun (The University of Sydney)
    *The Sylvester equation and the elliptic Korteweg–de Vries system*

15:00 Philip Broadbridge (La Trobe University)
*Non-classical symmetry solution of nonlinear reaction–diffusion: soil–water with plant roots*

16:00 Shengguo Zhu (Monash University)
*Recent progress on classical solutions for compressible isentropic Navier–Stokes equations with degenerate viscosities and vacuum*

16:30 Jean-Jerome Casanova (Monash University)
*Fluid structure system with boundary conditions involving the pressure*

17. Probability Theory and Stochastic Processes

W5C 232

14:00 Fima Klebaner (Monash University)
*Random initial conditions in differential equations*

15:00 Petru A. Cioica-Licht (University of Otago, NZ)
*Stochastic integration in quasi-Banach spaces*

16:00 Zdravko Botev (University of New South Wales)
*Sampling via regenerative chain Monte Carlo*

16:30 Liam S. Hodgkinson (University of Queensland)
*The long-term behaviour of an occupancy process*

18. Representation Theory

W5A 205

14:00 Kevin Coulembier (The University of Sydney)
*Auslander–Dlab–Ringel algebras and Ringel duality*

14:30 Bregje Pauwels (Australian National University)
*Gerstenhaber structure of a class of special biserial algebras*

15:00 Jessica Fintzen (Institute for Advanced Study, Princeton, USA)
*On the Moy–Prasad filtration and super-cuspidal representations*

16:00 Peter Hochs (The University of Adelaide)
*Blattner's conjecture as an index theorem*

16:30 Yaping Yang (The University of Melbourne)
*Towards a construction of higher dimensional loop Grassmannians*

20. Topology

W5A 103

14:00 Diarmuid Crowley (The University of Melbourne)
*The topological period–index conjecture for almost complex 6-manifolds*

15:00 Csaba Nagy (The University of Melbourne)
*Classifying 8-dimensional E-manifolds*

16:00 Daniel Mathews (Monash University)
*Knot invariants and cluster algebras*

16:30 Sophie Ham (Monash University)
*Geometric triangulations of knot complements*

# Wed 13 December 2017

▪ Mahler Lecture – Macquarie Theatre

09:00 ▸ Ivan Corwin (Columbia University, USA)
*Integrable probability*

▪ Plenary Lecture – Macquarie Theatre

10:00 ▸ Hans De Sterck (Monash University)
*Scalable PDE solvers on supercomputers: multilevel and parallel-in-time*

▫ *Morning Tea – Macquarie Theatre Foyer 11:00 – 11:30*

▪ Hanna Neumann Lecture – Macquarie Theatre

11:30 ▸ Georgia Benkart (University of Wisconsin–Madison, USA)
*Walking on graphs to Invariant Theory*

▫ *Lunch 12:30 – 14:00*

▫ *Debate: 'The traditional mathematics blackboard lecture is dead.' – Macquarie Theatre 13:00 – 14:00*

▪ Afternoon Special Sessions 14:00 – 15:30

▫ *Afternoon Tea – Macquarie Theatre Foyer 15:30 – 16:00*

▪ Afternoon Special Sessions 16:00 – 18:00

▫ *Drinks – Macquarie Theatre Foyer 17:45 – 18:30*

▪ Public Lecture – Macquarie Theatre

18:30 ▸ Michael Small (The University of Western Australia)
*Chaos is not random and complexity is not complicated*

## ▪ Afternoon Special Sessions – list of speakers

3. Applied/Industrial Mathematics

   W5C 221

   14:00 Zlatko Jovanoski (University of New South Wales Canberra)
   *A stochastic differential equation approach to modelling the growth phase of fire spread*

   14:30 Paul Smith (Macquarie University)
   *Quantifying the change in the far-field pattern induced by rounding the corners of a scatterer illuminated by a plane-wave electromagnetic field*

   15:00 Turker Topal (Macquarie University)
   *Accurate calculation of complex eigenvalues for TM-modes in 2D arbitrary cavities with longitudinal slit*

4. Category Theory, Algebraic Topology, K-Theory

   W5A 101

   14:00 Michael Alexander Hallam (The University of Adelaide)
   *End-periodic $K$-homology and positive scalar curvature*

   14:30 Marcy Robertson (The University of Melbourne)
   *Presheaf models for infinity modular operads*

   15:00 Edoardo Lanari (Macquarie University)
   *$\infty$-groupoids and the Homotopy Hypothesis*

   16:00 Matthew James Spong (The University of Melbourne)
   *The $K$-theory of loop spaces and elliptic cohomology*

   16:30 Chi-Kwong Fok (The University of Adelaide)
   *Real K-theory of compact Lie groups*

   17:00 Daniel Lin (Macquarie University)
   *Presheaves over join restriction categories*

   17:30 Yaping Yang (The University of Melbourne)
   *Algebraic elliptic cohomology and flops*

5. Complex Analysis, Geometry

   X5B 039

   14:00 Rod Gover (University of Auckland)
   *The projective geometry of Sasaki–Einstein structures and their compactification*

   15:00 Gerd Schmalz (University of New England)
   *Homogeneous tube domains in higher dimensions*

   16:00 Masoud Ganji (University of New England)
   *A criterion for the embedding of a 3-dimensional CR structure*

6. Computational Mathematics

   X5B 138

   14:00 Hans De Sterck (Monash University)
   *Nonlinearly preconditioned optimisation methods for tensor decompositions and recommendation*

   15:00 Ian Sloan (University of New South Wales)
   *On the generation of random fields*

   16:00 Markus Hegland (Australian National University)
   *Fractals and numerical linear algebra*

   16:30 Michael Assis (The University of Newcastle)
   *Systematic analysis of OEIS generating functions*

7. Dynamical Systems/Ergodic Theory

   W5A 201

   - 14:00 Tanja Schindler (Australian National University)
     *Trimmed sums for observables on the doubling map*
   - 14:30 Holger Dullin (The University of Sydney)
     *Stability of doubly periodic shear flow of the Euler equations*
   - 15:00 Sanjeeva Balasuriya (The University of Adelaide)
     *Stochastic sensitivity: a computable measure for uncertainty of deterministic trajectories*
   - 16:00 John Wormell (The University of Sydney)
     *Spectral Galerkin methods for transfer operators in uniformly expanding dynamics*
   - 16:30 Harry Crimmins (University of New South Wales)
     *Stability of Statistical Properties for some Dynamical Systems*
   - 17:00 Fadi Antown (University of New South Wales)
     *Optimal linear response for Markov chains*
   - 17:30 Timothy Siu (University of New South Wales)
     *Combinatorial model for the dynamics of birational maps over finite fields*

8. Education

   W5C 220

   - 14:00 Roland Dodd (Central Queensland University)
     *Bridging the gap for inclusive transition*
   - 14:30 Birgit Loch (La Trobe University)
     *Teaching wirelessly with a pen-enabled tablet*
   - 15:00 William Guo (Central Queensland University)
     *Improving retention and progression by rescheduling engineering mathematics units*
   - 16:00 Harkirat Dhindsa (Macquarie University)
     *Tertiary students' perceptions of assessments of, and attitudes to, Mathematics*
   - 16:30 Forum: 'Hot Topics' (1 hour)

9. Functional Analysis, Operator Algebra, Non-commutative Geometry

   C5A 226

   - 14:00 Jacqui Ramagge (The University of Sydney)
     *C*-algebras from self-similar actions and their states*
   - 15:00 Aidan Sims (University of Wollongong)
     *Rigidity for dynamics via operator algebras*
   - 16:00 Becky Armstrong (The University of Sydney)
     *Twisted $C^*$-algebras of topological higher-rank graphs: keeping things simple!*
   - 16:30 Kevin Aguyar Brix (University of Copenhagen, Denmark)
     *Investigating symbolic dynamics using C*-algebras*
   - 17:00 Thomas Pedersen (University of Wollongong)
     *On the $C^*$-algebras of a graph of groups*
   - 17:30 Elizabeth Bradford (University of South Australia)
     *Recursive algorithms for inversion of linear operator pencils*

10. Geometric Analysis

    C5A 232

    - 14:00 Artem Pulemotov (The University of Queensland)
      *Metrics with prescribed curvature on homogeneous spaces with intermediate subgroups*
    - 14:30 Jonathan Julian Zhu (Harvard University, USA)
      *Min–max theory for constant mean curvature hypersurfaces*

15:00 Alexander Majchrowski (The University of Sydney)
*Neck detection for the fully nonlinear flow $G$*

16:00 Jim Isenberg (University of Oregon, USA)
*Non-Kaehler Ricci flows that converge to Kaehler–Ricci solitons*

17:00 Erchuan Zhang (The University of Western Australia)
*Riemannian cubics in the manifold* $\mathrm{SPD}(n)$ *of all* $n \times n$ *symmetric positive-definite matrices*

17:30 Qirui Li (Australian National University)
*The planar dual Minkowski problem*

11. Harmonic Analysis

C5A 225

14:00 Maolin Zhou (University of New England)
*A principal eigenvalue problem with large degenerate advection*

14:30 Daniel Hauer (The University of Sydney)
*A generalised Gagliardo–Nirenberg type inequality with application to the $p(x)$-Laplacian*

12. Mathematical Biology

W5C 213

14:00 Pantea Pooladvand (The University of Sydney)
*Do T-cells compete for antigen?*

14:30 Adarsh Kumbhari (The University of Sydney)
*Modelling the impact of T-cell avidity on cancer vaccines*

15:00 Adrianne Jenner (The University of Sydney)
*Modelling heterogeneity in biology: how do cancer-killing viruses interact with tumour cells?*

16:00 Maia Nikolova Angelova (Deakin University)
*Mathematical model of glucose–insulin regulation with diabetically impaired ultradian oscillations*

16:30 Mark Nelson (University of Wollongong)
*Modelling the spread of smoking as an infectious disease*

13. Mathematical Optimization

X5B 136

14:00 Alex Parkinson (Macquarie University)
*Averaging of discrete-time singularly perturbed optimal control problems*

14:30 Scott Lindstrom (The University of Newcastle)
*Strong convergence for relaxed iterated approximate projection methods for convex feasibility problems*

15:00 Ali Eshragh (The University of Newcastle)
*A new approach to select the best subset of predictors in linear regression modeling*

16:00 Sogol Mohammadian (The University of Newcastle)
*Investigating Hamilton cycles through extreme points of a certain polytope*

16:30 Kieran Clancy (Flinders University)
*Extending a linear programming formulation for TSP*

17:00 Minh N. Dao (The University of Newcastle)
*On the generalized Douglas–Rachford algorithm for feasibility problems*

14. Mathematical Physics

W5A 202

17:30 Michael Assis (The University of Newcastle)
*Exactly-solved origami statistical mechanics*

15. Number Theory

    W5C 211

    14:30 Peter Forrester (The University of Melbourne)
    *Octonions in random matrix theory*

    15:00 Kam Hung Yau (University of New South Wales)
    *Distribution of $\alpha n + \beta$ modulo 1 over some arithmetic set*

    16:00 Timothy Trudgian (University of New South Wales Canberra)
    *Primes and squares — in less than two pages!*

    16:30 Stephen Meagher (University of New South Wales)
    *Chebotarev's density theorem over finite fields*

16. Partial Differential Equations

    C5A 229

    16:00 Qirui Li (Australian National University)
    *A class of optimal transportation problems on the sphere*

    16:30 Daniel Hauer (The University of Sydney)
    *A strong maximum principle on cones*

17. Probability Theory and Stochastic Processes

    W5C 232

    14:00 Meng Shi (Monash University)
    *Bootstrap random walk*

    14:30 Yunxuan Liu (Monash University)
    *Invariance principle for biased bootstrap random walks*

    15:00 Kais Hamza (Monash University)
    *General bootstrap random walks*

    16:00 Thomas Taimre (University of Queensland)
    *Exploiting asymptotic structure for efficient rare-event estimation for sums of random variables*

    16:30 Azam Asanjarani (AMSI/University of Melbourne)
    *Bursty Markovian arrival processes*

18. Representation Theory

    W5A 205

    14:00 Ben Webster (University of Waterloo, Canada)
    *The representation theory of symplectic singularities*

    15:00 Kari Vilonen (The University of Melbourne)
    *Langlands duality for real groups*

    16:00 Duy Ho (University of Canterbury, NZ)
    *On the classification of toroidal circle planes*

    16:30 Jon Xu (The University of Melbourne)
    *Chevalley groups and finite geometry*

    17:00 Yang Zhang (The University of Sydney)
    *The second fundamental theorem of invariant theory for the orthosymplectic supergroup*

19. Stochastic Models and Applications

    W5A 203

    14:30 Michael Stewart (The University of Sydney)
    *More sensitive mixture detection using the empirical moment-generating function*

    15:00 Justin Wishart (Macquarie University)
    *Homogeneous wavelet expansions of some fractional Gaussian fields*

    16:00 Thanakorn Nitithumbundit (The University of Sydney)
    *Modelling multivariate financial time series with variance gamma innovations*

16:30 Andrew Grant (Macquarie University)
*Comparing multivariate spectral densities*

17:00 Lijing Ma (Macquarie University)
*Multiple change-point detection in an AR(1) Process: comparison of different methods*

17:30 Nishanthi Raveendran (Macquarie University)
*Binary segmentation methods for spatial clustering*

20. Topology

W5A 103

14:00 Joan Licata (Australian National University)
*Contact manifolds with boundary*

14:30 Dominic Tate (The University of Sydney)
*Higher Teichmüller theory on closed and finite-area surfaces using techniques of Fock and Goncharov*

15:00 Alex Casella (The University of Sydney)
*Representations of fibered 3-manifolds using flags*

16:00 Michael Batanin (Macquarie University)
*$E_3$-algebra structure on the Davydov–Yetter deformation complex*

16:30 Florian Martin Laurent De Leger (Macquarie University)
*Contractibility of nerve of classifiers and application to the Turchin–Dwyer–Hess theorem (with Michael Batanin)*

# Thu 14 December 2017

■ Plenary Lecture – Macquarie Theatre

09:00 ► Hélène Frankowska (CNRS, France)
*Value function and necessary optimality conditions in deterministic optimal control*

■ Plenary Lecture – Macquarie Theatre

10:00 ► Philip Keith Pollett (University of Queensland)
*Metapopulations in evolving landscapes*

□ *Morning tea – Macquarie Theatre Foyer 11:00 – 11:30*

■ Morning Special Sessions 11:30 – 12:30

□ *Lunch 12:30 – 14:00*

□ *AustMS AGM – Macquarie Theatre 13:00 – 14:00*

■ Plenary Lecture – Macquarie Theatre

14:00 ► YoungJu Choie (Postech, South Korea)
*A vital role of automorphic forms in number theory*

□ *Afternoon Tea – Macquarie Theatre Foyer 15:00 – 15:30*

■ Afternoon Special Sessions 15:30 – 16:30

■ ANZIAM Lecture – Macquarie Theatre

16:30 ► Yvonne Stokes (The University of Adelaide)
*Can we make that fibre?*

□ *Conference Dinner – Curzon Hall 18:30 – 22:00*

- Morning Special Sessions – list of speakers

2. Algebra

   W5A 105

   11:30 John Cannon (The University of Sydney)
   *Fact-checking the ATLAS of Finite Groups*

   12:00 Hafiz Khusyairi (Australian National University)
   *Unexpected new formula for Grothendieck duality*

4. Category Theory, Algebraic Topology, K-Theory

   W5A 101

   11:30 Yuki Maehara (Macquarie University)
   *Mahavier limits*

   12:00 Stephen Lack (Macquarie University)
   *Parity for nestohedra*

5. Complex Analysis, Geometry

   X5B 039

   11:30 Emma Carberry (The University of Sydney)
   *Toroidal soap bubbles: constant mean curvature tori in $\mathbb{S}^3$ and $\mathbb{R}^3$*

   12:00 David Brander (Technical University of Denmark)
   *Cauchy problems for surfaces related to harmonic maps*

7. Dynamical Systems/Ergodic Theory

   W5A 201

   11:30 Milena Radnovic (The University of Sydney)
   *Short trajectories of integrable billiards*

   12:00 Bojan Crnkovic (University of Rijeka, Croatia)
   *Lattice structure detection and refinement DMD algorithm*

8. Education

   W5C 220

   11:30 Dilshara Hill (Macquarie University)
   *Assessment: a multi-pronged tool to motivate and engage*

   12:00 Deborah King (The University of Melbourne)
   *Investigating students' perceptions of graduate learning outcomes in mathematics*

9. Functional Analysis, Operator Algebra, Non-commutative Geometry

   C5A 226

   11:30 Peter Hochs (The University of Adelaide)
   *K-theory and characters*

   12:00 Guo Chuan Thiang (The University of Adelaide)
   *Hyperbolic and crystalline topological matter via Baum–Connes isomorphisms*

10. Geometric Analysis

    C5A 232

    11:30 Ross Ogilvie (The University of Sydney)
    *The space of harmonic tori in the 3-sphere*

    12:00 Paul Bryan (The University of Queensland)
    *Distance comparison for curve shortening of networks*

11. Harmonic Analysis

    C5A 225

    11:30 Anh Bui (Macquarie University)
    *On the flows associated to self-adjoint operators on metric measure spaces*

    12:00 Fu Ken Ly (The University of Sydney)
    *An embedding result for Hermite distribution spaces*

12. Mathematical Biology

    W5C 213

    11:30 Robyn Patrice Araujo (Queensland University of Technology)
    *The simple complexity of robust networks*

    12:00 John Murray (University of New South Wales)
    *Smoking prevalence and related death rates for Australian birth cohorts over the last century*

13. Mathematical Optimization

    X5B 136

    11:30 Vera Roshchina (RMIT University)
    *Multipoint Voronoi cells*

    12:00 Guoyin Li (University of New South Wales)
    *Computing radius of robust feasibility of uncertain linear conic programs via semidefinite programs*

14. Mathematical Physics

    W5A 202

    11:30 Zongzheng Zhou (Monash University)
    *Unified correlation function behaviours on high-dimensional tori*

    12:00 Abrahim Steve Nasrawi (Monash University)
    *Lifted worm process for the Ising model*

15. Number Theory

    W5C 211

    11:30 Simon Macourt (University of New South Wales)
    *Visible points on exponential curves*

    12:00 Yinan Zhang (Australian National University)
    *Computing p-adic regulators*

17. Probability Theory and Stochastic Processes

    W5C 232

    11:30 Jie Yen Fan (Monash University)
    *Measure-valued population processes and their asymptotics*

    12:00 Oscar Peralta (Technical University of Denmark)
    *On a class of bivariate phase-type distributions and its applications in risk theory*

18. Representation Theory

    W5A 205

    11:30 Arik Wilbert (University of Bonn/MPI Bonn, Germany)
    *Two-block Springer fibers and Springer representations in type D*

    12:00 Sinead Wilson (The University of Queensland)
    *Stabilisers of eigenvectors in complex reflection groups*

20. Topology

    W5A 103

    11:30 Marcy Robertson (The University of Melbourne)
    *An action of the Grothendieck–Teichmüller group*

    12:00 Artem Pulemotov (The University of Queensland)
    *Metrics with prescribed curvature on generalised flag manifolds*

21. LaTeX and beyond

    W5C 221

    11:30 Ross Moore (Macquarie University)
    *Authoring 'Tagged PDF' documents with LaTeX*

    12:00 John Banks (The University of Melbourne)
    *The Register! conference registration system*

- Afternoon Special Sessions – list of speakers

2. Algebra

   W5A 105

   15:30 Murray Elder (University of Technology, Sydney)
   *Permutations sorted by a finite and an infinite stack in series*

   16:00 Tim Stokes (University of Waikato, NZ)
   *Generalised domain and E-inverse semigroups*

4. Category Theory, Algebraic Topology, K-Theory

   W5A 101

   16:00 John Bourke (Macquarie University)
   *Braidings for skew monoidal categories*

5. Complex Analysis, Geometry

   X5B 039

   15:30 Alessandro Ottazzi (University of New South Wales)
   *Lie groups contacto-morphic to nilpotent Lie groups*

   16:00 Wolfgang Globke (The University of Adelaide)
   *Affinely flat algebraic groups and a conjecture of Popov*

8. Education

   W5C 220

   15:30 Gizem Intepe (Western Sydney University)
   *Examining students' interaction with mathematics consultation using Text Mining*

   16:00 Heather Lonsdale (Curtin University)
   *Third-year undergraduate projects in mathematics education: analysing student attitudes, student reflections, and predicting student performance*

9. Functional Analysis, Operator Algebra, Non-commutative Geometry

   C5A 226

   15:30 Silvestru Sever Dragomir (Victoria University)
   *Recent inequalities of Young type for positive operators in Hilbert spaces*

   16:00 Geetika Verma (University of South Australia)
   *The fundamental equations for the generalized resolvent of an elementary pencil in a unital Banach algebra*

10. Geometric Analysis

    C5A 232

    15:30 Changwei Xiong (Australian National University)
    *Convexity of non-negatively curved hypersurfaces with free boundary on a sphere*

    16:00 Yong Wei (Australian National University)
    *Volume preserving flow in hyperbolic space*

12. Mathematical Biology

    W5C 213

    15:30 Danya Rose (The University of Sydney)
    *Who gets the girl? On the operational sex ratio as an index for male strategy*

    16:00 Michael Greg Watson (The University of Sydney)
    *Multi-phase modelling of early fibrous cap formation in atherosclerosis*

14. Mathematical Physics

    W5A 202

    15:30 Guo Chuan Thiang (The University of Adelaide)
    *Duality methods for topological matter*

    16:00 Thomas Quella (The University of Melbourne)
    *Protection of topological phases in quantum spin systems by quantum deformed symmetries*

15. Number Theory

    W5C 211

    15:30 Jessica Fintzen (Institute for Advanced Study, Princeton, USA)
    *Families of p-adic automorphic forms on unitary groups*

    16:00 Min Sha (Macquarie University)
    *On the irregular primes with respect to Euler polynomials*

16. Partial Differential Equations

    C5A 229

    15:30 Yong Wei (Australian National University)
    *Volume preserving flow by powers of k-th mean curvature*

    16:00 Geoffrey Prince (Australian Mathematical Sciences Institute)
    *Variationality of PDEs*

17. Probability Theory and Stochastic Processes

    W5C 232

    15:30 Andrea Collevecchio (Monash University)
    *The branching-ruin number and the critical parameter of once-reinforced random walk on trees*

    16:00 Laurence Field (Australian National University)
    *Spatial decomposition for Brownian motion and SLE curves*

18. Representation Theory

    W5A 205

    15:30 Masoud Kamgarpour (University of Queensland)
    *Examples of mesopelagic Langlands correspondence*

    16:00 Anthony Licata (Australian National University)
    *Linear braids*

20. Topology

    W5A 103

    15:30 Hang Wang (The University of Adelaide)
    *Twisted Donaldson invariants*

    16:00 Paul Norbury (The University of Melbourne)
    *A new cohomology class in the moduli space of stable curves*

21. LaTeX and beyond

    W5C 221

    15:30 Dmitry Demskoi (Charles Sturt University)
    *Automated assessment by means of computer algebra, LaTeX and PDF forms*

# Fri 15 December 2017

■ Plenary Lecture – Macquarie Theatre

09:00 ▸ Michael Small (The University of Western Australia)
*Reconstructing continuous dynamical systems from time series data with discrete transition graphs*

■ Plenary Lecture – Macquarie Theatre

10:00 ▸ Catherine Greenhill (University of New South Wales)
*Two threshold problems for random graphs and hypergraphs*

□ *Morning Tea – Macquarie Theatre Foyer 11:00 – 11:30*

■ Plenary Lecture – Macquarie Theatre

11:30 ▸ Michael Cowling (University of New South Wales)
*Analysis on product spaces*

□ *Lunch 12:30 – 14:00*

■ Afternoon Special Sessions 14:00 – 15:30

□ *Afternoon Tea – Macquarie Theatre Foyer 15:30 – 16:00*

■ Afternoon Special Sessions 16:00 – 17:00

## ▪ Afternoon Special Sessions – list of speakers

### 3. Applied/Industrial Mathematics

W5C 221

14:00 Song-Ping Zhu (University of Wollongong)
*Pricing American-style Parisian options*

14:30 Ilknur Tulunay (University of Technology, Sydney)
*ST-metric method in Finance*

15:00 Elena Vinogradova (Macquarie University)
*Regularization of the first-kind surface integral equations arising in the wave diffraction on 2D arbitrary cavities with longitudinal slit*

16:00 Roslyn Hickson (IBM Research Australia)
*Dengue fever in Taiwan: an IBM Health Corps adventure*

### 4. Category Theory, Algebraic Topology, K-Theory

W5A 101

14:00 Jesse Burke (Australian National University)
*Transferring $A$-infinity structures along quasi-isomorphisms*

14:30 Richard Garner (Macquarie University)
*Ultrafilters*

15:00 Huanhuan Li (Western Sydney University)
*Graded Steinberg algebras and their representations*

16:00 Dominic Verity (Macquarie University)
*Generator notions in $\infty$-cosmology*

16:30 Alexander Campbell (Macquarie University)
*Enriched algebraic weak factorisation systems*

### 8. Education

W5C 220

14:00 SIGME organisational meeting

14:30 Judy-anne Osborn (The University of Newcastle)
*Communities of practice across pre-undergraduate and undergraduate mathematics*

15:00 Thomas Wong (The University of Melbourne)
*LaTeX + First Year Calculus = ???*

16:00 Lyn Armstrong (Western Sydney University)
*From where do our students come?*

16:30 Collin Grant Phillips (The University of Sydney)
*Employing cultural plasticity in STEM workshops for prospective indigenous Engineering and Information Technology students*

### 9. Functional Analysis, Operator Algebra, Non-commutative Geometry

C5A 226

14:00 Hang Wang (The University of Adelaide)
*Positive scalar curvature for proper actions*

14:30 Nathan Brownlowe (The University of Sydney)
*On Baumslag–Solitar monoids and their $C^*$-algebras*

15:00 Adam Sierakowski (University of Wollongong)
*Unbounded quasitraces, stable finiteness and pure infiniteness*

16:00 Zahra Afsar (University of Wollongong)
*KMS states on the $C^*$-algebras of Fell bundles over groupoids*

12. Mathematical Biology

W5C 213

14:00 Peter Kim (The University of Sydney)
*Modelling evolution of post-menopausal human longevity: the Grandmother Hypothesis*

16. Partial Differential Equations

C5A 229

14:00 Jiakun Liu (University of Wollongong)
*Bergman–Toeplitz operators on weakly pseudoconvex domains*

14:30 Jan Rozendaal (Australian National University)
*Stability theory for semigroups using* $(L^p, L^q)$ *Fourier multipliers*

15:00 Nalini Joshi (The University of Sydney)
*Geometric asymptotics*

17. Probability Theory and Stochastic Processes

W5C 232

14:00 Tanja Schindler (Australian National University)
*Convergence to extremal processes for Lévy processes with slowly varying canonical measure*

14:30 Zongzheng Zhou (Monash University)
*Green's function of a random length random walk on the torus*

15:00 Yan Dolinsky (Monash University)
*Duality and convergence for binomial markets with friction*

# List of Registrants

Current as of Friday 8 December 2017

| | |
|---|---|
| Dr Zahra Afsar | University of Wollongong |
| Mrs Shaymaa Shawkat Kadhim Al-shakarchi | University of New South Wales |
| Dr Amie Albrecht | University of South Australia |
| Ms Elizabeth Alford | Department of Defence |
| Mrs Huda Alrashdi | The University of Sydney |
| Prof Maia Nikolova Angelova | Deakin University |
| Mr Fadi Antown | University of New South Wales |
| Dr Robyn Patrice Araujo | Queensland University of Technology |
| Miss Becky Armstrong | The University of Sydney |
| Ms Lyn Armstrong | Western Sydney University |
| Dr Azam Asanjarani | AMSI/University of Melbourne |
| Dr Michael Assis | The University of Newcastle |
| Assoc Prof Dzmitry Badziahin | The University of Sydney |
| Miss Ayreena Bakhtawar | La Trobe University |
| Mx Sanjeeva Balasuriya | The University of Adelaide |
| Dr John Banks | The University of Melbourne |
| Ms Naomi Barber | Northern Beaches Christian School |
| Assoc Prof Michael Batanin | Macquarie University |
| Prof Nigel Bean | The University of Adelaide |
| Mx Kimberly Becker | The University of Adelaide |
| Mr Theo Bendit | The University of Newcastle |
| Prof Georgia Benkart | University of Wisconsin-Madison, USA |
| Dr Zdravko Botev | University of New South Wales |
| Dr John Bourke | Macquarie University |
| Dr Jonathan Bowden | Monash University |
| Ms Elizabeth Bradford | University of South Australia |
| Assoc Prof David Brander | Technical University of Denmark |
| Prof Richard P Brent | Australian National University |
| Mr Kevin Aguyar Brix | University of Copenhagen, Denmark |
| Prof Philip Broadbridge | La Trobe University |
| Dr Nathan Brownlowe | The University of Sydney |
| Mr Paul Bryan | The University of Queensland |
| Mx Nicholas Buchdahl | The University of Adelaide |
| Dr Anh Bui | Macquarie University |
| Miss Aarchana Bulathsinghala | Macquarie University |
| Dr Jesse Burke | Australian National University |
| Dr Alexander Campbell | Macquarie University |
| Prof John Cannon | The University of Sydney |
| Dr Emma Carberry | The University of Sydney |
| Mx Jean-Jerome Casanova | Monash University |
| Mr Alex Casella | The University of Sydney |
| Mx Yi-Lung Chen | University of New South Wales |
| Ms Zeying Chen | AMSI/University of Melbourne |
| Mr Hanz Martin Cheng | Monash University |
| Prof YoungJu Choie | Postech, South Korea |
| Mr Petru A. Cioica-Licht | University of Otago, NZ |
| Dr Kieran Clancy | Flinders University |
| Dr Samantha Clarke | The University of Sydney |
| Mrs Adelle Colbourn | Western Sydney University |

| | |
|---|---|
| Dr Andrea Collevecchio | Monash University |
| Prof Ivan Corwin | Columbia University, USA |
| Assoc Prof Adelle Coster | University of New South Wales |
| Dr Kevin Coulembier | The University of Sydney |
| Mr Don Coutts | Canberra Institute of Technology |
| Prof Michael Cowling | University of New South Wales |
| Mr Harry Crimmins | University of New South Wales |
| Mx Bojan Crnkovic | University of Rijeka, Croatia |
| Mx Diarmuid Crowley | The University of Melbourne |
| Dr Zsuzsanna Dancso | The University of Sydney |
| Dr Daniel Daners | The University of Sydney |
| Dr Minh N. Dao | The University of Newcastle |
| Prof Jan De Gier | The University of Melbourne |
| Mr Florian Martin Laurent De Leger | Macquarie University |
| Mr Raveen Daminda de Silva | University of New South Wales |
| Prof Hans De Sterck | Monash University |
| Dr Dmitry Demskoi | Charles Sturt University |
| Prof Jim Denier | Macquarie University |
| Dr Harkirat Dhindsa | Macquarie University |
| Mr Neil Kristofer Dizon | The University of Newcastle |
| Dr Josef Dick | University of New South Wales |
| Dr Roland Dodd | Central Queensland University |
| Assoc Prof Yan Dolinsky | Monash University |
| Prof Silvestru Sever Dragomir | Victoria University |
| Dr Jerome Droniou | Monash University |
| Dr Gabriel Drummond-Cole | IBS Center for Geometry and Physics, South Korea |
| Prof Yihong Du | University of New England |
| Dr Holger Dullin | The University of Sydney |
| Prof Xuan Duong | Macquarie University |
| Dr David Easdown | The University of Sydney |
| Dr James East | Western Sydney University |
| Prof Andrew Eberhard | RMIT University |
| Dr Martin Ehler | University of Vienna, Austria |
| Dr Murray Elder | University of Technology, Sydney |
| Dr Ali Eshragh | The University of Newcastle |
| Mr Fahad Fahad Alshammari | The University of Queensland |
| Ms Jie Yen Fan | Monash University |
| Dr Michal Ferov | University of Technology, Sydney |
| Dr Laurence Field | Australian National University |
| Dr Jessica Fintzen | Institute for Advanced Study, Princeton, USA |
| Dr Chi-Kwong Fok | The University of Adelaide |
| Ms Roslyn Forecast | RMIT University |
| Prof Peter Forrester | The University of Melbourne |
| Prof Hélène Frankowska | CNRS, France |
| Ms Dorothee Frey | Delft University of Technology, The Netherlands |
| Prof Gary Froyland | University of New South Wales |
| Dr Thomas Fung | Macquarie University |
| Prof Vladimir Gaitsgory | Macquarie University |
| Mr Masoud Ganji | University of New England |
| Dr Alexandr Garbali | The University of Melbourne |
| Dr Richard Garner | Macquarie University |
| Assoc Prof Timothy Garoni | Monash University |
| Dr Wolfgang Globke | The University of Adelaide |
| Mr Yoong Kuan Goh | University of Technology, Sydney |
| Mr Chris Gordon | Macquarie University |
| Prof Georg Gottwald | The University of Sydney |
| Prof Rod Gover | University of Auckland, NZ |
| Mr Andrew Grant | Macquarie University |
| Ms Catheryn Gray | University of New South Wales |

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| Dr Christopher Green | Macquarie University |
| Assoc Prof Catherine Greenhill | University of New South Wales |
| Prof Joseph Grotowski | The University of Queensland |
| Dr David Gruenewald | The University of Sydney |
| Mr Hao Guo | The University of Adelaide |
| Prof William Guo | Central Queensland University |
| Mr Zihua Guo | Monash University |
| Dr Philip Hackney | Macquarie University |
| Mx Christine Hale | Macquarie University |
| Mr Michael Alexander Hallam | The University of Adelaide |
| Miss Sophie Ham | Monash University |
| Assoc Prof Kais Hamza | Monash University |
| Dr Adam Harris | University of New England |
| Dr David Harvey | University of New South Wales |
| Dr Daniel Hauer | The University of Sydney |
| Prof Markus Hegland | Australian National University |
| Prof Anthony Henderson | The University of Sydney |
| Mr Michael Hendriksen | Western Sydney University |
| Dr Roslyn Hickson | IBM Research Australia |
| Ms Dilshara Hill | Macquarie University |
| Dr Duy Ho | University of Canterbury, NZ |
| Dr Peter Hochs | The University of Adelaide |
| Mr Liam S. Hodgkinson | University of Queensland |
| Dr Algy Howe | Australian National University |
| Mr Jinghao Huang | University of New South Wales |
| Dr Mumtaz Hussain | La Trobe University |
| Dr Gizem Intepe | Western Sydney University |
| Prof Jim Isenberg | University of Oregon, USA |
| Mr Clive Jackson | Victorian Government |
| Dr Deborah Jackson | La Trobe University |
| Ms Adrianne Jenner | The University of Sydney |
| Mr Michael Jennings | The University of Queensland |
| Mr Danesh Jogia | Department of Defence |
| Mr Daniel John | The University of Adelaide |
| Prof Michael Johnson | Macquarie University |
| Prof Nalini Joshi | The University of Sydney |
| Dr Zlatko Jovanoski | University of New South Wales Canberra |
| Mx Marcel Julliard | Macquarie University |
| Dr Masoud Kamgarpour | University of Queensland |
| Mr Aaron Jordan Kaw | University of New South Wales |
| Ms Carolyn Kennett | Macquarie University |
| Mr Hafiz Khusyairi | Australian National University |
| Assoc Prof Peter Kim | The University of Sydney |
| Assoc Prof Deborah King | The University of Melbourne |
| Prof Fima Klebaner | Monash University |
| Ms Sophie Klijn | Northern Beaches Secondary College |
| Dr Jonathan Kress | University of New South Wales |
| Mr Adarsh Kumbhari | The University of Sydney |
| Assoc Prof Frances Y. Kuo | University of New South Wales |
| Prof Stephen Lack | Macquarie University |
| Prof Philip Laird | University of Wollongong |
| Dr Bishnu Lamichhane | The University of Newcastle |
| Mr Edoardo Lanari | Macquarie University |
| Mr Jeffrey Lay | Australian National University |
| Dr Quoc Thong Le Gia | University of New South Wales |
| Dr Thomas Leistner | The University of Adelaide |
| Dr Guoyin Li | University of New South Wales |
| Mx Huanhuan Li | Western Sydney University |
| Dr Ji Li | Macquarie University |

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| Dr Qirui Li | Australian National University |
| Assoc Prof Anthony Licata | Australian National University |
| Dr Joan Licata | Australian National University |
| Mr Daniel Lin | Macquarie University |
| Mr Scott Lindstrom | The University of Newcastle |
| Dr Jiakun Liu | University of Wollongong |
| Mr Yunxuan Liu | Monash University |
| Prof Birgit Loch | La Trobe University |
| Dr Heather Lonsdale | Curtin University |
| Ms Sara Li-Yen Loo | The University of Sydney |
| Prof John Loxton | Western Sydney University |
| Dr Fu Ken Ly | The University of Sydney |
| Miss Lijing Ma | Macquarie University |
| Mr Daniel Mackinlay | University of New South Wales |
| Dr Shev MacNamara | University of Technology, Sydney |
| Mr Simon Macourt | University of New South Wales |
| Mr Yuki Maehara | Macquarie University |
| Mr Alexander Majchrowski | The University of Sydney |
| Mr Michael Arthur Mampusti | University of Wollongong |
| Dr Vladimir Mangazeev | Australian National University |
| Dr Daniel Francis Mansfield | University of New South Wales |
| Mrs Audrey Markowskei | Macquarie University |
| Dr Daniel Mathews | Monash University |
| Dr Nick McConnell | Defence Science and Technology Organisation |
| Assoc Prof James McCoy | University of Wollongong |
| Dr Robert McDougall | University of the Sunshine Coast |
| Mr Fazlul Md Fazlul Hoque | The University of Queensland |
| Mx Stephen Meagher | University of New South Wales |
| Dr Christopher Meaney | Macquarie University |
| Mr Samuel Mills | The University of Adelaide |
| Dr Terence Mills | Deakin University |
| Miss Sogol Mohammadian | The University of Newcastle |
| Dr Ross Moore | Macquarie University |
| Prof Sid Morris | Federation University Australia |
| Prof John Murray | University of New South Wales |
| Mx Zead Mustafa | Qatar University, UAE |
| Prof Mary Myerscough | The University of Sydney |
| Dr Gerry Myerson | Macquarie University |
| Mr Csaba Nagy | The University of Melbourne |
| Mr Abrahim Steve Nasrawi | Monash University |
| Assoc Prof Mark Nelson | University of Wollongong |
| Dr Giang Nguyen | The University of Adelaide |
| Ms Trang Nguyen | University of South Australia |
| Mr Thanakorn Nitithumbundit | The University of Sydney |
| Prof Paul Norbury | The University of Melbourne |
| Dr Ross Ogilvie | The University of Sydney |
| Prof Andrei Okounkov | Columbia University, USA |
| Mx Marielle Ong | University of Queensland |
| Dr Judy-anne Osborn | The University of Newcastle |
| Dr Alessandro Ottazzi | University of New South Wales |
| Mr George Papadopoulos | The University of Sydney |
| Mr Alex Parkinson | Macquarie University |
| Dr James Parkinson | The University of Sydney |
| Dr Bregje Pauwels | Australian National University |
| Mr Thomas Pedersen | University of Wollongong |
| Dr Richard Mark Pennifold | Department of Defence |
| Mr Oscar Peralta | Technical University of Denmark |
| Dr Collin Grant Phillips | The University of Sydney |
| Dr Guillermo Pineda-Villavicencio | Federation University Australia |

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| Prof Philip Keith Pollett | University of Queensland |
| Ms Pantea Pooladvand | The University of Sydney |
| Prof Geoffrey Prince | Australian Mathematical Sciences Institute |
| Dr Artem Pulemotov | The University of Queensland |
| Mx Ainsley Pullen | The University of Queensland |
| Dr Thomas Quella | The University of Melbourne |
| Dr Milena Radnovic | The University of Sydney |
| Mx Jacqui Ramagge | The University of Sydney |
| Dr Matthew Randall | |
| Mrs Nishanthi Raveendran | Macquarie University |
| Mr Rommel Real | Australian National University |
| Prof John Roberts | University of New South Wales |
| Dr Marcy Robertson | The University of Melbourne |
| Dr Danya Rose | The University of Sydney |
| Dr Vera Roshchina | RMIT University |
| Dr Jan Rozendaal | Australian National University |
| Dr Leanne Rylands | Western Sydney University |
| Mr Martin Sagradian | Macquarie University |
| Mr Fazal Ahmad Saikal | Ultimo TAFE Mathematics Section |
| Ms Tanja Schindler | Australian National University |
| Assoc Prof Gerd Schmalz | University of New England |
| Dr Jelena Schmalz | University of New England |
| Dr Katherine Anne Seaton | La Trobe University |
| Dr Min Sha | Macquarie University |
| Mr Donald Shearman | Western Sydney University |
| Miss Meng Shi | Monash University |
| Prof Harvinder Sidhu | University of New South Wales |
| Dr Adam Sierakowski | University of Wollongong |
| Dr Adam Sikora | Macquarie University |
| Prof Aidan Sims | University of Wollongong |
| Mr Timothy Siu | University of New South Wales |
| Prof Ian Sloan | University of New South Wales |
| Prof Michael Small | The University of Western Australia |
| Dr Geoffrey Smith | |
| Prof Paul Smith | Macquarie University |
| Miss Rebecca Smith | The University of Newcastle |
| Prof Kate Smith-Miles | The University of Melbourne |
| Dr Georgy Sofronov | Macquarie University |
| Mx Matthew James Spong | The University of Melbourne |
| Dr Peter Stacey | La Trobe University |
| Dr Michael Stewart | The University of Sydney |
| Dr Tim Stokes | University of Waikato, NZ |
| Assoc Prof Yvonne Stokes | The University of Adelaide |
| Prof Ross Howard Street | Macquarie University |
| Miss Michelle Strumila | The University of Melbourne |
| Mr Srinivasa Rao Subramanya Rao | Australian National University |
| Prof Fedor Sukochev | University of New South Wales |
| Dr Yingying Sun | The University of Sydney |
| Dr Nicole Sutherland | The University of Sydney |
| Dr Melissa Tacy | University of Otago, NZ |
| Dr Thomas Taimre | University of Queensland |
| Mr Dominic Tate | The University of Sydney |
| Dr Chuong Thai Doan | University of New South Wales |
| Dr Guo Chuan Thiang | The University of Adelaide |
| Miss Lauren Thornton | University of the Sunshine Coast |
| Dr Chris Tisdell | University of New South Wales |
| Mr Turker Topal | Macquarie University |
| Dr Timothy Trudgian | University of New South Wales Canberra |
| Dr Ilknur Tulunay | University of Technology, Sydney |

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| Dr Frank Valckenborgh | Macquarie University |
| Prof Dominic Verity | Macquarie University |
| Dr Geetika Verma | University of South Australia |
| Prof Kari Vilonen | The University of Melbourne |
| Dr Elena Vinogradova | Macquarie University |
| Dr Mircea Voineagu | University of New South Wales |
| Dr Raymond Vozzo | The University of Adelaide |
| Mr David Harley Wales | Western Sydney University |
| Mr Charles Walker | Macquarie University |
| Dr Hang Wang | The University of Adelaide |
| Dr Yucang Wang | Central Queensland University |
| Assoc Prof Lesley Ward | University of South Australia |
| Prof Ole Warnaar | The University of Queensland |
| Dr Michael Greg Watson | The University of Sydney |
| Mr Sam Weatherhog | The University of Queensland |
| Mx Ben Webster | University of Waterloo, Canada |
| Dr Yong Wei | Australian National University |
| Dr Arik Wilbert | University of Bonn/MPI Bonn, Germany |
| Prof George Willis | The University of Newcastle |
| Ms Sinead Wilson | The University of Queensland |
| Mx Justin Wishart | Macquarie University |
| Dr Thomas Wong | The University of Melbourne |
| Prof Leigh Wood | Macquarie University |
| Mr John Wormell | The University of Sydney |
| Dr Haotian Wu | The University of Sydney |
| Dr Changwei Xiong | Australian National University |
| Mr Jon Xu | The University of Melbourne |
| Dr Ting Xue | The University of Melbourne |
| Dr Oded Yacobi | The University of Sydney |
| Dr Yaping Yang | The University of Melbourne |
| Dr Bernard Yann | Monash University |
| Mr Kam Hung Yau | University of New South Wales |
| Dr David Yost | Federation University Australia |
| Mr Erchuan Zhang | The University of Western Australia |
| Dr Lele (Joyce) Zhang | The University of Melbourne |
| Dr Xin Zhang | The University of Melbourne |
| Mr Yang Zhang | The University of Sydney |
| Dr Yinan Zhang | Australian National University |
| Dr Zhou Zhang | The University of Sydney |
| Dr Liangyi Zhao | University of New South Wales |
| Dr Maolin Zhou | University of New England |
| Dr Zongzheng Zhou | Monash University |
| Mr Jonathan Julian Zhu | Harvard University |
| Dr Shengguo Zhu | Monash University |
| Prof Song-Ping Zhu | University of Wollongong |

# Abstracts

# 1. Plenary

### 1.1. Walking on graphs to Invariant Theory

Georgia Benkart (University of Wisconsin-Madison)

11:30 Wed 13 December 2017 – Macquarie Theatre
Prof Georgia Benkart

Molien's 1897 formula for the Poincaré series of the polynomial invariants of a finite group has given rise to results in algebraic geometry, coding theory, combinatorics, mathematical physics, and representation theory. This talk will discuss how some basic group theory can be used to count walks on graphs and and to derive an analogue of Molien's formula for tensor invariants. The ideas evolved from McKay's observation that there is a natural one-to-one correspondence between the finite subgroups of the special unitary group of $2 \times 2$ matrices and the simply-laced affine Dynkin diagrams, now a well-known result known as the McKay Correspondence. Walking results are also closely tied with Schur–Weyl duality, and when they are applied to the symmetric group and its permutation module, they lead to connections with the Potts lattice model in statistical mechanics and to the Fundamental Theorems of Invariant Theory for the symmetric group.

### 1.2. A vital role of automorphic forms in number theory

YoungJu Choie (Postech, South Korea)

14:00 Thu 14 December 2017 – Macquarie Theatre
Prof YoungJu Choie

In modern mathematics it is hard to imagine that automorphic forms and number theory are separated. For instance, automorphic forms played a key role in a proof of Fermat's Last Theorem by A. Wiles. I will explain how to use a relation between automorphic forms and parabolic cohomology.

### 1.3. Integrable probability

Ivan Corwin (Columbia University)

09:00 Wed 13 December 2017 – Macquarie Theatre
Prof Ivan Corwin

The probability of various outcomes of repeated fair coin tosses can be computed exactly using binomial coefficients. Performing asymptotics on these formulas uncovers the Gaussian distribution and a first instance of the central limit theorem. This talk will focus on a higher version of this story. We will explain how structures from representation theory (e.g., Macdonald polynomials) and quantum integrable systems (e.g., Yang–Baxter equation and Bethe *ansatz*) can be leveraged to create probabilistic models admitting explicit formulas which are asymptotically analyzable. These asymptotic behaviors are non-Gaussian and believed to characterize other universality classes.

### 1.4. Analysis on product spaces

Michael Cowling (University of New South Wales)

11:30 Fri 15 December 2017 – Macquarie Theatre
Prof Michael Cowling

Much analysis in $\mathbb{R}^n$ (and in more general contexts) uses, at least implicitly, the metric structure of the space. For example, Lebesgue's differentiation theorem uses properties involving covers of sets by balls. And a bijection of $\mathbb{R}^n$ that sends balls to balls is an affine map (when $n \geq 2$).

In recent years, interest has grown in analysis on 'product spaces', products of two metric spaces with a metric on each factor. Here the basic geometrical objects are 'rectangles' of products of balls in the two factors. Finding analogues of classical results requires an understanding of how rectangles fit together.

This talk will survey some of the results in this area, with an emphasis on some geometrical questions that are easy to state but hard to prove.

### 1.5. Scalable PDE solvers on supercomputers: multilevel and parallel-in-time

Hans De Sterck (Monash University)

10:00 Wed 13 December 2017 – Macquarie Theatre
Prof Hans De Sterck

The world's largest parallel computers now have millions of parallel processor cores, because processor speeds have stagnated and further speed increases need to come from increased parallelism. When solving time-dependent PDE problems with high resolution on such massively-parallel systems using spatial parallelism only, sequential time-stepping is becoming a computational bottleneck. In this context, parallelisation in time is a mechanism that can provide additional concurrency leading to further speedups. In this talk we consider multilevel parallel-in-time methods for solving hyperbolic PDEs on large parallel computers. The multigrid-reduction-in-time (MGRIT) method we use constructs a hierarchy of successively coarser temporal levels to accelerate the iterative solution that is computed in parallel on the finest level. We discuss issues of stability, spatial coarsening, convergence speed, adaptivity, and nonlinearity that arise when applying this technique to hyperbolic PDEs. Proof-of-concept parallel tests on up to 128,000 processor cores show robust scalability

and demonstrate the potential for runtime speed-ups over sequential time-stepping when spatial parallelism alone saturates. We conclude with perspectives on extensions to real-life applications.

This is joint work with Alexander Howse (University of Waterloo), Scott MacLachlan (Memorial University of Newfoundland), and Rob Falgout and Jacob Schroder (Lawrence Livermore National Laboratory).

**1.6.** Propagation, diffusion and free boundaries

Yihong Du (University of New England)

17:00 Tue 12 December 2017 – Macquarie Theatre
Prof Yihong Du

I will discuss some of the mathematical theories on nonlinear partial differential equations motivated by the desire of providing better models for various propagation phenomena. The classical works of Fisher, Kolmogorov–Petrovskii–Piskunov, Skellam and Aronson–Weinberger will be recalled briefly, and they will be compared with some recent results on models with free boundaries. In recent years, considerable momentum has been gathered in extending the traditional models to those with nonlocal diffusion, and to situations where the heterogeneity of the environment cannot be ignored. Some of the recent developments in these directions will also be discussed.

**1.7.** Value function and necessary optimality conditions in deterministic optimal control

Hélène Frankowska (CNRS)

09:00 Thu 14 December 2017 – Macquarie Theatre
Prof Hélène Frankowska

In this talk I will discuss some recent advances made in first and second order optimality conditions for the deterministic optimal control problem. The value function associated to this problem is the unique solution to a Hamilton–Jacobi. The control theoretic approach implied some new regularity results on the solution of this equation and left few problems open. The developed variational analysis techniques, being quite straightforward, apply as well to stochastic optimal control and optimal control of PDEs.

**1.8.** Two threshold problems for random graphs and hypergraphs

Catherine Greenhill (University of New South Wales)

10:00 Fri 15 December 2017 – Macquarie Theatre
Assoc Prof Catherine Greenhill, Daniel Altman, Peter Ayre, Amin Coja-Oghlan, Mikhail Isaev, Reshma Ramadurai

Probabilistic combinatorics is the study of random structures, such as random graphs. Many graph properties exhibit a "phase transition" with respect to the edge density. That is, the probability that the property holds moves rapidly from zero to one as the edge density crosses a narrow window around a threshold value. The aim is to locate the threshold density as precisely as possible.

As with many problems in combinatorics, the methods which are developed in order to obtain the answer are the real prize. I will discuss two threshold results for graphs, the methods used to prove them, and my recent work extending these results to hypergraphs.

**1.9.** Enumerative geometry and geometric representation theory

Andrei Okounkov (Columbia University)

11:30 Tue 12 December 2017 – Macquarie Theatre
Prof Andrei Okounkov

Certain problems in enumerative geometry turn out to be directly related to core questions in representation theory and to how it has been classically applied in mathematical physics. In my talk, I plan to give an informal introduction to this circle of ideas.

**1.10.** Metapopulations in evolving landscapes

Philip Keith Pollett (University of Queensland)

10:00 Thu 14 December 2017 – Macquarie Theatre
Prof Philip Keith Pollett

I will describe a model for populations that occupy several geographically separated patches of habitat, one which accounts for the evolution over time of landscape characteristics that affect the persistence of local populations. In particular, the probability of local extinction is allowed to evolve in time. This covers the widely studied case where patches are classified as being either suitable or unsuitable for occupancy. I will explain why, for large population networks, the persistence and equilibrium levels of the population are determined by the distribution of the life span of local populations, and not by the specific landscape dynamics.

**1.11.** Reconstructing continuous dynamical systems from time series data with discrete transition graphs

Michael Small (The University of Western Australia)

09:00 Fri 15 December 2017 – Macquarie Theatre
Prof Michael Small

Ordinal networks are constructed from observed time series data $\{x_t\}_t$ by mapping sequences of successive observations of length $w$, $(x_t, x_{t-1}, \ldots, x_{t-w+1})$ to permutations of the integers $\pi = 1, 2, \ldots, w$ such that the chosen permutation represents the relative magnitude of the numbers $x_{t-1}, x_{t-2}, \ldots, x_{t-w}$. That is $\pi_i > \pi_j$ implies $x_{t-i} > x_{t-j}$. A network is then constructed by identifying nodes on the network with each of the (potentially) $w!$ permutations. Nodes are linked if the corresponding permutations appear in successive windows. Networks constructed in this way from chaotic maps and flows (by introducing an embedding lag between the components) are evocative and we have demonstrated numerically that topological quantities estimated from from these networks capture important characteristics of the underlying dynamics. In particular, we observe this for network node entropy and provide analytic justification that both dynamical entropy and maximal Lyapunov exponent can be estimated from structural properties of the network. We show that by considering these ordinal transition networks as Markov processes, they capture (via relatively fast computation) dynamical features that are generally rather more difficult to estimate.

This is joint work with Michael McCullough, Konstantinos Sakellariou and Thomas Stemler.

**1.12.** Chaos is not random and complexity is not complicated

Michael Small (The University of Western Australia)

18:30 Wed 13 December 2017 – Macquarie Theatre
Prof Michael Small

Chaos theory is the study of relatively simple mathematical systems that behave in a complicated and apparently random way, but are not. Complex systems are systems made from very many simple components interacting and producing emergent behaviour beyond that of which the individual components are capable. Chaos arises in many common physical systems — from a dripping tap to atmospheric circulation. With the aid of some of these systems, I will explain the mathematical origin and signature of chaos. In collaboration between UWA and CSIRO, my research group is currently studying a range of complex systems: flocking of birds, collective dynamics of neurones, power grids and utility distribution networks, and interaction between players (both in an AFL game and in resource markets). I will show how we are developing mathematical tools to better understand, predict and interact with systems such as these.

**1.13.** Can we make that fibre?

Yvonne Stokes (The University of Adelaide)

16:30 Thu 14 December 2017 – Macquarie Theatre
Assoc Prof Yvonne Stokes

The development of microstructured optical fibres, containing patterns of air channels, have revolutionised optical fibre technology, promising a virtually limitless range of fibre designs for a wide range of applications, including communication networks, medical devices and sensing. But fabrication of a fibre with a desired structure presents a major challenge. What initial preform is suitable and what draw parameters should be used? Can it even be made? This is an inverse problem and mathematics is essential to its solution.

Modelling of fibre drawing has been a topic of interest for around five decades, motivated initially by the 'spinning' of textile fibres and, more recently, the importance of optical fibres in modern technologies. The slenderness of the geometry enables extensional flow theory to be used to develop accurate and efficient models. With neglect of surface tension the model may be written as a boundary-value problem in one spatial dimension for the cross-sectional area as a function of axial position, which is readily solved. When surface tension is important, as in the drawing of microstructured optical fibres, the model is comprised of a modified one-dimensional boundary-value problem coupled with a two-dimensional free-boundary problem for the transverse flow and, while this approach was used with success for fibres with simple geometries, application to fibres of arbitrary cross-section proved elusive until recently. I will describe the recent breakthrough by myself and coworkers enabling solution of the slender-geometry model with surface tension for the drawing of fibres of arbitrary geometry. I will discuss the progress that this has brought, including solution of the inverse problem. I will also show some stunningly accurate comparisons of model and experiment and discuss ongoing work to explain some perplexing discrepancies that arise at times.

# 2. Algebra

**2.1.** Fact-checking the ATLAS of Finite Groups

John Cannon (The University of Sydney)

11:30 Thu 14 December 2017 – W5A 105
Prof John Cannon

On 24 April 2015, J.P. Serre gave a talk at Harvard, titled "Finite Groups, Yesterday & Today", which attracted considerable interest. Amongst other issues he drew attention to the fact that, while the proofs of many recent results in group theory and related areas are based on information taken from the tables of complex characters given in the ATLAS of Finite Groups, no written proofs exist of the correctness of most (any?) of these tables.

About a decade earlier Bill Unger had published a new approach to computing character tables and in the light of subsequent improvements to that algorithm we felt that we could compute all but 5 or 6 of the 430 character tables presented in the ATLAS employing a different method than that used to construct the ATLAS table. With this project nearing completion we will outline the character table algorithm and the results of our verification.

We will also point out that Serre's statement raises a number of important issues:

- How should the reliability of mathematical tables be established, especially those that are commonly used in the proofs of new mathematical theory? One needs to reflect on the fact that many theoretical papers contain errors that range from the trivial to the serious.
- What other results and tables in group theory should we be losing sleep over? For example there are many closely related tables relating to the ATLAS groups: Schur indices, automorphism groups, maximal subgroups, modular characters, etc. Experts believe there are many errors in these tables but they are widely used. What should be done about this?

**2.2.** Integer polygons with given perimeter

James East (Western Sydney University)

14:00 Tue 12 December 2017 – W5A 105
Dr James East

A classical result of Honsberger states that the number of incongruent triangles having integer sides and perimeter $n$ is the nearest integer to $\frac{1}{48}n^2$ ($n$ even) or $\frac{1}{48}(n+3)^2$ ($n$ odd). Several proofs of this result exist, some using very sophisticated methods. I'll discuss some recent joint work with Ron Niles in which we solve the analogous problem for $m$-gons (for arbitrary but fixed $m \geq 3$), and for polygons (with arbitrary number of sides). We also show that the solution to the latter is asymptotic to $2^{n-1}/n$.

**2.3.** Permutations sorted by a finite and an infinite stack in series

Murray Elder (University of Technology, Sydney)

15:30 Thu 14 December 2017 – W5A 105
Murray Elder, Yoong Kuan Goh

An *antichain* is a subset of a partially ordered set such that any two elements in the subset are incomparable. *Pattern avoidance* is a partial order on the set of all finite permutations. We prove that the set of permutations sorted by a stack of depth $t \geq 3$ and an infinite stack in series has infinite basis, by constructing an infinite antichain. This answers an open question on identifying the breakpoint for the basis to change from finite to infinite in a sorting process with two stacks in series.

**2.4.** Isomorphism problem for virtually-free groups

Michal Ferov (University of Technology, Sydney)

16:00 Tue 12 December 2017 – W5A 105
Dr Michal Ferov

The Isomorphism problem is one of the well-known decision problems in combinatorial group theory. In general, it is unsolvable and it is known to be effectively solvable (i.e., by an algorithm with known space/time complexity) only for a few classes of groups. In my talk I will sketch an outline of an algorithm that solves the Isomorphism problem for virtually-free groups and explain why it is complexity bounded.

This is joint work with Murray Elder.

**2.5.** Unexpected new formula for Grothendieck duality

Hafiz Khusyairi (Australian National University)

12:00 Thu 14 December 2017 – W5A 105
Mr Hafiz Khusyairi

A few years ago, a surprising new formula for the twisted inverse-image functor of Grothendieck duality came up in the literature. I will begin the talk by revisiting the notions of the derived category of a ring and the relevant derived functors. Then, I will present the formula in a purely ring-theoretical setting and discuss how this formula was not very well understood. I will also talk about how a recent result improved our understanding of this formula and opened a door for generalisation to the non-noetherian setting.

**2.6.** On base radical operators Part 2: classes of finite Puczylowski algebras

Robert McDougall (University of the Sunshine Coast)

15:00 Tue 12 December 2017 – W5A 105
Dr Robert McDougall

In this presentation, we use the methods successful in Part 1 to reveal results in finite settings for algebras introduced by Puczylowski (which includes groups and multi-operator groups like rings). Many of the results true for classes of associative rings remain useful in this more general setting. The relations between the class operators employed show the maximum order of the semigroup they form.

**2.7.** Concrete mathematical incompleteness and the Finite Upper Shift Kernel theorem

Ainsley Pullen (The University of Queensland)

16:30 Tue 12 December 2017 – W5A 105
Ainsley Pullen

Incompleteness was famously investigated by Gödel who demonstrated that any consistent system has undecidable statements which cannot be proven or disproven within the system. However, the example of such a statement given by Gödel is somewhat unsatisfactory because it relies on an artificial construction utilising self-reference. Concrete mathematical incompleteness is an area of meta-mathematics which responds to this by looking for undecidable statements which could be considered as natural questions for a mathematician to be interested in.

Friedman recently presented an instance of concrete mathematical incompleteness called the Finite Upper Shift Kernel theorem, which is a combinatorial statement about directed graphs and their kernels. Friedman proved that the Finite Upper Shift Kernel theorem is equivalent to the consistency of SRP, which is a system that is strictly stronger than Zermelo–Fraenkle set theory and the axiom of Choice (ZFC). Consequently the consistency of SRP implies the consistency of ZFC. Hence the Finite Upper Shift Kernel theorem implies the consistency of ZFC and so cannot be proven in ZFC due to Gödel's second incompleteness theorem.

This result by Friedman was then utilised by Aaronson and Yedidia to construct a Turing machine which had undecidable behaviour in ZFC. They did this by building the Turing machine to search for a counterexample to the Upper Shift Kernel Theorem. We clarify the imprecise characterisation given by Aaronson and Yedidia as well as presenting both the results in a framework more understandable to a general mathematician.

**2.8.** Generalised domain and $E$-inverse semigroups

Tim Stokes (University of Waikato)

16:00 Thu 14 December 2017 – W5A 105
Dr Tim Stokes

Various generalisations of Green's relations on semigroups have been considered over the years, and those for which there is a unique idempotent in each class are of particular interest. For example, regular semigroups are such that every $\mathscr{R}$-class (equivalently, every $\mathscr{L}$-class) contains at least one idempotent, and those for which the idempotent is unique are exactly inverse semigroups. One obtains variants by limiting the set of idempotents. For example, amongst involuted semigroups, those having a projection in each $\mathscr{L}$-class and $\mathscr{R}$-class are the $*$-regular semigroups as defined by Drazin, and in this case the projection in each class is automatically unique. In such cases we may define one or two unary operations that pick out the idempotent in the class of an element. In this talk we generalise this as far as it will go, giving an axiomatization in terms of such unary operations of (left/right/two-sided) $E$-semiabundant semigroups with unique idempotents in each class. As a special case, we obtain a generalisation of inverse semigroups in which the idempotents relative to which inverses may be defined are constrained, generalising Drazin's $*$-regular semigroups. All axiomatizations turn out to be finite and equational.

**2.9.** On base radical operators Part 1: classes of finite associative rings

Lauren Thornton (University of the Sunshine Coast)

14:30 Tue 12 December 2017 – W5A 105
Miss Lauren Thornton

Class operators are used to give a complete listing of possible radical and semisimple classes for universal classes of finite associative rings. General relations between operators reveal the maximum order of the semigroup they form is 46. In this setting, hereditary radical classes are precisely the homomorphically closed semisimple classes, and strongly semisimple classes are radical-semisimple.

# 3. Applied/Industrial Mathematics

**3.1.** The two-train separation problem on non-level track

Amie Albrecht (University of South Australia)

14:00 Tue 12 December 2017 – W5C 221

Amie Albrecht, Phil Howlett, Peter Pudney, Xuan Vu, Peng Zhou

When two trains travel along the same track in the same direction it is a common safety requirement that they cannot simultaneously occupy the same section of track. In this talk we find necessary conditions on non-level track to minimize the total traction energy required for both trains to complete their respective journeys within the allowed time subject to safe separation constraints in the form of a prescribed set of latest allowed section exit times for the leading train and a corresponding prescribed set of earliest allowed section entry times for the following train. We use classical methods of constrained optimization to show that the optimal driving strategies subject to the sets of prescribed section clearance times are completely defined for the leading train by a non-increasing sequence of optimal section driving speeds and for the following train by a non-decreasing sequence of optimal section driving speeds. We illustrate our results by finding the optimal driving strategies and associated speed profiles for both the leading train and the following train in an elementary but realistic example.

**3.2.** Dengue fever in Taiwan: an IBM Health Corps adventure

Roslyn Hickson (IBM Research Australia)

16:00 Fri 15 December 2017 – W5C 221

R.I. Hickson, D.-P. Liu, Y.-L. Liu, H.-Y. Cheng, C. Wei, N. Dawe, S. Hussain, J. Piccone, C. Hammond, L. Haselden, S. Venkatraman

Dengue fever is a mosquito-borne disease, with *Aedes aegypti* the primary vector. There was an unexpectedly large number of human dengue cases in Taiwan in 2015, increasing from the typical low numbers of around five hundred to over forty thousand cases. IBM Health Corps worked with the Taiwan Centers for Disease Control (CDC) to develop a decision support tool based on mathematical models to evaluate potential new interventions. We focussed on the example intervention of mosquito population reduction by releasing Wolbachia-carrying male mosquitoes. This presentation will discuss the mathematical models and demonstrate how the outputs were visualised in the decision support tool.

**3.3.** A stochastic differential equation approach to modelling the growth phase of fire spread

Zlatko Jovanoski (University of New South Wales Canberra)

14:00 Wed 13 December 2017 – W5C 221

Dr Zlatko Jovanoski

From a point source, landscape fires accelerate until they reach a quasi-equilibrium rate of spread. In comparison with the vast literature that deals with modelling the quasi-equilibrium rate of spread, there is little that specifically considers this growth phase of a fire's development. The rate of acceleration depends on access of the fire front to the wind as the area increases, interactions between different parts of the fire perimeter which change with area and intensity, variations in ambient and induced wind speed and direction, variation in moisture content of the fuel, fuel stratification and slope variation. Present models of fire growth from a point ignition are expressed as deterministic algebraic equations, thereby downplaying variability and history. The many variables involved make predictions of rate of spread from a point source very difficult.

In this paper we propose an approach based on the use of stochastic differential equations to investigate the growth of a fire to quasi-equilibrium. In addition to providing a more faithful portrayal of the time series data relating to fire growth, this approach allows for better discrimination of the mechanisms driving the growth phase of fire spread.

**3.4.** Analysis of nitrogen removal in the activated sludge process

Mark Nelson (University of Wollongong)

16:00 Tue 12 December 2017 – W5C 221

Assoc Prof Mark Nelson

The activated sludge process is the most widely-used process for the biological treatment of both domestic and industrial wastewaters. Wastewater treatment plants based on the activated sludge process are in widespread use in both developed and developing countries.

The 'activated sludge model number 1' (ASM1) is an internationally accepted standard for activated sludge modeling. This model describes nitrogen and chemical oxygen demand within suspended-growth treatment processes, including mechanisms for nitrification and denitrification.

We analyse the biological treatment of a wastewater in the activated sludge process when a cascade of up to three reactors is deployed. We first consider a 'standard reactor cascade' in which a

settling unit is placed after the final reactor in the cascade. The recycle stream from the settling unit is fed into the first reactor of the cascade. Variations on the standard reactor cascade are then considered. These variations take two forms. Firstly, turning off the oxygen supply to a reactor. This converts the reactor from aerobic to anaerobic operation. Secondly, the placement of internal recycle units.

A combination of direct numerical integration with continuation methods is used to investigate the steady-state behaviour of these systems. We investigate how the operation of the recycle units effects the concentration of total nitrogen in the effluent stream and identify conditions for effective nitrification and denitrification to occur in the reactor.

In addition to identifying operating conditions which minimise the total nitrogen in the effluent stream we conclude that continuation methods provide the right tool to investigate how changes in process parameters effect outputs in a systematic manner.

**3.5.** Potential theory problems for arbitrary rotationally symmetric double-connected conductors: rigorous approach

Martin Sagradian (Macquarie University)

16:30 Tue 12 December 2017 – W5C 221

Martin Sagradian

This paper considers potential theory problems for rotationally symmetric conductors with arbitrary profile. Mathematically, the problem is described by the boundary value problem for the Laplace equation subject to Dirichlet boundary conditions. We consider double-connected conductors with apertures of equal angular size. The problem is solved by the semi-analytical Method of Regularization (MoR) that provides a mathematically rigorous solution.

The MoR, based on Abel's integral transform and theory of triple series equations with the Jacobi polynomials, allows us to transform the ill-posed initial system of series equations arising from the standard formulation of the problem to a well-conditioned second kind Fredholm matrix equation. Numerical algorithms based upon the solution of the matrix equation, after truncation to a finite system of equations, converge with guaranteed and predictable accuracy.

In this paper the generalization of the solution algorithm for arbitrarily shaped double-connected screens is developed in the case of a rotationally symmetric prescribed potential and the solution for the complementary structures in the general case (for arbitrarily preassigned potential) is obtained.

**3.6.** Quantifying the change in the far-field pattern induced by rounding the corners of a scatterer illuminated by a plane-wave electromagnetic field

Paul Smith (Macquarie University)

14:30 Wed 13 December 2017 – W5C 221

Audrey J. Markowskei, Paul D. Smith

When a perfectly electrically conducting two-dimensional scatterer, which is smooth except at finitely many sharp corner points, is illuminated by an $E$-polarised electromagnetic plane wave, the surface current density exhibits singularities at those corner points, whilst in the $H$-polarised case the surface density exhibits singularities in its derivative at those points. Once the corners are rounded, the surface density becomes non-singular. It is of interest to examine the impact of this rounding upon observed physical quantities such as the far-field as the rounding becomes more pronounced.

An integral equation formulation is a satisfactory basis of numerical studies of the scattering of plane waves by a smooth obstacle; its solution provides a surface density from which all physical quantities can be calculated. Whilst this approach can be adapted to accommodate obstacles with sharp corners, efficient methods for the calculation of the desired surface density depend upon the introduction of graded meshes. In this presentation, we describe the appropriate modifications that are subsequently employed to quantify the changes induced in the far-field pattern when the corners are rounded. We examine the difference of the far-field pattern from that of the unrounded structure as a function of the parameter $k\rho$ where $k$ is the wavenumber and $\rho$ is the radius of curvature of the rounded corner. It is found that the difference is $O((k\rho)^m)$ as $k\rho$ approaches zero, for some positive exponent $m$ depending upon boundary and other conditions. A number of structures with single or multiple corners are examined with a variety of boundary conditions: $E$- or $H$-polarised cases as well as the impedance-loaded case.

**3.7.** Accurate calculation of complex eigenvalues for TM-modes in 2D arbitrary cavities with longitudinal slit

Turker Topal (Macquarie University)

15:00 Wed 13 December 2017 – W5C 221

Mr Turker Topal, Elena Vinogradova, Yu. A. Tuchkin

The rigorous Method of Regularization ([1]–[3]) is implemented for accurate calculation of the complex eigenvalues in open arbitrary 2D cavities. Based on standard integral representation in terms of surface quantities and a Green's function, a first kind Fredholm integral equation can be obtained. The regularization procedure employs the technique of analytical semi-inversion,

which transforms the initial ill-posed equation of the first kind into the well-conditioned second kind Fredholm equation in matrix formulation. The resulting system of infinite linear algebraic equations can be solved effectively using the truncation method, which produces an algebraic system with uniformly bounded condition number.

The characteristic equation for finding the complex eigenvalues is easily determined using one of the postulates of linear algebra: the non-trivial solutions of the homogeneous matrix equation exist when the determinant takes zero values; i.e., solving this equation for the increasing values, we attain the stabilization of the beforehand given number of significant digits in the complex eigenvalues and after that we stop the calculation routine.

There are no restrictions on a shape of bounding contours, except its smoothness. In addition, the slit width has also no restrictions on its value, whether it is narrow or wide. The large-scaled calculations of the complex eigenvalues have been performed for the open cavities of circular, elliptical and rectangular cross-section, which are widely used in practice.

[1] Y. A. Tuchkin, *Wave scattering by open cylindrical screens of arbitrary profile with Dirichlet boundary conditions*, in Soviet Physics Doklady, vol. 30, p. 1027, 1985.
[2] E. Vinogradova, *Electromagnetic plane wave scattering by arbitrary two-dimensional cavities: Rigorous approach*, Wave Motion, vol. 70, pp. 47–64, 2017.
[3] S. S. Vinogradov, P. D. Smith, and E. D. Vinogradova; Canonical problems in scattering and potential theory Part II: Acoustic and Electromagnetic diffraction by canonical structures. CRC Press, 2002.

### 3.8. ST-metric method in Finance

Ilknur Tulunay (University of Technology, Sydney)

14:30 Fri 15 December 2017 – W5C 221
Dr Ilknur Tulunay

This method uses an information theoretic concept, Topsøe distance, which extends from probabilities to real number series on the interval $(0,1]$. Given two probabilities, Topsøe distance is the symmetrized Kullback–Leibler divergence of the average of these probabilities. It does not satisfy the triangle property and so is not a metric. However, its square root *is* a metric. Extending the square root of Topsøe distance from probabilities to real number series on $(0,1]$ gives a metric, called the ST-metric. I present how to apply ST-metric on financial return series. I show that the ST-metric method is consistent with mean–variance rule and stochastic dominance of order one and two. The ST-metric of an investment with risk-free rate considers the entire movement of the investment (all moments of the distributions) relative to the risk-free rate over the investment period, and so offers a better adjusted risk–return analysis than mean–variance and stochastic dominance methods.

### 3.9. Regularization of the first-kind surface integral equations arising in the wave diffraction on 2D arbitrary cavities with longitudinal slit

Elena Vinogradova (Macquarie University)

15:00 Fri 15 December 2017 – W5C 221
Elena D. Vinogradova

Diffraction of acoustic and electromagnetic waves from two-dimensional arbitrarily shaped open cavities is reduced to a mixed boundary value problem for the Helmholtz equation. The customary way of solving such problems employs the classical potential theory, which reduces the initial problem to a first kind integral equation with the Green's function as a kernel and an unknown density function, representing the jump of single-layer or double-layer potential over the cavity surface. These equations are ill-conditioned and their direct use for computation is highly problematic. We develop a semi-analytical regularization procedure, which reduces the first kind integral equation to a well-conditioned second-kind system of linear algebraic equations. It is proved that the solution of the truncated system of equations converges fast to the exact solution, as truncation number is increased. The developed method has been used, in particular, for comprehensive analysis of scattering problems involving finite sinusoidal gratings, short-circuited waveguides with finite flanges, and airfoils.

### 3.10. A study of optimizing courier routes in CBD areas

Lele (Joyce) Zhang (The University of Melbourne)

15:00 Tue 12 December 2017 – W5C 221
Mx Lele (Joyce) Zhang

The rapid development of major cities and consequently fast-growing traffic congestion raise significant challenges for determining efficient distribution routes in central city areas. This paper develops a model, formulated as a bi-level multi-objective optimisation, for determining the optimal on-street loading zones for courier vehicles to use to minimise operating and environmental costs. The traffic paths used to access loading zones and the paths used to cart the goods to establishments are determined. Genetic algorithms are used to search optimal solutions. The model is tested on Sydney's and Melbourne's CBD areas. The output can provide guidance for couriers as well as planners who are involved in determining duration limits at loading zones.

**3.11.** Pricing American-style Parisian options

Song-Ping Zhu (University of Wollongong)

14:00 Fri 15 December 2017 – W5C 221

Prof Song-Ping Zhu

In this talk, pricing of various American-style Parisian options will be discussed. After pointing out the fundamental difference between American-style 'in' and 'out' Parisian options, I shall demonstrate how a closed-form analytic solution for American-style 'up-and-in' Parisian options can be worked out, which does not explicitly involve a moving boundary as far as the 'mother option' is concerned. For American-style 'up--and-out' Parisian options, a very efficient numerical approach is proposed, based on the *moving window* technique developed in Zhu and Chen (2013), in order to simplify the solution procedure. Preliminary numerical results are presented to show some very interesting features of American-style 'up-and-out' Parisian options.

# 4. Category Theory, Algebraic Topology, K-Theory

**4.1.** Braidings for skew monoidal categories

John Bourke (Macquarie University)

16:00 Thu 14 December 2017 – W5A 101
Dr John Bourke

Skew monoidal categories are a certain laxified version of monoidal category. They were introduced by Szlachanyi in 2012 in relation to bialgebroids over rings. In 2016 I described some examples of these structures arising in higher category theory. A natural question to ask is: "what is the correct notion of braiding in the skew context?" The answer is not, perhaps, what one might first guess. In this talk I will define braided skew monoidal categories and give some examples of them.

This is joint work with Steve Lack.

**4.2.** Transferring $A$-infinity structures along quasi-isomorphisms

Jesse Burke (Australian National University)

14:00 Fri 15 December 2017 – W5A 101
Dr Jesse Burke

It has been long understood how to transfer $A$-infinity algebra structures along a homotopy equivalence of complexes. I will talk about a recent result showing $A$-infinity algebra structures may be transferred along (semi-)projective resolutions of complexes.

This gives a new result when the ground ring is not a field, because a (semi-)projective resolution is very rarely a homotopy equivalence. $A$-infinity morphisms, modules, and morphisms of modules can also be transferred, and if the complex in question is homologically bounded below, the transferred structures are all unique up to appropriate homotopy. This work is motivated by the study of free resolutions in homological commutative algebra, but the techniques apply in much wider generality. The main technique of proof is obstruction theory.

**4.3.** Enriched algebraic weak factorisation systems

Alexander Campbell (Macquarie University)

16:30 Fri 15 December 2017 – W5A 101
Dr Alexander Campbell

It is known that if $\mathcal{V}$ is a monoidal model category in which every object is cofibrant, then any cofibrantly generated $\mathcal{V}$-enriched model category has a $\mathcal{V}$-enriched cofibrant replacement comonad; conversely, if a monoidal model category $\mathcal{V}$ (with cofibrant unit object) has a $\mathcal{V}$-enriched cofibrant replacement comonad, then every object of $\mathcal{V}$ must be cofibrant. These results leave open the question of what extra structure, if not an enrichment in the ordinary sense, is naturally possessed by the cofibrant replacement comonad of an enriched model category when not every object of the base monoidal model category is cofibrant.

In this talk I will introduce the notions of locally weak comonad and of monoidal and enriched algebraic weak factorisation system, and will propose an answer to the above question by showing that the cofibrant replacement comonad of an enriched algebraic weak factorisation system is a locally weak comonad. Special attention will be given to the monoidal model category of 2-categories with the Gray tensor product, in which not every object is cofibrant.

**4.4.** Functors to categories of manifolds

Diarmuid Crowley (The University of Melbourne)

16:00 Tue 12 December 2017 – W5A 101
Diarmuid Crowley

In this talk I will describe how Wall's theory of thickenings allows us to define functors on the homotopy category of certain finite CW-complexes with values in groups of certain diffeomorphism classes of manifolds.

I will then report on joint work with Csaba Nagy where establish basic facts and computations for these functors in important special cases.

**4.5.** Real K-theory of compact Lie groups

Chi-Kwong Fok (The University of Adelaide)

16:30 Wed 13 December 2017 – W5A 101
Dr Chi-Kwong Fok

Let $G$ be a compact connected Lie group, viewed as a $G$-space via the conjugation action. A theorem of Brylinski–Zhang states that the equivariant K-theory of $G$ is the ring of Kähler differentials of its complex representation ring, while a recent deep theorem by Freed–Hopkins–Teleman asserts a canonical isomorphism between the twisted equivariant version and the Verlinde algebra of $G$. In this talk, I will present generalizations of both results in the context of Atiyah's Real K-theory.

**4.6.** Ultrafilters

Richard Garner (Macquarie University)

14:30 Fri 15 December 2017 – W5A 101
Dr Richard Garner

Ultrafilters are important structures in areas of mathematics as diverse as combinatorics, model theory, topology and dynamical systems. In this talk, I explain how the notions of ultrafilter, ultrapower, product of ultrafilters, and Rudin–Keisler

ordering of ultrafilters, are all encapsulated in the following result: the category of finite-coproduct-preserving endofunctors of the category of sets is a presheaf category.

**4.7.** End-periodic $K$-homology and positive scalar curvature

Michael Alexander Hallam (The University of Adelaide)

14:00 Wed 13 December 2017 – W5A 101
Michael Hallam, Mathai Varghese

In this talk I will introduce a new variant of $K$-homology, called 'end-periodic $K$-homology', that is tailored to a recent index theorem for end-periodic manifolds by Mrowka, Ruberman and Saveliev. The new $K$-homology groups elegantly encapsulate invariance properties of end-periodic rho invariants, and in fact are naturally isomorphic to the standard $K$-homology groups. The isomorphism preserves rho invariants, and so can be used to transfer results on positive scalar curvature for odd-dimensional manifolds to even-dimensional manifolds.

This is joint work with Mathai Varghese.

**4.8.** Parity for nestohedra

Stephen Lack (Macquarie University)

12:00 Thu 14 December 2017 – W5A 101
Prof Stephen Lack

In 1987, Street showed how each simplex generated an $\omega$-category; that is, a (possibly) infinite-dimensional category. This allowed a general definition of the nerve of an $\omega$-category. The $\omega$-categories corresponding to simplices were called *orientals*, and Street later developed the formalism of *parity complex*, which abstracted the key features of these orientals, and also included as examples the cubes and the globes (balls). Various other researchers came up with alternative formalisms. All of them involve some sort of combinatorial structure involving faces with a specified orientation, called a parity.

The nestohedra are a family of polytopes which arose in work of de Concini and Procesi. They include the simplices, the cubes, the associahedra (of Stasheff and Tamari), and the permutohedra. I will consider these nestohedra as purely combinatorial structures, and describe a general notion of parity for them.

This is joint work with Christopher Nguyen, and builds on material in his thesis.

**4.9.** $\infty$-groupoids and the Homotopy Hypothesis

Edoardo Lanari (Macquarie University)

15:00 Wed 13 December 2017 – W5A 101
Mr Edoardo Lanari

In this talk I will introduce a globular model for weak $\infty$-groupoids, due to A. Grothendieck, and illustrate the basic features of their homotopy theory. It is conjectured that the $(\infty, 1)$ category they present models homotopy types (this is the so called 'Homotopy Hypothesis'), which has been proven to hold true for essentially every other existing model of $\infty$-groupoids (e.g., Kan complexes). I will also outline original ideas and results of my work, along with important results in the literature on this topic, to give an idea on how to prove this conjecture.

**4.10.** Graded Steinberg algebras and their representations

Huanhuan Li (Western Sydney University)

15:00 Fri 15 December 2017 – W5A 101
Dr Huanhuan li

We study the category of left unital graded modules over the Steinberg algebra of a graded ample Hausdorff groupoid. We show that this category is isomorphic to the category of unital left modules over the Steinberg algebra of the skew-product groupoid arising from the grading. To do this, we show that the Steinberg algebra of the skew product is graded isomorphic to a natural generalisation of the the Cohen–Montgomery smash product of the Steinberg algebra of the underlying groupoid with the grading group. This is joint work with Pere Ara, Roozbeh Hazrat, Aidan Sims.

**4.11.** Presheaves over join restriction categories

Daniel Lin (Macquarie University)

17:00 Wed 13 December 2017 – W5A 101
Mr Daniel Lin

Restriction categories were first introduced in the early 1990s and later studied in the early 2000s as a means of generalising the notion of a partial map category; the idea being to capture the partiality of each map through a corresponding idempotent on its domain, called a restriction idempotent. As it turns out, the hom-sets of any restriction category has a natural partial ordering, and this, together with the notion of compatibility, gave rise to the notion of a join restriction category.

In this talk, we shall see that every join restriction category may be freely completed to a cocomplete join restriction category, given by the partial map category of sheaves on some site. However, we shall also see that every join restriction category has a free cocompletion equivalent to this partial map category of sheaves. This equivalent category takes a simpler form, with join restriction presheaves as its objects.

### 4.12. Mahavier limits

Yuki Maehara (Macquarie University)

11:30 Thu 14 December 2017 – W5A 101
Mr Yuki Maehara

Sequential limits have long been valued by continuum theorists (here 'continuum' means 'compact, connected Hausdorff space') as a useful tool to construct/describe complicated spaces in terms of much simpler ones. When viewed as such a tool, however, the usual notion of limit can sometimes be too restrictive. They thus introduced the notion of Mahavier limit in the 2000s, where the continuous maps in the diagram are replaced by upper semi-continuous, closed set-valued functions.

This talk will be based on my honours thesis, in which I characterised Mahavier limits by a certain universal property that looks somewhat similar to the definition of oplax limits in 2-category theory. I will also discuss some of my recent findings such as how Mahavier limits can be seen as enriched weighted limits.

### 4.13. A functorial approach to classifying manifolds

Csaba Nagy (The University of Melbourne)

16:30 Tue 12 December 2017 – W5A 101
Mr Csaba Nagy

The aim of this talk is to show how basic concepts of category theory can be used in the classification of smooth manifolds.

We consider smooth simply-connected $n$-manifolds $M$ with $([n/2]-1)$-skeleton a given CW-complex $K$ and $H_{[n/2]}(M) = 0$. These manifolds form a finitely generated abelian group $\Theta_n(K)$, and it can be shown that $\Theta_n$ is a functor from the category of CW-complexes to groups. Computation of $\Theta_n(K)$ relies on (among other things) a generalization of Haefliger's exact sequence involving groups of links, which also turns out to be natural in $K$. As an example I will present the computation of $\Theta_8(K)$ in the case when $K$ is a wedge of 2-spheres. If time permits I will also talk about the role of $\Theta_n(K)$ in the classification of a larger class of manifolds.

### 4.14. Presheaf models for infinity modular operads

Marcy Robertson (The University of Melbourne)

14:30 Wed 13 December 2017 – W5A 101
Dr Marcy Robertson

Getzler and Kapronov introduced the notion of a modular operad to encode the grafting of the stable algebraic curves along boundary components. These objects have played a key role in the description of BV-algebra structures in noncommutativity geometry and physics. Minor generalizations of this theory have lead to the notion of compact symmetric multicategories which play a role in categorical versions of quantum theory.

We wish to study a version of these objects where composition and contraction are only defined up to (coherent) homotopy. To this end, we introduce an appropriate category of undirected graphs $\mathfrak{M}$, and identify subcategories of $\mathfrak{M}$-presheaves which model the indicated behavior. For set-valued presheaves, these are objects satisfying an inner horn filling condition. For space-valued presheaves these are objects satisfying a Segal-type condition, which are also the fibrant objects in a certain Quillen model structure.

### 4.15. The $K$-theory of loop spaces and elliptic cohomology

Matthew James Spong (The University of Melbourne)

16:00 Wed 13 December 2017 – W5A 101
Mr Matthew James Spong

Let $T$ be a torus. In 1994 Ian Grojnowski gave a construction of a $T$-equivariant elliptic cohomology theory associated to an elliptic curve over the complex numbers. However, as noted by Grojnowski himself, this construction is somewhat ad hoc and unwieldy to work with. Let $M$ be a $T$-space and $LM$ the space of free loops in $M$, so that there is an action of $LT$ on $LM$, where $LT$ is the group of free loops in the torus. Based on work of Nitya Kitchloo, we construct a version of equivariant $K$-theory for $LT$-spaces, and show that the $LT$-equivariant $K$-theory of $LM$ is isomorphic to Grojnowski's theory on the $T$-space $M$. Since the loop space construction is motivated by the idea of fields on a circle, this suggests a physical interpretation of Grojnowski's theory.

### 4.16. Real sets

Ross Howard Street (Macquarie University)

14:00 Tue 12 December 2017 – W5A 101
Prof Ross Howard Street

After reviewing a universal characterization of the extended positive real numbers published by Denis Higgs in 1978, we define a category which provides an answer to the questions:

- what is a set with half an element?
- what is a set with $\pi$ elements?

That is, we categorify (or objectify) the monoid $[0,\infty]$ under addition. The category of these extended positive real sets is equipped with a countable tensor product. We develop somewhat the theory of categories with countable tensors; we call the commutative such categories *series monoidal*. We may include some remarks on sets having cardinalities in $[-\infty,\infty]$.

This is joint work with George Janelidze.

**4.17.** Generator notions in $\infty$-cosmology

Dominic Verity (Macquarie University)

16:00 Fri 15 December 2017 – W5A 101
Prof Dominic Verity, Assoc Prof Emily Riehl

$\infty$-Cosmoi provide a framework in which to develop the abstract category theory of various kinds of $(\infty,1)$-categorical structures. In essence, an $\infty$-cosmos is simply a finitely complete $(\infty,2)$-category, although for expository reasons they are often taken to be categories of fibrant objects enriched in the Joyal model structure. This notion is general enough to immediately encompass most of the common models of $(\infty,1)$-categories; quasi-categories, complete Segal-spaces, $\Theta_1$-spaces and such like. At the same time, it is powerful enough to develop a theory of (co)cartesian fibrations, a calculus of two-sided modules (profunctors), Yoneda's lemma, theories of adjunction and Kan extension and so forth. Indeed, much of this theory can be developed in the setting of the (strict, classical) *homotopy 2-category* obtained from the $\infty$-cosmos by applying the homotopy category construction to its hom-spaces.

In this talk we briefly recap the cosmological approach to the category theory of $\infty$-categorical structures and discuss how it encompasses fibred categorical notions. This leads us naturally to the study of certain generating sets of "compact" objects in an $\infty$-cosmos, a mechanism which allows us to adapt certain fibrewise arguments into the $\infty$-cosmos framework.

**4.18.** Computations in Bredon motivic cohomology

Mircea Voineagu (University of New South Wales)

15:00 Tue 12 December 2017 – W5A 101
Dr Mircea Voineagu

We construct a category of $\mathbb{Z}/2$-equivariant motives and relate it with the $\mathbb{Z}/2$-equivariant motivic homotopy category. Bredon motivic cohomology is represented in this category of $\mathbb{Z}/2$-equivariant motives. We also identify weight 1 of Bredon motivic cohomology of a point.

**4.19.** Universal properties of polynomials via doctrinal Yoneda structures

Charles Walker (Macquarie University)

14:30 Tue 12 December 2017 – W5A 101
Mr Charles Walker

Given a category $\mathscr{E}$ with pullbacks, one may form the bicategory of spans in $\mathscr{E}$, denoted **Span**($\mathscr{E}$). The universal properties satisfied by this construction, as established by Dawson, Paré, Pronk and Hermida, simply describe what data one needs in order to construct a homomorphism of bicategories from this bicategory **Span**($\mathscr{E}$) to another bicategory $\mathscr{C}$.

In this talk, it is our primary goal to describe an analogue of these results for the bicategory of polynomials, denoted **Poly**($\mathscr{E}$), both with the simpler cartesian 2-cells, and the more complex general 2-cells between polynomials.

However, we do not prove these results directly; indeed, it is the secondary goal of this talk to show how one may avoid most of the coherence conditions which stem from the complicated nature of polynomial composition. This is to be done through the use of Yoneda structures. Our approach will thus lead to a proof of the universal properties of the polynomial construction, whilst avoiding many of the coherence conditions that would have appeared in a direct proof.

**4.20.** Algebraic elliptic cohomology and flops

Yaping Yang (The University of Melbourne)

17:30 Wed 13 December 2017 – W5A 101
Marc Levine, Yaping Yang, Gufang Zhao

I will talk about the algebraic elliptic cohomology theory coming from Krichever's elliptic genus. It is an oriented cohomology theory on smooth varieties over an arbitrary perfect field. We show that in the algebraic cobordism ring with rational coefficients, the ideal generated by differences of classical flops coincides with the kernel of Krichever's elliptic genus. This generalizes a theorem of Totaro in the complex analytic setting. I will also discuss the convergence of the motivic Adams spectral sequence, which is relevant to the integral version of the above theorem.

This talk is based on my joint work with Marc Levine and Gufang Zhao.

# 5. Complex Analysis, Geometry

**5.1.** Cauchy problems for surfaces related to harmonic maps

David Brander (Technical University of Denmark)

12:00 Thu 14 December 2017 – X5B 039
Assoc Prof David Brander

It has been known since the 1990s that harmonic maps from Riemannian or Lorentzian surfaces into Symmetric spaces admit loop group generalizations of the classical Weierstrass representation (Riemannian) or d'Alembert solution of the wave equation (Lorentzian). These allow one to construct solutions to the various geometric problems that are associated to harmonic maps. The utility of these representations is obstructed by the loss of geometric information in the loop group decomposition that relates the harmonic map to the "Weierstrass" data. Recently, special types of Weierstrass data have been introduced that contain full geometric information along a curve. I will discuss applications of this technique to the construction of integrable surfaces, such as Willmore surfaces and surfaces of constant curvature.

**5.2.** Toroidal soap bubbles: constant mean curvature tori in $\mathbb{S}^3$ and $\mathbb{R}^3$

Emma Carberry (The University of Sydney)

11:30 Thu 14 December 2017 – X5B 039
Dr Emma Carberry

Constant mean curvature (CMC) tori in $\mathbb{S}^3$, $\mathbb{R}^3$ or $\mathbb{H}^3$ are in bijective correspondence with spectral curve data, consisting of a hyperelliptic curve, a line bundle on this curve and some additional data, which in particular determines the relevant space form. This point of view is particularly relevant for considering moduli-space questions, such as the prevalence of tori amongst CMC planes and whether tori can be deformed. I will address these questions for the spherical and Euclidean cases, using Whitham deformations.

**5.3.** A criterion for the embedding of a 3-dimensional CR structure

Masoud Ganji (University of New England)

16:00 Wed 13 December 2017 – X5B 039
Gerd Schmalz, Masoud Ganji

For any 3-dimensional CR structure $M$ we define a class of Lorentzian metrics on a real line bundle over $M$ . This construction generalises the celebrated Fefferman metrics. We show that $M$ is realisable as an embedded CR-manifold if and only if there exists a representative of those metrics for which the complexified Ricci tensor vanishes on the $\alpha$-planes.

This is a joint work with Gerd Schmalz.

**5.4.** Affinely flat algebraic groups and a conjecture of Popov

Wolfgang Globke (The University of Adelaide)

16:00 Thu 14 December 2017 – X5B 039
Dr Wolfgang Globke

A Lie group $G$ admits a flat affine connection if there exists a linear representation on a vector space $V$ such that $G$ has an open orbit in $V$ and $\dim G = \dim V$. Such a module is called an *étale module*. It is called *super-étale* if the stabilizer of a point in the open orbit is trivial.

In 2013 Popov proved that reductive algebraic groups admitting super-étale modules are special algebraic groups in the sense of Serre. He further conjectured that a reductive group admitting a super-étale module is always isomorphic to a product of general linear groups. In light of previously available examples, one can conjecture more generally that in such a group all simple factors are either special linear groups or $\mathrm{Sp}_2$. We show that this is not the case by constructing a family of super-étale modules for groups with a factor $\mathrm{Sp}_n$ for arbitrary $n \geq 1$. A similar construction provides a family of étale modules for groups with a factor $\mathrm{SO}_n$, which shows that groups with étale modules with non-trivial stabilizer are not necessarily special.

**5.5.** The projective geometry of Sasaki–Einstein structures and their compactification

Rod Gover (University of Auckland, NZ)

14:00 Wed 13 December 2017 – X5B 039
Prof Rod Gover

Sasaki geometry is often viewed as the odd dimensional analogue of Kaehler geometry. In particular a Riemannian or pseudo-Riemannian manifold is Sasakian if its standard metric cone is Kaehler or, respectively, pseudo-Kaehler. We show that there is a natural link between Sasaki geometry and projective differential geometry. The situation is particularly elegant for Sasaki–Einstein geometries and in this setting we use projective geometry to provide the resolution of such structures into less rigid components. This is analogous to usual picture of a Kaehler structure: a symplectic manifold equipped also with a compatible complex structure; or as a complex manifold equipped with a suitable Hermitian metric; or finally as a Riemannian manifold with a complex structure that is compatible with the metric and parallel for the Levi–Civita connection. However the treatment of Sasaki geometry this way is locally more interesting and involves the

projective Cartan or tractor connection. This enables us to describe a natural type of compactification of complete non-compact pseudo-Riemannian Sasakian geometries. The boundary is a Fefferman space that fibres over over a CR manifold.

This is joint work with Katharina Neusser and Travis Willse.

**5.6.** Using the Schottky–Klein prime function to compute harmonic measure distribution functions of a class of multiply connected planar domains

Christopher Green (Macquarie University)

14:30 Tue 12 December 2017 – X5B 039

Christopher C. Green, Marie A. Snipes, Lesley A. Ward

We will show how to construct explicit formulae for the harmonic measure distribution functions, dubbed $h$-functions, of symmetric multiply connected slit domains whose boundaries consist of an even number of colinear slits. With the definition and interpretation of $h$-functions in mind for one of these multiply connected slit domains $\Omega$ (refer to Lesley Ward's abstract for her talk in this special session), we will employ the special function theory of the Schottky–Klein prime function $\omega(\zeta,\alpha)$ and its associated constructive methods in conformal mapping to build explicit formulae for the $h$-functions of domains $\Omega$ with *any* finite even number of slits.

This is joint work with Marie Snipes and Lesley Ward, and generalises to domains of higher connectivity their results with Darren Crowdy in the case of two slits.

**5.7.** The Donaldson–Narasimhan–Seshadri Theorem

Marielle Ong (University of Queensland)

15:00 Tue 12 December 2017 – X5B 039

Mx Marielle Ong

In 1965, Narasimhan and Seshadri proved a correspondence between stable, degree 0 holomorphic vector bundles over a compact Riemann surface $X$ and unitary representations of the fundamental group of $X$. Moreover, this theorem reveals a profound relationship between the holomorphic structure of the vector bundle and the topology of the base manifold. Its proof involved highly sophisticated techniques from deformation theory and algebraic geometry. In 1983, Donaldson provided a much shorter, differential geometric proof by invoking basic Yang–Mills theory of smooth unitary connections. In this talk, we will discuss the statement of the Narasimhan–Seshadri theorem and the techniques involved in Donaldson's proof.

**5.8.** Lie groups contacto-morphic to nilpotent Lie groups

Alessandro Ottazzi (University of New South Wales)

15:30 Thu 14 December 2017 – X5B 039

Dr Alessandro Ottazzi

Consider a 3-dimensional connected and simply connected Lie group $G$ endowed with a left-invariant contact structure. When is $G$ contactomorphic to the three dimensional Heisenberg group? While in the three dimensional case much is known, we propose a criterium for left-invariant (generalised) contact structures on general Lie groups to be equivalent to a nilpotent one. Our method relies on Tanaka prolongation theory.

This is a work in progress in collaboration with S. Nicolussi Golo.

**5.9.** Flat $(2,3,5)$-distributions and Chazy's equations

Matthew Randall (None)

16:00 Tue 12 December 2017 – X5B 039

Dr Matthew Randall

In the theory of generic 2-plane fields on 5-manifolds, or $(2,3,5)$-distributions, the local equivalence problem was solved by Cartan who also constructed the fundamental curvature invariant. For these distributions described by a single function of the form $F(q)$, the vanishing condition for the curvature invariant is given by a 6th order nonlinear ODE. Furthermore, An and Nurowski showed that this ODE is the Legendre transform of the nonlinear ODE that appeared in Noth's thesis in 1904. We show that the 6th order ODE can be reduced to a 3rd order nonlinear ODE that is a generalised Chazy equation. The ODE in Noth's thesis can similarly be reduced to another generalised Chazy equation, which has its Chazy parameter given by the reciprocal of the former. As a consequence of solving the related generalised Chazy equations, we obtain additional examples of flat $(2,3,5)$-distributions.

This talk is based on work that is available at arXiv:1506.02473 and arXiv:1607.04961.

**5.10.** Homogeneous tube domains in higher dimensions

Gerd Schmalz (University of New England)

15:00 Wed 13 December 2017 – X5B 039

Assoc Prof Gerd Schmalz

The study of homogeneous domains goes back to Cartan, and much is known about such domains that admit a bounded realisation. We present new families of homogeneous domains, which possess affinely homogenous tubular boundaries.

This is joint work with V. Ejov (Flinders University) and A. Medvedev (SISSA Trieste).

**5.11.** Using the Schottky–Klein prime function to compute the harmonic measure distribution function of a doubly connected planar domain

Lesley Ward (University of South Australia)

14:00 Tue 12 December 2017 – X5B 039
Assoc Prof Lesley Ward

Consider releasing a Brownian particle from a basepoint $z_0$ in a planar domain $\Omega \subset \mathbb{C}$. What is the chance, denoted $h_{\Omega,z_0}(r)$, that the particle's first exit from $\Omega$ occurs within a fixed distance $r > 0$ of $z_0$? The function of $r$ suggested by this question, denoted $h_{\Omega,z_0} : [0,\infty) \to [0,1]$, is called the *harmonic measure distribution function*, or *h-function*, of $\Omega$ with respect to $z_0$. We can think of the $h$-function as a signature that encodes the geometry of the boundary of $\Omega$. In the language of PDEs, the $h$-function can also be formulated in terms of a suitable Dirichlet problem on $\Omega$. The $h$-function has been studied by Walden, Ward, Snipes, Barton and Betsakos among others. For simply connected domains $\Omega$, the theory of $h$-functions is now quite well developed, and in particular the $h$-function can often be explicitly computed, making use of the Riemann mapping theorem. However, until now, for multiply connected domains the theory of $h$-functions has been almost entirely out of reach.

It turns out that the theory of the Schottky–Klein prime function, as recently developed by Crowdy and collaborators including Marshall and Green, can be applied here. I will describe joint work with Darren Crowdy and Marie Snipes, showing how the Schottky–Klein prime function $\omega(\zeta,\alpha)$ of a concentric annulus allows us to compute explicitly the $h$-function of a doubly connected slit domain, for instance $\mathbb{C} \setminus ([0,1/3] \cup [2/3,1])$. This is the first time that the $h$-function of any multiply connected domain has been computed explicitly. This talk is linked to Christopher Green's talk in this special session, which deals with the $h$-functions of slit domains of higher connectivity.

# 6. Computational Mathematics

**6.1.** Systematic analysis of OEIS generating functions

Michael Assis (The University of Newcastle)

16:30 Wed 13 December 2017 – X5B 138
Michael Assis

Given a sequence of integers, one would like to understand the pattern which generates the sequence, as well as its asymptotics. If the sequence is viewed as the coefficients of the series expansion of a function, its generating function, many questions regarding the sequence can be answered more easily. If the generating function satisfies a linear ODE or a nonlinear algebraic DE, the differential equation can be found if enough terms in the sequence are given. In this talk I'll discuss my implementation in C of such a search for ODEs, applications, and a systematic search of the entire Online Encyclopedia of Integer Sequences (OEIS) for generating functions.

**6.2.** Convergence analysis of a family of ELLAM schemes for a fully coupled model of miscible displacement in porous media

Hanz Martin Cheng (Monash University)

14:30 Tue 12 December 2017 – X5B 138
Hanz Martin Cheng, Jerome Droniou, Kim-Ngan Le

We analyse the convergence of numerical schemes in the GDM (Gradient Discretisation Method)–ELLAM (Eulerian Lagrangian localised adjoint method) framework for a strongly coupled elliptic–parabolic PDE which models miscible displacement in porous media. These schemes include, but are not limited to MFEM (Mixed Finite Element)–ELLAM and HMM (Hybrid Mimetic Mixed)–ELLAM schemes. Existing analysis performed for the advection–diffusion component of this model usually consists of performing an operator splitting, and thus treated the advective and diffusive components of the PDE separately. Without accounting for diffusion, the maximum principle is accessible, and thus doing an analysis of ELLAM for FV schemes yields $L^\infty$ bounds on the approximate solution. On the contrary, in the presence of diffusion, the maximum principle is not necessarily satisfied (even on rectangular grids, because of the anisotropy of the permeability and the diffusion–dispersion tensors). In this paper, we present a complete analysis of the advection–diffusion PDE, only relying on estimates that are expected from numerical methods; that is, coercivity but not the maximum principle. Moreover, as opposed to existing literature, our analysis is performed only with weak regularity assumptions on the solution (which is mostly the case in practice). The analysis performed in this paper can also be carried over to other similar models.

**6.3.** Nonlinearly preconditioned optimisation methods for tensor decompositions and recommendation

Hans De Sterck (Monash University)

14:00 Wed 13 December 2017 – X5B 138
Prof Hans De Sterck

This talk discusses nonlinear acceleration for iterative optimization methods of alternating least squares (ALS) type applied to tensor decompositions and matrix completion. Our approach extends traditional linear preconditioning ideas to the case of genuinely nonlinear preconditioning, where the preconditioning operation involves use of fully non-linear transformations. In this context, the ALS-type iterations can be used as nonlinear preconditioners for preconditioned versions of various types of traditional continuous optimisation methods, such as nonlinear conjugate gradients (NCG), LBFGS, non-linear GMRES, and Nesterov's method. Equivalently, we can say that NCG, LBFGS, NGMRES or Nesterov are used to accelerate ALS convergence. Numerical results show that the resulting combined methods perform much better than either stand-alone ALS or the stand-alone continuous optimisation methods, offering substantial improvements in terms of time-to-solution and robustness over state-of-the-art methods. The methods are illustrated for canonical tensor decompositions, for Tucker tensor decompositions on manifolds, and for recommendation problems in a parallel data analytics framework.

**6.4.** Designing high-order schemes for diffusion problems on generic polytopal cells

Jerome Droniou (Monash University)

14:00 Tue 12 December 2017 – X5B 138
Dr Jerome Droniou

Dealing with meshes presenting complex geometries has become essential in practical reservoir engineering applications (e.g., oil recovery, carbon storage, etc.). Due to the various geophysical features encountered in underground reservoirs, such as compacted rock layers, faults, etc., the available meshes are not made of simple cells like tetrahedra, and classical finite element methods cannot be used to compute approximate solution to models of interest.

Over the past 10 years or so, various schemes have been developed for diffusion problems, with the objective to be applicable on meshes made of generic polygonal/polyhedral cells. Most of these

schemes were initially low-order methods, but recently some high-order variants appeared in the literature: Mimetic Finite Differences, Virtual Element Methods, Hybrid High-Order, . . . .

In this talk, we will present a generic construction of such high-order methods. The starting point is the identification, thanks to the gradient discretisation method (GDM), of key features that any scheme for diffusion problem should satisfy to be convergent. Based on these features, we will show how to design high-order schemes, whose unknowns are polynomials in the cell and on the faces of the mesh. This design is done in two steps: construction, from these unknowns, of a consistent high-order gradient, and design of a stabilisation term to ensure that the resulting scheme is well-posed and robust. This stabilisation term is not uniquely designed; rather, we identify generic properties that this term should satisfy. Embedding this construction in the GDM enables off-the-shelve convergence results and analysis tools to be applied to the resulting high-order method.

**6.5.** Optimal Monte Carlo integration

Martin Ehler (University of Vienna)

16:00 Tue 12 December 2017 – X5B 138
Dr Martin Ehler

The decay rate of Monte Carlo integration is usually $-\frac{1}{2}$. However, re-weighting of random points can sometimes be used to improve the convergence order. We contribute theoretical and numerical results for Sobolev spaces on closed Riemannian manifolds and related spaces, where we verify that such re-weighting yields optimal approximation rates up to a logarithmic factor.

**6.6.** Fractals and numerical linear algebra

Markus Hegland (Australian National University)

16:00 Wed 13 December 2017 – X5B 138
Prof Markus Hegland

Fractals are defined as fixed points of iterated functions and fractal functions are functions for which the graph is a fractal. Here we will discuss vectors which are obtained by sampling a fractal functions. These vectors can be described as fixed points of linear difference equations. In this talk we will introduce these equations, discuss their fixed points and applications to fractal compression.

This is joint work with my students and with M. Barnsley and P. Massopust.

Reference: Numerics and Fractals, M.Barnsley, M.H. and P. Massopust, Bull. Inst. Math., Acad. Sin., 9 (3), 2014, pp. 389–439.

**6.7.** A new minimisation principle for the Poisson equation leading to a flexible finite-element approach

Bishnu Lamichhane (The University of Newcastle)

15:00 Tue 12 December 2017 – X5B 138
Dr Bishnu Lamichhane

We introduce a new minimisation principle for the Poisson equation using two variables: the solution and the gradient of the solution. This principle allows us to use any conforming finite element spaces for both variables, where the finite element spaces do not need to satisfy a so-called inf–sup condition. A numerical example demonstrates the superiority of the approach.

**6.8.** Sparse isotropic regularisation for spherical harmonic representations of random fields

Quoc Thong Le Gia (Univ. of New South Wales)

16:30 Tue 12 December 2017 – X5B 138
Dr Quoc Thong Le Gia

We discuss sparse isotropic regularisation for a random field on the unit sphere in $\mathbb{R}^3$, where the field is expanded in terms of a spherical harmonic basis. A key feature is that the norm used in the regularisation term, a hybrid of the $\ell_1$ and $\ell_2$-norms, is chosen so that the regularisation preserves isotropy, in the sense that if the observed random field is strongly isotropic then so too is the regularised field. The Pareto efficient frontier displays the trade-off between the sparsity-inducing norm and the data discrepancy term, in order to help in the choice of a suitable regularisation parameter. A numerical example using Cosmic Microwave Background (CMB) data is considered in detail. In particular, the numerical results explore the trade-off between regularisation and discrepancy, and show that substantial sparsity can be achieved alone with resulting small $L_2$ error.

This is a joint work with Yu Guang Wang (La Trobe), Ian Sloan (UNSW) and Rob Womersley (UNSW).

**6.9.** On the generation of random fields

Ian Sloan (University of New South Wales)

15:00 Wed 13 December 2017 – X5B 138
Ian Sloan, Ivan Graham (Univ. Bath), Frances Kuo (UNSW), Dirk Nuyens (KU Leuven), Robert Sceichl (Univ. Bath)

The generation of Gaussian random fields is a challenging problem in computational mathematics, especially when the correlation length is short and the field is rough. The traditional approach is to make use of a truncated Karhunen–Loeve (KL) expansion, but the generation of even a single realisation of the field may then be effectively beyond reach (especially for 3-dimensional domains) if the need is to obtain an expected $L_2$ error of say 5%, because of the potentially very

slow convergence of the KL expansion. In this talk a completely different approach is used, in which the field is initially generated at a regular grid on a rectangle that contains the physical domain, and then possibly interpolated to obtain the field at other points. In that case there is no need for any truncation, rather the main problem becomes the factorisation of a large dense matrix. For this we use circulant embedding and FFT ideas.

We note that the use of IBC ideas to study the random field generation problem, for example to find the standard information cost of obtaining an expected $L_2$ error, has as far as we know not been studied. It might be interesting to do so, but with the reservation that in the grid-based approach, as above, the main computational issues concern not the information cost but rather the factorisation of large matrices.

# 7. Dynamical Systems/Ergodic Theory

**7.1.** Optimal linear response for Markov chains

Fadi Antown (University of New South Wales)

17:00 Wed 13 December 2017 – W5A 201
Mr Fadi Antown

The linear response of a dynamical system refers to changes to properties of the system when small external perturbations are applied. Much of the theoretical focus on linear response has been on establishing that for various classes of systems, there is a principle of linear response. Our focus in this work is in a much less studied direction, namely, determining those perturbations that lead to 'maximal' response. The practical implication of optimizing response is that it allows the identification of the perturbations that provoke a maximal system response. In the finite-state Markov chains setting, we consider selecting the perturbations that (i) maximise the linear response of the equilibrium distribution of the system, (ii) maximise the expectation of the linear response with respect to an observable, and (iii) maximise the linear response of the rate of convergence of the system to the equilibrium distribution. Furthermore, application of the theory to various dynamics will be given.

This is a joint work with Davor Dragičević and Gary Froyland.

**7.2.** Stochastic sensitivity: a computable measure for uncertainty of deterministic trajectories

Sanjeeva Balasuriya (The University of Adelaide)

15:00 Wed 13 December 2017 – W5A 201
Sanjeeva Balasuriya

Uncertainties in velocity data are often ignored when computing Lagrangian particle trajectories of fluids. Modelling these as noise in the velocity field leads to a random deviation from each trajectory. This deviation is examined within the context of small (multiplicative) stochasticity applying to a two-dimensional unsteady flow operating over a finite-time. It is proven that the deviation's expectation is zero, and that its variance is bounded by a quantity defined to be the stochastic sensitivity $S^2$. The $S^2$ field provides a measure of uncertainty for trajectories beginning at each location. An easily computable expression for $S^2$ is derived. Monte Carlo simulations are used on a model flow to quantitatively validate the usage of $S^2$, and moreover demonstrate the significant potential of $S^2$ as a new tool for identifying coherent structures in flows even when the velocity is only available as data.

**7.3.** Stability of Statistical Properties for some Dynamical Systems

Harry Crimmins (University of New South Wales)

16:30 Wed 13 December 2017 – W5A 201
Mr Harry Crimmins

For sufficiently chaotic dynamical systems the existence of statistical laws, such as a Central Limit Theorem or Large Deviation Principle, can be obtained by examining the spectral properties of an analytically 'twisted' transfer operator. It is natural to ask if these statistical properties are robust to perturbations in the dynamics, which may arise e.g. via the idealisation of a physical system, or the numerical approximation of an abstract one. We extend the methods for proving the stability of the spectrum for 'untwisted' transfer operators to the twisted case, and consequently prove the stability of various statistical properties with respect to general perturbations. As an application, we use the theory developed to compute the variance and rate function associated with the dynamics of a piecewise expanding map in one-dimension.

**7.4.** Lattice structure detection and refinement DMD algorithm

Bojan Crnkovic (University of Rijeka)

12:00 Thu 14 December 2017 – W5A 201
Mr Bojan Crnkovic

Dynamic Mode Decomposition (DMD) is a class of numerical algorithms for computation of the eigenvalues and eigenfunctions of the Koopman operator. The Koopman eigenvalues form a lattice structure that depends on the principal generating eigenvalues. This can also be observed in numerical approximations of Koopman eigenvalues using some DMD algorithm but the numerical error is present and obtained result has an proximate lattice structure. We will present a modification of a DDMD-RRR algorithm that promotes the lattice structure and reduces the numerical error by Least Squares Minimisation of the Wasserstein distance form the ideal lattice. The algorithm can be used to automatically detect the lattice structure, principal generators and can correct the errors with the application of Ritz pair refinement of targeted eigenvalues in the lattice.

talks continued on next page

**7.5.** Stability of doubly periodic shear flow of the Euler equations

Holger Dullin (The University of Sydney)

14:30 Wed 13 December 2017 – W5A 201

Dr Holger Dullin

The Euler fluid equations allow for explicit solutions called shear flows. For a doubly periodic shear flow the linearisation about this solution leads to a complex Hill's equation. Using the Hill determinant we explicitly construct the Evans function whose zeroes give the location of the point spectrum of the linearised operator. Using the Evans function we prove a theorem that gives the exact number of eigenvalues in the point spectrum off the imaginary axis. This result had been conjectured, but it was difficult to prove because some of these eigenvalues are off the real (and the imaginary) axis. We overcome these difficulties by using bifurcation theory of eigenvalues based on the Evans function/Hill determinant.

**7.6.** Short trajectories of integrable billiards

Milena Radnovic (The University of Sydney)

11:30 Thu 14 December 2017 – W5A 201

Dr Milena Radnovic

We classify short periodic trajectories of billiards within ellipsoids.

**7.7.** Trimmed sums for observables on the doubling map

Tanja Schindler (Australian National University)

14:00 Wed 13 December 2017 – W5A 201

Alan Haynes, Tanja Schindler

For measure preserving ergodic dynamical systems there is no strong law of large numbers if the expectation has infinite mean. In some cases it is possible to obtain a generalised strong law of large numbers by deleting the maximum entry, for examples for the digits of a continued fraction expansion. Haynes proved that there is no strong law of large numbers by only deleting a finite number of terms (light trimming) on iterations of the doubling map with observable $1/x$, even though this would be possible if one considered independent random variables with the same distribution function. Based on this result Haynes and myself have shown that a strong law does still hold in this case depending if for the number of deleted terms $b_n$ of the sum of the first $n$ entries it holds that $\lim_{n\to\infty} b_n/\log\log\log n = \infty$ or not.

This is joint work with Alan Haynes.

**7.8.** Combinatorial model for the dynamics of birational maps over finite fields

Timothy Siu (University of New South Wales)

17:30 Wed 13 December 2017 – W5A 201

Mr Timothy Siu

Consider a random permutation of $N$ points represented as a functional graph (with vertices and directed edges). Suppose we (randomly) chop off one of the edges. We will be left with one less cycle, and a 'string'. Repeat this process of chopping edges a total of s times, we will end up with $s$ strings. How many cycles will we be left with? What is the proportion of space left in cycles? What is the distribution of the strings? We will see that playing this game is a good model for the dynamics of birational maps.

**7.9.** Spectral Galerkin methods for transfer operators in uniformly expanding dynamics

John Wormell (The University of Sydney)

16:00 Wed 13 December 2017 – W5A 201

John P. Wormell

We present a spectral method for numerically estimating statistical properties of uniformly-expanding Markov maps. We prove bounds on entries of the Fourier and Chebyshev basis coefficient matrices of transfer operators, and show that statistical properties estimated using finite-dimensional restrictions of these matrices consequently converge at classical spectral rates: exponentially for analytic maps, and polynomially for differentiable maps. Unlike the Ulam-based approaches, this convergence is found to occur within a single space, enabling easily justified rigorous numerical estimation of any quantity derived from the transfer operator, e.g. linear response.

Our results suggest algorithms to numerically estimate statistical properties of Markov maps. We demonstrate an adaptive implementation of these algorithms making use of our software package, Poltergeist.jl. We show that the algorithm can, in only a fraction of a second on a personal computer, produce estimates of many statistical properties accurate to 14 decimal places.

# 8. Education

**8.1.** From where do our students come?

Lyn Armstrong (Western Sydney University)

16:00 Fri 15 December 2017 – W5C 220

Ms Lyn Armstrong, Mr Donald Shearman

It is well known that the mathematics background of students entering university to study mathematics and statistics subjects has declined in recent years. We have known for some time that at our institution over 50% of students studying a first-year mathematics or statistics subject have no senior high school mathematics. Our assumption was that this high proportion was the result of the non-current school leaver entry group and that this proportion varied for different disciplines. Using data from 2015 and 2016 (four semesters) for 14 subjects we investigated the profile of the students in terms of their mathematics background, whether they were a current school leaver, the level of Mathematics Education Support Hub (MESH) workshop support they undertook and their final mark in the subject. Further exploration of these characteristics focused on four first-year subjects; Statistics for Business, Mathematics for Engineers Preliminary, Mathematics for Engineers 1 and Mathematics for Engineers 2. Our assumption that the high proportion of students having no senior mathematics was a result of non-current school leaver entry was found to be false. In fact, a high proportion of students entering directly from school don't have basic senior high school mathematics. This proportion shows little variation between business and engineering. In the subjects under investigation, the profile of students taking up the support opportunities provided by the university, and how these impact on final grades, will be discussed. Analysis of this profile raises questions about the optimal focus for student support in order to provide maximum impact.

**8.2.** Tertiary students' perceptions of assessments of, and attitudes to, Mathematics

Harkirat Dhindsa (Macquarie University)

16:00 Wed 13 December 2017 – W5C 220

Dr Harkirat Dhindsa, AP Leanne Rylands

The aim of this study was to investigate first-year students' perception of mathematics assessment and their attitudes towards mathematics. A paper survey consisting of six scales (Congruence; Authenticity; Transparency; Diversity; Student Consultation – Actual; Student Consultation – Expected) and an attitude scale was administered to 98 first-year students (mean age 20.3 years; 23.5% female and 76.5% male) enrolled in a discrete mathematics subject at Western Sydney University, NSW, Australia. The alpha reliability and discriminant validity coefficients values revealed that the overall instrument and scales were valid and reliable. The students perceived that the subject assessment was often congruent with planned objectives, transparent and suited to the students with diverse ability. They were also satisfied with the actual level of their consultation in deciding assessment tasks. However they believed that their assessment covered the application questions (Authenticity) sometimes only. The mean scores for male (2.41) and female (1.97) students for authenticity scale were significantly different. Their attitudes towards mathematics were positive and correlated positively and significantly with authenticity and diversity of assessment. Further research on how to improve students' attitudes towards mathematics by improving their perceptions towards mathematics assessment is recommended.

**8.3.** Bridging the gap for inclusive transition

Roland Dodd (Central Queensland University)

14:00 Wed 13 December 2017 – W5C 220

Dr Roland Dodd, Antony Dekkers, Prof William Guo

The mathematics capability of students, entering CQUs engineering program, has a very large variation. Students with weak numeracy and algebra skills struggle in their first year engineering mathematics studies. Consequently this places great pressure upon the MATH11218 Applied Mathematics unit that engineering students study as their first engineering mathematics unit. Over the very long term attrition/failure rates have broadly been around 25–30 percent in this unit. In the Term 1, 2014 offering this exceeded 40 percent necessitating the need for an alternative approach and action to help address this issue.

A unique approach, to help address this issue, was to encourage students to self-assess their mathematics competency, by means of online diagnostic testing, before self-electing the appropriate level of mathematics study. An online diagnostic test was introduced into the engineering program along with a MATH11247 Foundation Mathematics unit to further support the main MATH11218 unit offering.

This paper discusses the motivating factors for the introduction and delivery of a foundation mathematics unit for improved retention and progression of the first-year engineering students at CQU since introduction in 2016. The results of student outcomes are presented with a focus upon a comparison of two cohorts of students

across 2016 and 2017. One cohort elects to undertake a foundation mathematics unit prior to standard first-year engineering mathematics studies and the other cohort electing not to undertake this enrolment.

**8.4.** Improving retention and progression by rescheduling engineering mathematics units

William Guo (Central Queensland University)

15:00 Wed 13 December 2017 – W5C 220

Prof William Guo, Dr Roland Dodd, Dr Yucang Wang

At Central Queensland University, students enrolled in Bachelor of Engineering are predominately from regional areas, and roughly have a 60–40 percent split between on-campus and distance cohorts. The continuing mining downturn in regional areas, for the past several years, has deterred many potential students from choosing engineering as their preferred career. This downturn saw gradual shifts in engineering student intake from 2012. Parallel to this, the engineering mathematics units had kept the same approach and structure in their delivery for more than a decade without adapting to the changes in student cohorts. The effect of such detachment was accumulated to a point where 47 percent of the first-year students failed the compulsory first year mathematics units in 2014, more than 15 percent higher than any prior year. Such incident forced the then new mathematics team at the time to promptly address this issue with approaches that have continued to evolve in recent years. A number of measures were proposed and implemented gradually since 2015, which has resulted in positive outcomes and impact. This presentation focuses on how rescheduling engineering mathematics units has improved retention and progression of the first-year engineering students at CQU since 2015.

**8.5.** Assessment: a multi-pronged tool to motivate and engage

Dilshara Hill (Macquarie University)

11:30 Thu 14 December 2017 – W5C 220

Frank Valckenborgh, Dilshara Hill

Engagement and motivation of students studying mathematics at university level is an increasing and arguably rather complicated problem, in particular for the larger first-year service units. Together with frequently occurring weak numeracy skills at the start of their tertiary studies we see these students struggling in their successive mathematics units, and later physics and engineering units depending on those. Furthermore, of those students who manage to pass, there are some who appear unable to retain learnt knowledge from their previous units when they progress with their studies and so they continue to struggle.

In this presentation we propose a method to help address some of these issues — the use of carefully informed short in-tutorial quizzes as an additional form of assessment. Indeed, an important aspect of assessment is that it provides the students with timely and accurate feedback on their advancement in the subject, and guidance on what is required to maintain satisfactory progress. This distinct form of assessment which we have developed is thoughtfully designed to motivate and engage students, and we also see that it overcomes some of the traditional problems associated with various other forms of assessment. We will discuss the particular process used and present an evaluation of this form of assessment.

**8.6.** Examining students' interaction with mathematics consultation using Text Mining

Gizem Intepe (Western Sydney University)

15:30 Thu 14 December 2017 – W5C 220

Dr Gizem Intepe

There has always been a requirement for learning support in mathematics and statistics in tertiary education and the need for support in universities in Australia is increasing rapidly. Mathematics Education Support Hub at Western Sydney University provides support to students at the libraries in all campuses to increase their understanding, knowledge and abilities in numeracy, mathematics, statistics and assists all students regardless of program whether undergraduate or not. Team collects data on every consultation from the very beginning. This study examines tutor's explanations about the students' query on every consultation between 2013 and 2017 to work out the topics that students struggle the most and seek help during their degree. Useful information from the documents are extracted and processed by R as a text mining tool. Research showed that, interestingly but not surprisingly, the main topics where students seek help appears to be almost the same for all levels of study.

**8.7.** Impact and sustainability of a cross-disciplinary mathematics support program

Deborah Jackson (La Trobe University)

14:30 Tue 12 December 2017 – W5C 220

Dr Deborah Jackson

'Mathematics support' can materialize in many forms. A conglomeration of interventions that help and guide students to a better understanding and appreciation of mathematics, and its

links to their subject, are gathered together under this one title. However, 'support' can vary immensely. It can be the 'help session', or 'online materials for perusal and action', or 'tests and follow-up learning', or the 'bridging course', or the 'workshop', etc. How do we know, and how can we measure, whether the form of support we choose improves students' outcomes, their retention, mathematical skills and confidence? Mathematics support should not only aim to 'fill in the gaps' of a student's knowledge and skill, but should also aim to eke out the underpinning lack of skill holding a student back, and act upon it. With students at different stages in their skills development, support should be flexible, individual, adjust to individual needs, and engage students well. It should also motivate and encourage. The Maths Skills Program at La Trobe's College of Science, Health and Engineering, has been running since 2010. It has not only sustained its existence over those years, it has expanded and improved to become a vital support resource for many subjects. It is a set of programs, each designed for a particular subject or discipline, all developed under the one model. This presentation looks at the program's sustainability over 14 iterations (7 years), and explores its impact on students.

**8.8.** Investigating students' perceptions of graduate learning outcomes in mathematics

Deborah King (The University of Melbourne)

12:00 Thu 14 December 2017 – W5C 220

Assoc Prof Deborah King (UoM), Prof Cristina Varsavsky (Monash), Dr Kelly Matthews (UQ), Assoc Prof Shaun Belward (JCU)

In this talk we will report on findings of a recent study that explores the perceptions mathematics students have of the knowledge and skills they develop throughout their programme of study. The study addresses current concerns about the employability of mathematics graduates by contributing much needed insight into how degree programs are developing broader learning outcomes for students majoring in mathematics. Specifically, the study asked students who were close to completing a mathematics major ($n$ = 144) from four Australian institutions, to indicate the extent to which opportunities to develop mathematical knowledge along with more transferable skills (communication to experts and non-experts, writing, working in teams and thinking ethically) were included and assessed in their major. Their perceptions were compared to the importance they assign to each of these outcomes, their own assessment of improvement during the program, and their confidence in applying these outcomes

**8.9.** Teaching wirelessly with a pen-enabled tablet

Birgit Loch (La Trobe University)

14:30 Wed 13 December 2017 – W5C 220

Prof Birgit Loch

In this presentation, I will discuss the benefits of being able to walk around the classroom while explaining mathematics in handwriting on a tablet, and demonstrate a few options to set up wireless projection from a pen-enabled tablet. Wireless teaching removes the barrier between the lecturer and the students, particularly in large lecture theatres, and students find they are more actively participating if the lecturer comes to them. While I will focus on tablet PC (e.g. Surface Pro) and iPad (Pro), similar approaches are possible with other pen-enabled devices. The audience is invited to bring their own pen-enabled devices.

**8.10.** Third-year undergraduate projects in mathematics education: analysing student attitudes, student reflections, and predicting student performance

Heather Lonsdale (Curtin University)

16:00 Thu 14 December 2017 – W5C 220

Heather Lonsdale, Matthew Allen, Christel Ernest, Kai Striega

In this talk I will present a selection of different projects undertaken by third-year students, as a capstone research project in their undergraduate mathematics degree. This is a semester-long project which gave them a chance to use the mathematics and statistics knowledge acquired throughout their degree and embed it into a context. For the students whose work I will present (Christel, Matt and Kai), the context was tertiary mathematics education.

Christel analysed student attitudes to mathematics and learning activities, looking at how these varied with the course of study and the gender of the student. Matt conducted qualitative data analysis of student reflections on oral assessment, finding correlations between different reflective themes and the final grade. Kai investigated a variety of collaborative filtering algorithms, and applied these to predict student performance and make recommendations on selection of mathematics units.

**8.11.** Lessons from problem solving in ancient China

Terence Mills (Deakin University)

16:30 Tue 12 December 2017 – W5C 220

T.M. Mills

Problem solving has enjoyed a prominent place in mathematics education for centuries.

The *Nine Chapters of the Mathematical Art* is an anonymous mathematical work that originated in

China more than 2000 years ago. This work consists of 246 problems which have been organised into nine sections or chapters. It is a major landmark in the history of mathematics in China. An English translation was produced by Kangshen, Crossley, and Lun in 1999. The main aim of this presentation is to offer an overview of this book by discussing a selection of problems from the text.

What can we learn about teaching mathematics through problem solving from the *Nine Chapters*? A stated aim of the Australian Curriculum is to promote intercultural understanding as a general capability in our students: "In the Australian Curriculum, students develop intercultural understanding as they learn to value their own cultures, languages and beliefs, and those of others" (ACARA, 2016). Clearly this can be done through subjects such as languages, history, music, politics, and art.

Mathematics can also play its part in this national endeavour. Studying mathematics from other cultures and civilisations is another way to increase the interest of our students in those cultures. The study of mathematics, especially ancient mathematics, is an avenue to promoting understanding of those cultures.

For example, it has often been debated whether Pythagoras' theorem was established in ancient China before or after it was established in ancient Greece. Instead our students should be impressed that this result flowered, seemingly independently, in these ancient cultures. This engenders interest in — and respect for — those cultures.

The *Nine Chapters* provides mathematics students with wonderful insight into the culture of ancient China.

### **8.12.** Communities of practice across pre-undergraduate and undergraduate mathematics

Judy-anne Osborn (The University of Newcastle)

14:30 Fri 15 December 2017 – W5C 220
Dr Judy-anne Osborn

I report on research at the University of Newcastle, designed to understand and strengthen a community of practice (and praxis!) spanning mathematicians and statisticians across the University teaching students from their entry through Enabling Programs through to Research Higher Degrees.

### **8.13.** Employing cultural plasticity in STEM workshops for prospective indigenous Engineering and Information Technology students

Collin Grant Phillips (The University of Sydney)

16:30 Fri 15 December 2017 – W5C 220
Dr Collin Grant Phillips

Indigenous school students from the ACT, NSW, QLD, SA and TAS were selected and invited to attend a week of intensive seminars, activities and workshops called the *STEM (Science, Technology, Engineering and Mathematics) Spring Workshop.* The STEM spring workshops were conducted by the Faculty of Engineering and Information Technology at the University of Sydney (UoS) to help prospective indigenous STEM students to learn more about STEM studies and activities. The Mathematics Learning Centre at the UoS conducted the mathematics sessions for the STEM workshop. We will outline some of the processes used to design the mathematics sessions. These include assessing and analysing the students' mathematical backgrounds, abilities, confidences and enthusiasm for mathematics and STEM subjects. We will also describe how the teaching curriculum and teaching material were developed. Finally, we will present and discuss the responses from the students.

As a matter of course, the Mathematics Learning Centre at the UoS supports a culturally diverse student cohort. Often, it's not that a student can't do the maths it is just they think about it differently. The talk outlines how the Mathematics Learning Centre is adaptive to student needs and backgrounds including cultural backgrounds, is responsive to students' specific modes of thought, and remains agile in continuously modifying teaching techniques and technology to advance student (and teacher) understanding. As such, we employ cultural plasticity to provide effective support for students.

### **8.14.** Engagement-focused learning in large service-level courses

Rebecca Smith (The University of Newcastle)

15:00 Tue 12 December 2017 – W5C 220
Miss Rebecca Smith; Dr Mumtaz Hussain

We will explore students' attitudes towards Mathematics in a tertiary education setting from a practitioner's perspective. Although there are no easy solutions to the problems encountered by students and educators alike, we observed that through some understanding and acknowledgment, new strategies and approaches can be adapted from existing ones which can aid all. The strategies we will present were successfully trialled at an Australian regional University within a Prepartorial level Mathematics service course in 2015 and 2016.

**8.15.** No, Professor: you don't need to reverse the order of integration!

Chris Tisdell (University of New South Wales)

16:00 Tue 12 December 2017 – W5C 220
Dr Chris Tisdell

Calculus books are full of worked examples where the order of integration is reversed in double integrals. Moreover, the narrative associated with these examples is that the reversal is necessary in order to solve the problem.

I illustrate that the method of integration by parts can be directly applied to many of the classic pedagogical problems in the literature concerning double integrals, without taking the well-worn steps associated with reversing the order of integration.

I advocate for integration by parts to be a part of the pedagogical conversation in the learning and teaching of double integral methods; and call for more debate around its use in the learning and teaching of other areas of mathematics. Finally, I emphasise the need for critical approaches in the pedagogy of mathematics more broadly.

**8.16.** Linking mathematical theories to computation and modelling for engineering applications

Yucang Wang (Central Queensland University)

14:00 Tue 12 December 2017 – W5C 220
Dr Yucang Wang, Prof William Guo, Dr Roland Dodd

Most engineering and scientific problems are too complicated to be solved using analytical techniques. An alternative approach is the use of numerical procedures to obtain approximations to the exact solutions. Computational modelling is an integral skill set in problem solving for engineering graduates in the current technology-driven focus of world industries. To meet this need, in 2015 the engineering team at Central Queensland University decided to develop a new unit to provide engineering students with a new opportunity in expanding their theoretical mathematics knowledge into the computational domain. The new unit, Applied Computational Modelling (MATH12225), was first offered in the second term of 2016. This unit uses MATLAB to deliver computational and modelling techniques to bridge the mathematical theories, gained from students' prior mathematics study, with real practices required in engineering disciplinary units in the 3rd and 4th years.

This presentation shares our effort in creating, delivering, and improving this new unit and students' learning outcomes and feedback on many issues ranging from the basic programming concepts to implementing complicated algorithms to solve real-world problems during their studies.

**8.17.** LaTeX + First Year Calculus = ???

Thomas Wong (The University of Melbourne)

15:00 Fri 15 December 2017 – W5C 220
Dr Thomas Wong

Assignments form a major component of continuous assessment in first year calculus. These assignments are generally hand-written with varying degrees of comprehensibility in terms of both content and aesthetics.

During my time as a graduate student instructor, I explicitly targeted this issue by implementing a LaTeX typesetting requirement for assignment submissions. In this talk, I will present my implementation through a sample of the materials from the subject.

# 9. Functional Analysis, Operator Algebra, Non-commutative Geometry

**9.1.** KMS states on the $C^*$-algebras of Fell bundles over groupoids

Zahra Afsar (University of Wollongong)

16:00 Fri 15 December 2017 – C5A 226
Dr Zahra Afsar

We consider fibre-wise singly generated Fell bundles over étale groupoids. Given a continuous real-valued 1-cocycle on the groupoid, there is a natural dynamics on the cross-sectional algebra of the Fell bundle.

In this talk, which is a joint work with Aidan Sims, I will talk about the Kubo–Martin–Schwinger equilibrium states (KMS states) for the above dynamics. Following work of Neshveyev on equilibrium states on groupoid $C^*$-algebras, we describe the equilibrium states of the cross-sectional algebra in terms of measurable fields of traces on the $C^*$-algebras of the restrictions of the Fell bundle to the isotropy subgroups of the groupoid.

**9.2.** Isomorphisms of $AC(\sigma)$ spaces

Shaymaa Shawkat Kadhim Al-shakarchi (University of New South Wales)

16:00 Tue 12 December 2017 – C5A 226
Mrs Shaymaa Shawkat Kadhim Al-shakarchi

The classical Banach–Stone Theorem for spaces $C(K)$ of continuous functions is important in developing the spectral theory of self-adjoint and normal operators on a Hilbert space. In 2005, Doust and Ashton introduced algebras $AC(\sigma)$ of absolutely continuous functions defined on a compact subset of the complex plane, and asked whether there was a similar link for these algebras between the properties of the domain $\sigma$ and the Banach algebra properties of the function space.

In 2015 Doust and Leinert showed that if $AC(\sigma_1)$ is algebra isomorphic to $AC(\sigma_2)$ then $sigma_1$ and $\sigma_2$ must be homeomorphic, and they produced an example to show that the converse is false. In this talk I will look at the case where $\sigma$ is the spectrum of a compact operator. While we are yet to discover necessary and sufficient conditions for two of these function spaces to be isomorphic, we have some interesting special cases, and a simpler example of homeomorphic sets which produce non-isomorphic function algebras.

**9.3.** Twisted $C^*$-algebras of topological higher-rank graphs: keeping things simple!

Becky Armstrong (The University of Sydney)

16:00 Wed 13 December 2017 – C5A 226
Miss Becky Armstrong

Since their introduction twenty years ago, $C^*$-algebras associated to directed graphs have become a popular tool for investigating various classes of $C^*$-algebras, and have provided a fruitful source of examples. Directed graph $C^*$-algebras have been generalised in many ways, including the $k$-graph $C^*$-algebras of Kumjian and Pask, the topological graph $C^*$-algebras of Katsura, the topological $k$-graph $C^*$-algebras of Yeend, and the twisted $k$-graph $C^*$-algebras of Kumjian, Pask, and Sims. In this talk, I will discuss the results of my PhD project, in which I use groupoid techniques to construct and study twisted $C^*$-algebras of topological $k$-graphs. My main result is a characterisation of simplicity for these $C^*$-algebras in terms of the underlying graphical and cohomological data.

This is joint work with PhD supervisors, Nathan Brownlowe and Aidan Sims.

**9.4.** Recursive algorithms for inversion of linear operator pencils

Elizabeth Bradford (University of South Australia)

17:30 Wed 13 December 2017 – C5A 226
Ms Elizabeth Bradford

There are numerous examples of systems that can be represented by linear equations. In many cases the system coefficient is an operator that depends on an unknown parameter. We are interested in what happens to the solution when we change this parameter. If the coefficient is a linear operator pencil which depends on a single complex parameter and the resolvent is analytic on a deleted neighbourhood of the origin, the resolvent can be calculated by different procedures. We calculate the resolvent matrix using different recursive procedures which, for finite dimensional problems, will terminate after a finite number of steps. We will briefly compare the different methods.

**9.5.** Investigating symbolic dynamics using $C^*$-algebras

Kevin Aguyar Brix (University of Copenhagen)

16:30 Wed 13 December 2017 – C5A 226
Kevin Aguyar Brix

The symbiotic relationship between symbolic dynamics and operator algebras was initiated by Cuntz and Krieger via their introduction of the Cuntz–Krieger algebra in 1980. Within the last 5–10 years, this connection was made more explicit with the introduction of continuous orbit equivalence and eventual conjugacy and the application of groupoid techniques to characterize these relations in terms of dynamics, groupoids and Cuntz–Krieger algebras. We will take a closer look at some of these results.

**9.6.** On Baumslag–Solitar monoids and their $C^*$-algebras

Nathan Brownlowe (The University of Sydney)

14:30 Fri 15 December 2017 – C5A 226
Dr Nathan Brownlowe

At the 2016 AustMS meeting, Zahra Afsar and I spoke about the $C^*$-algebras of right LCM semigroups and their KMS states. Our general framework captured the results Orloff Clark, an Huef and Raeburn on the KMS structure of the $C^*$-algebras of the Baumslag–Solitar monoid $BS(c,d)^+$, for $c$ and $d$ integers with the same sign. The case where $c$ and $d$ have different signs has since proved to be an interesting example, and I will talk about the differences.

This is joint work with Nadia Larsen, Jacqui Ramagge and Nicolai Stammeier.

**9.7.** Recent inequalities of Young type for positive operators in Hilbert spaces

Silvestru Sever Dragomir (Victoria University)

15:30 Thu 14 December 2017 – C5A 226
Prof Silvestru Sever Dragomir

In this presentation some recent refinements and reverses of the famous Youngs scalar inequality will be reviewed. Applications to the operator Young's inequality for positive operators in complex Hilbert spaces will be provided. Some reverses of McCarthy's vector and trace inequalities will be given as well. The related papers of the author in preprint form are available at Research Group in Mathematical Inequalities and Applications (RGMIA) web site:
http://rgmia.org/index.php

**9.8.** K-theory and characters

Peter Hochs (The University of Adelaide)

11:30 Thu 14 December 2017 – C5A 226
Dr Peter Hochs

Let $G$ be a semisimple Lie group. Using orbital integrals, we define traces on a convolution algebra of functions on $G$. These define maps from the $K$-theory of the reduced $C^*$-algebra of $G$ to the complex numbers. Those maps can be used to extract values of characters of tempered representations of $G$ from classes in $K$-theory. In work with Hang Wang, we use this to compute characters via a fixed point theorem in index theory, and to relate $K$-theory to character identities in the Langlands program.

**9.9.** Derivations into ideals of semifinite von Neumann algebras

Jinghao Huang (University of New South Wales)

15:00 Tue 12 December 2017 – C5A 226
Aleksey Ber, Jinghao Huang, Galina Levitina, Fedor Sukochev

A derivation problem introduced by Barry Johnson is one of the classical problems in operator algebra theory. In 1985, Kaftal and Weiss showed that every derivation $\delta : A \to L_p(M,\tau) \cap M$, for $1 \le p < \infty$, is inner if $A$ is an abelian (or properly infinite) von Neumann subalgebra of a semifinite von Neumann algebra $M$, where $\tau$ is a faithful semifinite normal trace on $M$ and $L_p(M,\tau)$, with $1 \le p < \infty$, is the non-commutative $L_p$-space relative to $\tau$. However, the question whether every derivation from an arbitrary von Neumann subalgebra into $L_p(M,\tau)\cap M$, $1 \le p < \infty$, is inner was left unresolved in that paper. In this talk, I will give an overview of the previous results and outline my work (with Ber, Levitina, Sukochev) which resolves the case left by Kaftal and Weiss.

**9.10.** Mauldin–Williams graphs and their KMS states

Michael Arthur Mampusti (University of Wollongong)

16:30 Tue 12 December 2017 – C5A 226
Mr Michael Arthur Mampusti

In this talk, we will look at iterated function systems as a framework for the study of fractals, and how Mauldin–Williams graphs generalise such systems for the study of more general fractal sets. Using some key examples, we focus on the dynamics of Mauldin–Williams graphs, and how they give rise to interesting $C^*$-algebras. In particular, we look at how the dynamics of a Mauldin–Williams graph determines the KMS state structure of the associated $C^*$-algberas.

The material from this talk forms part of my PhD thesis supervised by David Pask and Aidan Sims.

**9.11.** On the $C^*$-algebras of a graph of groups

Thomas Pedersen (University of Wollongong)

17:00 Wed 13 December 2017 – C5A 226
Mr Thomas Pedersen

Graphs of groups, consisting of an undirected graph with associated vertex and edge groups, were introduced by Bass and Serre in the 1970s. The study of these objects is interesting because they have a one-to-one correspondence with orientation-preserving group actions on trees. We discuss several $C^*$-algebras that can be constructed from a graph of groups, and explore parallels between these and the directed graph $C^*$-algebras established in the 1980s and '90s.

**9.12.** C*-algebras from self-similar actions and their states

Jacqui Ramagge (The University of Sydney)

14:00 Wed 13 December 2017 – C5A 226
Jacqui Ramagge

We will consider self-similar actions of groupoids on the path space of a directed graph, use them to construct C*-algebras, and describe the classification of the KMS states on the algebras.

**9.13.** Unbounded quasitraces, stable finiteness and pure infiniteness

Adam Sierakowski (University of Wollongong)

15:00 Fri 15 December 2017 – C5A 226
David Pask, Aidan Sims, Adam Sierakowski

We prove that if $A$ is a $\sigma$-unital exact $C^*$-algebra of real rank zero, then every state on $K_0(A)$ is induced by a 2-quasitrace on $A$. This yields a generalisation of Rainone's work on pure infiniteness and stable finiteness of crossed products to the non-unital case. It also applies to $k$-graph $C^*$-algebras associated to row-finite $k$-graphs with no sources. We show that for a twisted $C^*$-algebra of a cofinal $k$-graph with no sources, stable finiteness is independent of the twisting cocycle. We also study pure infiniteness of twisted $C^*$-algebras.

**9.14.** Rigidity for dynamics via operator algebras

Aidan Sims (University of Wollongong)

15:00 Wed 13 December 2017 – C5A 226
Prof Aidan Sims

Groupoids are algebraic objects that encode very general dynamical systems. The study of $C^*$-algebras constructed from groupoids goes back to Renault's PhD thesis in 1980, and has been very influential. I will describe some recent results proved jointly with Carlsen, Ruiz and Tomforde that show how a groupoid can be reconstructed from its $C^*$-algebra, and that use this procedure to prove new rigidity results for various types of dynamical systems.

**9.15.** Conformal trace theorem for Julia sets

Fedor Sukochev (University of New South Wales)

14:00 Tue 12 December 2017 – C5A 226
Prof Alain Connes, Prof Fedor Sukochev, Dr Dmitriy Zanin

This talk illustrates the role of the quantised calculus in the concrete example of Julia sets. It is based on the recent papers: *Conformal trace theorem for Julia sets of quadratic polynomials*, Connes, McDonald, Sukochev, Zanin, *ETDS*.

**9.16.** Hyperbolic and crystalline topological matter via Baum–Connes isomorphisms

Guo Chuan Thiang (The University of Adelaide)

12:00 Thu 14 December 2017 – C5A 226
Dr Guo Chuan Thiang

Much of the literature on topological phases implicitly uses Fourier transforms over a lattice of Euclidean symmetries, and bundle-theoretic invariants over the dual group (a Brillouin torus). Real physical systems often have much more interesting symmetries or take place in non-Euclidean geometries. I will outline the noncommutative 'Bloch–Fourier theory' for topological phases in these settings, and use the Baum–-Connes isomorphisms to simplify their K-theoretic analysis.

**9.17.** The fundamental equations for the generalized resolvent of an elementary pencil in a unital Banach algebra

Geetika Verma (University of South Australia)

16:00 Thu 14 December 2017 – C5A 226
Amie Albrecht, Phil Howlett, Geetika Verma

We show that the generalized resolvent of an elementary linear pencil in a unital Banach algebra over the field of complex numbers is analytic on an open annular region of the complex plane if and only if the coefficients of the Laurent series expansion satisfy a system of left and right fundamental equations and are geometrically bounded. Our analysis includes the case where the resolvent has an isolated essential singularity at the origin. We find a closed form for the resolvent and use the fundamental equations to establish key spectral separation properties when the resolvent has only a finite number of isolated singularities.

**9.18.** Positive scalar curvature for proper actions

Hang Wang (The University of Adelaide)

14:00 Fri 15 December 2017 – C5A 226
Mr Hao Guo, Elder Prof Varghese Mathai, Dr Hang Wang

In this talk, we study equivariant index theory for proper co-compact actions. Using vanishing of this equivariant index we obtain obstructions to invariant Riemannian metrics of positive scalar curvature. We also prove the existence of invariant Riemannian metrics of positive scalar curvature under certain very general hypotheses on the group and its action on the manifold.

This is joint work with Varghese Mathai and Hao Guo.

# 10. Geometric Analysis

**10.1.** Distance comparison for curve shortening of networks

Paul Bryan (The University of Queensland)

12:00 Thu 14 December 2017 – C5A 232
Paul Bryan

The curve shortening flow for networks, first introduced by Mullins to study the evolution of grain boundaries models two-dimensional multiphase systems capturing the dynamics of interface boundaries. It is also an example of a Brakke flow by Mean Curvature, that is necessarily singular, exhibiting qualitative differences in behaviour to the smooth case. This talk will discuss how distance comparison techniques previously used in the smooth setting may be adapted to non-smooth regimes. Many novel features arise such as non-uniqueness of embedded, self-similar solutions, and generally expected singular behaviour. Understanding singularity formation is an actively studied topic and is an essential ingredient for further analysis and global results for the flow, which may be amenable to analysis by the distance comparison techniques described in this talk.

**10.2.** Non-Kaehler Ricci flows that converge to Kaehler–Ricci solitons

Jim Isenberg (University of Oregon)

16:00 Wed 13 December 2017 – C5A 232
Prof Jim Isenberg

We consider a family of Riemannian (non-Kaehler) Ricci flow solutions which develop finite-time (Type I) singularities such that parabolic rescalings at the singularities take the form of shrinking Kaehler–Ricci solitons. In particular, the singularity models for these solutions are the 'blowdown soliton' studied by Feldman–Ilmanen–Knopf. Our results support the conjecture that the blowdown soliton is stable under Ricci flow. As well, our work provides the first set of rigorous examples of non-Kaehler Ricci flow solutions which become asymptotically Kaehler in suitable neighborhoods of the developing singularities.

**10.3.** The planar dual Minkowski problem

Qirui Li (Australian National University)

17:30 Wed 13 December 2017 – C5A 232
Dr Qirui Li

Various geometric measures have been discovered and introduced in the area of convex geometry, and the associated Minkowski type problems have been studied. Among them, the dual Minkowski problem has attracted much attention recently. In this talk, a complete solution to the problem for the planar case will be presented.

The talk is based on joint work with Shibing Chen.

**10.4.** Neck detection for the fully nonlinear flow $G$

Alexander Majchrowski (The University of Sydney)

15:00 Wed 13 December 2017 – C5A 232
Mr Alexander Majchrowski

I will discuss neck detection and a surgery procedure for mean curvature flow with surgeries for two-convex hypersurfaces and how this can be extended to a fully nonlinear flow, $G = \left(\sum_{i<j} \frac{1}{\lambda_i + \lambda_j}\right)^{-1}$ as studied by Huisken and Brendle; available at ArXiv: 1507.04651.

**10.5.** The space of harmonic tori in the 3-sphere

Ross Ogilvie (The University of Sydney)

11:30 Thu 14 December 2017 – C5A 232
Dr Ross Ogilvie

It is known that harmonic tori in the 3-sphere may be completely characterised in terms of algebraic data via the spectral curve construction (due to Hitchin). This provides a natural setting for a space of harmonic maps. The strata of this space corresponding to spectral curves with low genus can be explicitly determined by consideration of elliptic integrals, allowing one to determine the connected components and their topology.

**10.6.** Metrics with prescribed curvature on homogeneous spaces with intermediate subgroups

Artem Pulemotov (The University of Queensland)

14:00 Wed 13 December 2017 – C5A 232
Dr Artem Pulemotov

We will discuss the problem of recovering a Riemannian metric from its Ricci curvature on a homogeneous space $G/H$. In particular, we will explain how the existence of an intermediate subgroup $K$ (i.e., one that satisfies $H < K < G$) affects the solvability of this problem.

This is based upon joint work with Mark Gould (The University of Queensland).

talks continued on next page

**10.7.** Volume preserving flow in hyperbolic space

Yong Wei (Australian National University)

16:00 Thu 14 December 2017 – C5A 232
Dr Yong Wei

We consider the volume preserving flow of closed horospherical convex hypersurfaces in hyperbolic space with the speed given by any positive power of a smooth symmetric, strictly increasing, and homogeneous of degree one function $f$ of the principal curvatures which is inverse concave and has dual $f_*$ approaching zero on the boundary of the positive cone. We prove that if the initial hypersurface is horospherical convex, then the solution of the flow becomes strictly horospherical convex for $t > 0$, the flow exists for all time and converges to a geodesic sphere exponentially in the smooth topology. This talk is the hyperbolic analogue of my talk given in PDE session. However, the method of the proof follows different approaches in many steps.

**10.8.** Convexity of non-negatively curved hypersurfaces with free boundary on a sphere

Changwei Xiong (Australian National University)

15:30 Thu 14 December 2017 – C5A 232
Dr Changwei Xiong

When is an immersed hypersurface in Euclidean space globally convex? One answer given by Hadamard in 1897 is that, any closed immersed surface with positive Gaussian curvature in 3-dimensional Euclidean space must be the boundary of a convex body. After the later efforts by Stoker, van Heijenoort, Chern–Lashof, and Sacksteder, the answer for hypersurfaces without boundary now is quite clear. In this talk we shall focus on this problem for hypersurfaces with boundary. More precisely, our work shows that any compact immersed hypersurface in Euclidean space with non-negative sectional curvatures, and with free boundary on the standard sphere, must be globally convex. The key ingredient in the proof is a gluing process which reduces the problem with boundary to that without boundary.

This work is joint with Mohammad Ghomi.

**10.9.** Riemannian cubics in the manifold $\mathrm{SPD}(n)$ of all $n \times n$ symmetric positive-definite matrices

Erchuan Zhang (The University of Western Australia)

17:00 Wed 13 December 2017 – C5A 232
Erchuan Zhang, Lyle Noakes

The manifold $\mathrm{SPD}(n)$ of all $n \times n$ symmetric positive-definite (SPD) matrices is widely used in image analysis, machine learning and statistics. In this paper we investigate Riemannian cubics in $\mathrm{SPD}(n)$ with respect to an invariant metric. Motivated by Riemannian cubics in a Lie group with a bi-invariant metric, Riemannian cubics in $\mathrm{SPD}(n)$ are reduced to so-called *Lie quadratics* in the Lie algebra $\mathfrak{gl}(n)$ by introducing an extended definition of *left Lie reduction*. Results are proved for these Lie quadratics, focusing on cubics in the Riemannian sub-manifold of all $n \times n$ diagonal SPD matrices, and on relationships between Riemannian cubics in $\mathrm{SPD}(n)$ and in $SO(n)$. Null Riemannian cubics in $\mathrm{SPD}(n)$ are given in closed form, and non-null Riemannian cubics in $\mathrm{SPD}(2)$ are also considered.

**10.10.** Mean curvature flows of closed hypersurfaces in warped product manifolds

Zhou Zhang (The University of Sydney)

17:00 Wed 13 December 2017 – C5A 232
Zhou Zhang

For warped product manifolds with closed hypersurfaces fibering over the real line, we prove that under not-too-restrictive conditions on the warping function, there exists a large class of closed hypersurfaces as geodesic graphs over the totally geodesic hypersurface (i.e., the central fibre of the warped product manifold), such that the mean curvature flow starting from them exists for all time and converges to the totally geodesic hypersurface.

This is a joint work with Zheng Huang and Hengyu Zhou.

**10.11.** Min–max theory for constant mean curvature hypersurfaces

Jonathan Julian Zhu (Harvard University)

14:30 Wed 13 December 2017 – C5A 232
Mr Jonathan Julian Zhu

We describe the construction of closed constant mean curvature (CMC) hypersurfaces using min–max methods. In particular, our theory allows us to show the existence of closed CMC hypersurfaces of any prescribed mean curvature in any closed Riemannian manifold.

This work is joint with Xin Zhou.

# 11. Harmonic Analysis

**11.1.** On the flows associated to self-adjoint operators on metric measure spaces

Anh Bui (Macquarie University)

11:30 Thu 14 December 2017 – C5A 225
Dr Anh Bui

Let $X$ be a metric space with a doubling measure satisfying $\mu(B) \gtrsim r_B^n$ for any ball $B$ with any radius $r_B > 0$. Let $L$ be a non-negative self-adjoint operator on $L^2(X)$. We assume that $e^{-tL}$ satisfies a Gaussian upper bound and that the flow $e^{itL}$ satisfies a typical $L^1 - L^\infty$ dispersive estimate of the form

$$\|e^{itL}\|_{L^1 \to L^\infty} \lesssim |t|^{-\frac{n}{2}}.$$

Then we prove a similar $L^1 - L^\infty$ dispersive estimate for a general class of flows $e^{it\phi(L)}$, with $\phi(r)$ of power type near 0 and near $\infty$. In the case of fractional powers $\phi(L) = L^\nu$, $\nu \in (0,1)$, we deduce dispersive estimates for $e^{itL^\nu}$ with data in Sobolev, Besov or Hardy spaces $H^p_L$ with $p \in (0,1]$, associated to the operator $L$.

This is joint work with P. D'Ancona, X. T. Duong and D. Müller.

**11.2.** Sparse dominations and sharp weighted estimates for singular integral operators

Dorothee Frey (Delft University of Technology)

16:30 Tue 12 December 2017 – C5A 225
Ms Dorothee Frey

We shall discuss the concept of sparse dominations of singular integral operators, in particular for those operators whose kernel do not satisfy any regularity estimate. Such sparse dominations lead to sharp weighted norm estimates and weighted weak-type estimates for operators such as Riesz transforms and multipliers associated with a second order elliptic operator.

**11.3.** A generalised Gagliardo–Nirenberg type inequality with application to the $p(x)$-Laplacian

Daniel Hauer (The University of Sydney)

14:30 Wed 13 December 2017 – C5A 225
Dr Daniel Hauer

In this talk, we present a generalised Gagliardo–Nirenberg inequality and show how to apply this to establish a new regularisation effect of the non-linear semigroup generated by the $p(x)$-Laplacian.

**11.4.** An embedding result for Hermite distribution spaces

Fu Ken Ly (The University of Sydney)

12:00 Thu 14 December 2017 – C5A 225
Dr Fu Ken Ly

We present certain Sobolev-type embeddings for weighted Besov and Triebel–Lizorkin spaces in the setting of the Hermite operator $-\Delta + |x|^2$. These embeddings are characterized in terms of a lower bound condition of the weights applied to balls.

This is based on joint work with The Anh Bui and Ji Li.

**11.5.** The connection between vanishing reverse-Hölder weights and functions of vanishing mean oscillation

Stephanie Mills (University of South Australia)

16:00 Tue 12 December 2017 – C5A 225
Ms Stephanie Mills

One way to quantify how far a function $\omega : \mathbb{R} \to \mathbb{R}_+$ is from being constant is through its reverse-Hölder characteristics $[\omega]_{\mathrm{RH}_q}$, for all $q \in [1,\infty)$. These numbers measure to what extent $\omega$ locally satisfies the converse of Hölder's inequality with exponent $q$. Meanwhile, a way to quantify the extent to which a function $\varphi : \mathbb{R} \to \mathbb{R}$ oscillates locally is through its bounded mean oscillation (BMO) norm $\|\varphi\|$. It is well known that the logarithm $\varphi = \log\omega$ of a $\mathrm{RH}_q$ function $\omega$ lies in the BMO class (has finite BMO norm), while only a partial converse holds: the exponential $\omega = \exp(\varphi)$ of a BMO function $\varphi$ lies in a reverse-Hölder class $\mathrm{RH}_q$ if the BMO norm $\|\varphi\|$ is sufficiently small. Our aim is to sharpen this result.

Specifically, we introduce new classes $\mathrm{VRH}_q$ of *vanishing reverse-Hölder-q* functions, and show that the logarithms $\varphi = \log\omega$ of $\mathrm{VRH}_q$ functions lie in the subspace VMO of BMO consisting of functions of vanishing mean oscillation. This result extends an early result of Sarason about $A_2$ weights and VMO. Next, in work in progress, we aim to show that the full converse holds: if $\varphi$ is in VMO then $\exp(\varphi)$ is in $\mathrm{VRH}_q$, with no size restriction on the BMO norm of $\varphi$. We plan to use these results, and their dyadic analogues, to devise a new proof of an averaging theorem of Pipher, Ward and Xiao, which says that the geometric–arithmetic average of a family of dyadic $\mathrm{RH}_q$ functions lies in (continuous) $\mathrm{RH}_q$.

This is joint work with Lesley Ward.

talks continued on next page

**11.6.** Spectral multipliers for sub-Laplacians on $NA$ groups

Alessandro Ottazzi (University of New South Wales)

14:30 Tue 12 December 2017 – C5A 225
Dr Alessandro Ottazzi

Let $G = NA$, where $N$ is a stratified Lie group and $A = \mathbb{R}$ acts on $N$ via automorphic dilations. Homogeneous sub-Laplacians on $N$ and $A$ can be lifted to left-invariant operators on $G$ and their sum is a sub-Laplacian $\Delta$ on $G$. In this talk I discuss a theorem of Mihlin[†]–Hörmander type for spectral multipliers of $\Delta$. One of the tools of the proof is a Caldéron–Zygmund theory adapted to the control distance associated with $\Delta$.

This work is in collaboration with A. Martini and M. Vallarino.

[†]Russian: Михлин, Соломон Григорьевич

**11.7.** Operator-valued $(L^p, L^q)$ Fourier multipliers

Jan Rozendaal (Australian National University)

15:00 Tue 12 December 2017 – C5A 225
Jan Rozendaal

In this talk I will discuss some recent advances in the theory of Banach space valued harmonic analysis, pertaining to the following question. Let $X$ and $Y$ be Banach spaces, $m : \mathbb{R}^d \to \mathscr{L}(X, Y)$ and $p, q \in [1, \infty]$. Under which conditions is the Fourier multiplier operator $f \mapsto \mathscr{F}^{-1}(m \cdot \mathscr{F} f)$ bounded from $L^p(\mathbb{R}^d; X)$ to $L^q(\mathbb{R}^d; Y)$?

This talk is based on joint work with M. Veraar (Delft University of Technology).

**11.8.** Riesz transform and harmonic functions

Adam Sikora (Macquarie University)

14:00 Tue 12 December 2017 – C5A 225
Dr Adam Sikora

Let $(X, d, \mu)$ be a doubling metric measure space endowed with a Dirichlet form satisfying a scale-invariant $L^2$-Poincaré inequality. We show that, for $p \in (2, \infty)$, the following conditions are equivalent:

(i) $(G_p)$: $L^p$-estimate for the gradient of the associated heat semigroup;
(ii) $(RH_p)$: $L^p$-reverse Hölder inequality for the gradients of harmonic functions;
(iii) $(R_p)$: $L^p$-boundedness of the Riesz transform $(p < \infty)$.

Joint work with Thierry Coulhon, Renjin Jiang and Pekka Koskela.

**11.9.** A principal eigenvalue problem with large degenerate advection

Maolin Zhou (University of New England)

14:00 Wed 13 December 2017 – C5A 225
Dr Maolin Zhou

In this article, we study the asymptotic behavior of the principal eigenvalue of some eigenvalue problem when the advection coefficient converges to infinity. This problem is relevant to nonlinear propagation phenomena in reaction–diffusion equations.

# 12. Mathematical Biology

**12.1.** Mathematical model of glucose–insulin regulation with diabetically impaired ultradian oscillations

Maia Nikolova Angelova (Deakin University)

16:00 Wed 13 December 2017 – W5C 213
Prof Maia Nikolova Angelova, Adam Bridgewater, Dr Benoit Huard

We study the effect of diabetic deficiencies on the production of an oscillatory ultradian regime using a deterministic nonlinear model of glucose–insulin regulation which incorporates two physiological delays. It is shown that insulin resistance impairs the production of oscillations by dampening the ultradian cycles. Four strategies for restoring healthy regulation are explored. Through the introduction of an instantaneous glucose-dependent insulin response, explicit conditions for the existence of periodic solutions in the linearised model are formulated, significantly reducing the complexity of identifying an oscillatory regime. It is shown that the model is suitable for representing the effect of diabetes on the oscillatory regulation. In particular, it may provide additional pathways for reintroducing a physiologically appropriate cyclic regulation and devise new regimes for a personalized treatment. Finally, in view of the recent efforts for the development of an artificial pancreas, these results open the way for more in-depth analysis of the underlying mechanisms which are most responsible for generating the oscillations.

This talk is based on joint work with Benoit Huard, Jonathan Easton and Adam Bridgewater [1,2].

[1] Huard B., Bridgewater A., Angelova M. *Mathematical investigation of diabetically impaired ultradian oscillations in the glucose–insulin regulation*. Journal of Theoretical Biology 418, 2017, pp. 66–76.

[2] Huard, B., Easton J., Angelova M. *Investigation of stability in a two-delay model of ultradian oscillations in glucose–insulin regulation*. Commun. Nonlinear Sci. Numer. Simul. 26 (1–3), 2015, pp. 211–222.

**12.2.** The simple complexity of robust networks

Robyn Patrice Araujo (Queensland University of Technology)

11:30 Thu 14 December 2017 – W5C 213
Dr Robyn Patrice Araujo

While mathematics has long been considered “an essential tool for physics", the foundations of biology and the life sciences have received significantly less influence from mathematical ideas and theory. In this talk, I will give a brief discussion of my recent research on robustness in molecular signalling networks, as an example of a complex biological question that calls for a mathematical answer. In particular, it has been a long-standing mystery how the extraordinarily complex communication networks inside living cells, comprising thousands of different interacting molecules, are able to function robustly since complexity is generally associated with fragility. Mathematics has now suggested a resolution to this paradox through the discovery that robust adaptive signalling networks must be constructed from a just small number of well-defined universal modules (or ‘motifs’), connected together. The existence of these newly-discovered modules has important implications for evolutionary biology, embryology and development, cancer research, and drug development.

**12.3.** Akt translocation as a harmonic oscillator

Catheryn Gray (University of New South Wales)

14:30 Tue 12 December 2017 – W5C 213
Ms Catheryn Gray

Akt is a key signalling protein of mammalian cells. As a major nutrient sensor, it regulates a range of cellular processes, such as glucose metabolism, cell growth, and apoptosis. The dysregulation of Akt is implicated in a wide variety of disorders, from diabetes to cancer.

As a critical cross-talk node in a number of signal transduction pathways, Akt derives signalling specificity from its biochemical state but also importantly from its intracellular location. Akt is initially synthesized within the cytosol of the cell, but only becomes activated (phosphorylated) at the outer plasma membrane (PM). Currently, knowledge about the process of Akt translocation from cytosol to PM is rudimentary, although there is evidence that it is a staged process.

We have developed a three compartment model to describe Akt translocation. If an implicit conservation relation is assumed, it can be shown that this system is equivalent to the harmonic oscillator equation, a well-studied second order differential equation. Using this framework, we elucidate the different modes of behaviour of the Akt translocation system, and derive conditions on the model for the manifestation of these modes. The results are also applicable to other signalling molecules where it can be assumed that a conservation relation holds true.

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**12.4.** Non-binary unrooted tree-based networks

Michael Hendriksen (Western Sydney University)

15:00 Tue 12 December 2017 – W5C 213

Mr Michael Hendriksen

There is contemporary debate in biology as to whether evolution of some species is inherently tree-like, with some reticulations between the branches (e.g., horizontal gene transfer and hybridisations), or whether there are too many reticulation events to describe these histories as tree-like in any meaningful way. In 2015, Francis and Steel introduced the concept of tree-based networks in the rooted, binary network setting to differentiate between these possibilities. Since then there has been a great deal of interest in the area. In particular, Jetten and van Iersel (2017) extended the concept to non-binary rooted networks to allow for rapid speciation events or uncertainty about order of speciation events, and Francis, Huber and Moulton (2017) extended it to binary unrooted networks, to allow for uncertainty about root location. In this talk we present some preliminary results in the area of nonbinary unrooted networks, including characterisations of extensions of both the tree-based property and the related concept of a fully tree-based network.

**12.5.** Modelling heterogeneity in biology: how do cancer-killing viruses interact with tumour cells?

Adrianne Jenner (The University of Sydney)

15:00 Wed 13 December 2017 – W5C 213

Ms Adrianne Jenner

For some time now, the use of viruses as potential anti-cancer agents has been of much interest in oncology. Through genetic modification, viruses can be forced to selectively infect, and replicate within, tumour cells, killing them in the process. One of the major challenges faced by mathematical modellers is accounting for heterogeneity in the virus–tumour interaction. In this study, we have derived a system of integro-differential equations to describe the processes acting in the virus–tumour system, allowing for the replication characteristics of the virus to be gamma distributed random variables. The model parameters, including viral burst size, viral burst rate and infectivity, were determined via simultaneous and hierarchical optimisation across multiple experimental data sets. The sensitivity of the parameter values was assessed and the parameter space explored to determine the regions of applicability of the system. From our optimised model we were able to infer the specific effects of the E1B 19 and E1B 55 genes and how different levels of genetic modifications affect the anti-tumour potency. The model also provides a platform from which we can explore and optimise the efficacy of other viral treatments and application modalities.

**12.6.** Delivery and diffusion in membranes

Aaron Jordan Kaw (University of New South Wales)

14:00 Tue 12 December 2017 – W5C 213

Aaron J Kaw, Assoc Prof Adelle Coster

Lateral diffusion of proteins on cell membranes is a fundamental process in biology. Investigations of protein delivery to the cell's plasma membrane give insights into many disease and function related processes. The delivery is achieved by embedding proteins on internal membranes known as vesicles. Such vesicles are delivered to the cell surface and their membranes fuse. This occurs via two main fusion modalities known as 'full-fusion' and 'kiss-and-run'. The former is a mathematically extreme case of the latter. Both modes contrast in energy and resource expenditure.

A model is presented of the lateral diffusion of proteins in both fusion modalities as well as a Finite Element Method implementation developed to numerically solve the system. This method has necessitated reformulating the classical second-order partial differential diffusion equation as an integro-differential equation. Problems involving the intersection of multiple connected manifolds often result in solutions with discontinuous derivatives, and the equation reformulation enabled a tractable and accurate numerical solution for the geometry involved here.

The results produced at high spatial and temporal resolution allow insights unattainable in the laboratory setting. Discriminative features between the two modes of fusion have been determined, including the early concentration spread and variability in diffusive response. These are promising candidates as predictor variables for an experimental classifier. It remains to be seen whether they remain discriminative when the experimental constraints are additionally applied to the model.

The modelling platform developed here will provide the basis for not only classifiers of fusion events, but also insights into other lateral diffusion problems ubiquitous in cell biology.

**12.7.** Modelling evolution of post-menopausal human longevity: the Grandmother Hypothesis

Peter Kim (The University of Sydney)

14:00 Fri 15 December 2017 – W5C 213

Assoc Prof Peter Kim

Human post-menopausal longevity makes us unique among primates, but how did it evolve? One explanation, the Grandmother Hypothesis, proposes that as grasslands spread in ancient Africa

displacing foods ancestral youngsters could effectively exploit, older females whose fertility was declining left more descendants by subsidizing grandchildren and allowing mothers to have new babies sooner. As more robust elders could help more descendants, selection favoured increased longevity while maintaining the ancestral end of female fertility.

Firstly, we develop a probabilistic agent-based model that incorporates two sexes and mating, fertility–longevity tradeoffs, and the possibility of grandmother help. Using this model, we show how the grandmother effect could have driven the evolution of human longevity. Simulations reveal two stable life-histories, one human-like and the other like our nearest cousins, the great apes.

This and other related questions in social and evolutionary dynamics give rise to a variety of unique mathematical models and problems using ODEs, PDEs, and agent-based models. Thus, I will also introduce some of the projects being addressed by others in our research group.

**12.8.** Modelling the impact of T-cell avidity on cancer vaccines

Adarsh Kumbhari (The University of Sydney)

14:30 Wed 13 December 2017 – W5C 213
Mr Adarsh Kumbhari

Therapeutic cancer vaccines treat cancers that have already developed by stimulating cytotoxic T-cells. Despite showing promise, positive clinical outcomes have yet to be realised. Vaccines elicit a low-avidity (i.e., weakly tumour-killing) T-cell response, and the mere presence of low-avidity T-cells can inhibit cancer killing by tumourlytic high-avidity T-cells via the stripping of surface antigen. This may explain the observed inefficacy of therapeutic cancer vaccines. By modelling this with a system of ordinary differential equations we explore what is the optimal stimulation window.

**12.9.** Smoking prevalence and related death rates for Australian birth cohorts over the last century

John Murray (University of New South Wales)

12:00 Thu 14 December 2017 – W5C 213
Prof John Murray, Dr Stephen Wade, Prof Karen Canfell

Smoking of tobacco is the leading preventable cause of death in Australia. How we can best reduce the approximately 15,000 Australians it kills each year is dependent on accurately describing our history of smoking. This will allow us to estimate how this burden of disease will change in the future.

Incorporating data from 11 Australian surveys, we determined smoking prevalence and probability distributions for age of smoking initiation and quit rates for male and female 5-year birth cohorts from 1920–24 through to 1980–84. We fitted a dynamical model to these data to determine prevalence of Never, Current and Former smokers for each cohort and over all ages. Expressing the excess Current and Former smoker death rates as optimal control functions, allowed estimates of their values across the cohorts.

**12.10.** Modelling the spread of smoking as an infectious disease

Mark Nelson (University of Wollongong)

16:30 Wed 13 December 2017 – W5C 213
Assoc Prof Mark Nelson

SIR models were originally developed to analyse the spread of infectious diseases. More recently the SIR framework has been applied to study the dynamics of social and behavioural processes such as eating disorders, drug additions, the spread of ideas, alcoholism and smoking. The SIR analogy can be employed when the problem 'state' (i.e., the infection) can be viewed as occurring as the result of frequent or intense interactions between individuals in different compartments.

An important feature of many 'social diseases' is the ease with which 'recovered' individuals relapse into problematic behaviour. Thus the modelling framework has to be based upon a SIRI model rather than a SIS model.

In this work we view smoking as an infectious disease that is spreading through a population. We investigate how education campaigns and an individual's determination to quit smoking influence the proportion of smokers in a population.

**12.11.** Do T-cells compete for antigen?

Pantea Pooladvand (The University of Sydney)

14:00 Wed 13 December 2017 – W5C 213
Ms Pantea Pooladvand

When antigen is presented to helper $T$-cells, the immune response is two-fold. First, the $T$-cells will go through rapid expansion, followed by a contraction phase which subsequently contributes to immunological memory.

It is difficult to assess the contribution of precursor frequency to the $T$-cell numbers at the peak of the response due to the widely differing views in recent publications. Does the initial number of $T$-cells determine the peak or is the $T$-cell response limited by the amount of antigen present?

Inspired by new experimental results from our collaborators, we introduce a simple system of ODEs to investigate this problem by considering

that the $T$-cells compete for limited amount of antigen. We propose that this competition between $T$-cells limits the peak of response and we compare the dynamics from this system to our collaborators' data.

**12.12.** Who gets the girl? On the operational sex ratio as an index for male strategy

Danya Rose (The University of Sydney)

15:30 Thu 14 December 2017 – W5C 213
Dr Danya Rose

The operational sex ratio (OSR) is defined as the ratio of eligible males to fertile females in a population. If males compete with each other for paternities according to their father's strategy, does mating with as many females as possible (multiple-mating), or does preventing other males access to one's own mate (mate-guarding) win out? We build a two-strategy ODE model of a primate-like population in which males inherit their father's mating strategy when they mature, and investigate the correlation between OSR and dominant strategy.

**12.13.** Multi-phase modelling of early fibrous cap formation in *atherosclerosis*

Michael Greg Watson (The University of Sydney)

16:00 Thu 14 December 2017 – W5C 213
Dr Michael Greg Watson, Prof Mary R. Myerscough

Advanced *atherosclerotic* plaques are characterised by the accumulation of cellular debris and extracellular fat in the arterial intima. Smooth muscle cells (SMCs) are recruited from the media to synthesise a fibrous cap of tissue that sequesters this thrombogenic material from the bloodstream. Whilst this process is believed to provide crucial protection from clinical sequelae such as heart attack and stroke, the mechanisms underlying cap evolution remain poorly understood. Evidence suggests that certain plaques will remain strong and stable, whilst others become fragile and dangerously vulnerable to rupture.

Using a multi-phase approach with non-standard boundary conditions, we investigate early cap formation in the intima by modelling SMC migration from the media in response to a PDGF signal produced at the endothelium. Simulations indicate that the emergence of a cap-resembling SMC profile requires a critical balance between the relative rates of cell supply from the media, chemotactic migration within the intima and cell loss by apoptosis (or phenotype change). Moreover, a sensitivity analysis highlights a number of disease-associated parameters that may be linked to variations in cap stability.

# 13. Mathematical Optimization

**13.1.** Extending a linear programming formulation for TSP

Kieran Clancy (Flinders University)

16:30 Wed 13 December 2017 – X5B 136
Dr Kieran Clancy

The travelling salesman problem (TSP) is a well-known NP-hard problem where one seeks to find a route which visits each city in a set precisely once and returns to the starting city, while minimising the cost of the route. A common approach to solving TSP is to use a relaxed linear programming formulation with branch-and-cut techniques. In this talk, we consider three polynomial-size linear programming formulations of TSP, due to Gouveia and Pires (2001); Sherali, Sarin and Tsai (2006); and a formulation derived from Filar et al. (2015). The three formulations are described and their relaxations are compared using a set of asymmetric TSP instances. A new linear program (Clancy, 2017) is constructed using Filar et al. (2015) as a starting point then adding new constraints as well as constraints based on the other formulations. Numerical results are presented showing the obtained improvements on the given TSP instances.

**13.2.** On the generalized Douglas–Rachford algorithm for feasibility problems

Minh N. Dao (The University of Newcastle)

17:00 Wed 13 December 2017 – X5B 136
Dr Minh N. Dao

In this work, we study the generalized Douglas–Rachford algorithm and its cyclic variants which include many projection-type methods such as the classical Douglas–Rachford algorithm and the alternating projection algorithm. Specifically, we establish several local linear convergence results for the algorithm in solving feasibility problems with finitely many closed possibly nonconvex sets under different assumptions. Our findings not only relax some regularity conditions but also improve linear convergence rates in the literature. In the presence of convexity, the linear convergence is global.

**13.3.** Radius theorems for monotone mappings

Andrew Eberhard (RMIT University)

15:00 Tue 12 December 2017 – X5B 136
Prof Andrew Eberhard

For a Hilbert space $X$ and a mapping $F : X \rightrightarrows X$ (potentially set-valued) that is maximal monotone locally around a pair $(\bar{x}, \bar{y})$ in its graph, we obtain a radius theorem of the following kind: the infimum of the norm of a linear and bounded single-valued mapping $B$ such that $F + B$ is not locally monotone around $(\bar{x}, \bar{y} + B\bar{x})$ equals the monotonicity modulus of $F$. Moreover, the infimum is not changed if taken with respect to $B$ symmetric, negative semidefinite and of rank one, and also not changed if taken with respect to all functions $f : X \to X$ that are Lipschitz continuous around $\bar{x}$ and $\|B\|$ is replaced by the Lipschitz modulus of $f$ at $\bar{x}$. As applications, a radius theorem is obtained for the strong second-order sufficient optimality condition of an optimization problem, which in turn yields a radius theorem for quadratic convergence of the Newton method applied to that problem. A radius theorem is also derived for mappings that are merely hypomonotone.

This is joint work with A. Donchev and R.T. Rockafellar.

**13.4.** A new approach to select the best subset of predictors in linear regression modeling

Ali Eshragh (The University of Newcastle)

15:00 Wed 13 December 2017 – X5B 136
Ali Eshragh, Hadi Charkhgard

We study the problem of selecting the best subset of $p$ predictors in linear regression modeling given $n$ observations. This problem naturally contains two objective functions including minimising the amount of bias and minimising the number of predictors. The existing approaches transform the problem into a single-objective optimization problem. We discuss the main practical drawbacks of the current approaches and propose a new bi-objective optimisation approach to overcome those issues. Computational results show the efficacy of this new approach.

**13.5.** Averaging in singularly perturbed deterministic and stochastic optimal control problems and dynamic games

Vladimir Gaitsgory (Macquarie University)

14:00 Tue 12 December 2017 – X5B 136
Prof Vladimir Gaitsgory

Models of real life dynamical systems are often characterized by the fact that their state variables are decomposed into groups of slow and fast ones, this decomposition being formalized with a special introduction of a small parameter. Such systems are commonly called singularly perturbed (SP). In this talk, we will discuss ways of using averaging techniques for construction of asymptotically near optimal solutions in problems of optimal control and dynamic games considered on trajectories of SP systems.

**13.6.** Computing radius of robust feasibility of uncertain linear conic programs via semidefinite programs

Guoyin Li (University of New South Wales)

12:00 Thu 14 December 2017 – X5B 136
Dr Guoyin Li

The radius of robust feasibility provides a numerical value for the largest possible uncertainty set that guarantees robust feasibility of an uncertain linear conic program. This determines when the robust feasible set is non-empty. Otherwise the robust counterpart of an uncertain program is not well-defined as a robust optimization problem. In this talk, we address a key fundamental question of robust optimization: How to compute the radius of robust feasibility of uncertain linear conic programs, including linear programs? We first provide computable lower and upper bounds for the radius of robust feasibility for general uncertain linear conic programs under the commonly used ball uncertainty set. We then provide classes of linear conic programs where the bounds are calculated by finding the optimal values of related semidefinite linear programs (SDPs). The classes, in particular, include the important classes of uncertain SDPs and second-order cone programs. Then, we present an exact formula for the radius of robust feasibility for a class of uncertain linear conic programs. We show that in the case of an uncertain linear program the formula allows us to calculate the radius by finding the optimal value of an associated second-order cone program. As an application, we show how the well-studied distance to ill-posedness of parametric linear conic systems can be calculated using the radius of robust feasibility. This is done by providing formulas for the lower and upper bounds and a new exact formula for the distance to ill-posedness

**13.7.** Strong convergence for relaxed iterated approximate projection methods for convex feasibility problems

Scott Lindstrom (The University of Newcastle)

14:30 Wed 13 December 2017 – X5B 136
Mr Scott Lindstrom

We investigate iterative schemes for solving convex feasibility problems which replace projections onto sets with projections onto separating hyperplanes. In considering the general extension to averaged operators with reflection parameters, we prove a global convergence for several approximate projection methods. In so doing, we recover as special cases convergence for methods with various kinds of projections. Interestingly, the theory does not rely on firm non-expansivity but only on quasi-nonexpansivity, and the convergence with true projections does not rely on finite dimensionality.

**13.8.** Investigating Hamilton cycles through extreme points of a certain polytope

Sogol Mohammadian (The University of Newcastle)

16:00 Wed 13 December 2017 – X5B 136
Miss Sogol Mohammadian

In this talk we study a certain polytope arising from embedding the Hamiltonian cycle problem (HCP) in a discounted Markov decision process (MDP). The HCP can be reduced to finding the extreme points of a certain polytope associated with a graph. We characterize the feasible bases of that polytope, and find the expected number of feasible bases associated with the extreme points of that polytope corresponding to a given random graph. Finally, we develop a random walk algorithm on the feasible bases of that polytope and present some numerical results.

**13.9.** Averaging of discrete-time singularly perturbed optimal control problems

Alex Parkinson (Macquarie University)

14:00 Wed 13 December 2017 – X5B 136
Mr Alex Parkinson

Current methods for solutions of singularly perturbed (SP) optimal control problems in discrete time rely on the so-called reduction technique whereby near optimal controls are constructed on the basis of solutions of the degenerate problem obtained by disregarding the fast dynamics. This technique is capable of dealing with many important classes of discrete time SP optimal control problems however is not applicable in general. A method of averaging of the slow dynamics over occupational measures generated by the state-control trajectories of the fast sub-system (considered with "frozen" slow states) is presented in this talk.

**13.10.** On the reconstruction of polytopes

Guillermo Pineda-Villavicencio (Federation University Australia)

16:30 Tue 12 December 2017 – X5B 136
Dr Guillermo Pineda-Villavicencio

Blind and Mani, and later Kalai, showed that the face lattice of a simple polytope is determined by its graph, namely its 1-skeleton. Call a vertex of a $d$-polytope nonsimple if the number of edges incident to it is $> d$.

We show that (1) the face lattice of any $d$-polytope with at most two nonsimple vertices is determined by its 1-skeleton; (2) the face lattice of any $d$-polytope with at most $d-2$ nonsimple vertices is determined by its 2-skeleton; and (3) for any

$d > 3$ there are two $d$-polytopes with $d-1$ non-simple vertices, isomorphic $(d-3)$-skeleton and nonisomorphic face lattices. In particular, the result (1) is best possible for 4-polytopes.

This is a joint work with Joseph Doolittle (University of Kansas), Eran Nevo (Hebrew University of Jerusalem), Julien Ugon (Federation University Australia) and David Yost (Federation University Australia).

**13.11.** Multipoint Voronoi cells

Vera Roshchina (RMIT University)

11:30 Thu 14 December 2017 – X5B 136
Dr Vera Roshchina

Given a finite set $S$ in a Euclidean space, each point $s$ from $S$ can be assigned the Voronoi cell of all points for which $s$ is the closest point in $S$. Voronoi cells are polyhedral sets with nonempty interiors. Generally speaking, given a polyhedral set $P$ and a point $s$ in its interior, this polyhedral set $P$ can be reconstructed as a Voronoi cell of $s$ with respect to some finite set $S$ in the Euclidean space.

We study generalised multipoint Voronoi cells, and two-point cells in particular, focussing on the structure of these cells. In contrast to the classical case, not every polyhedral set can be represented as a Voronoi cell of two points, however, for many polyhedral sets it is possible to obtain explicit representations via multipoint Voronoi cells.

This is joint work with Juan-Enrique Martinez-Legaz (Universitat Autònoma de Barcelona, Spain) and Maxim Todorov (Universidad de las Américas Puebla, Mexico).

**13.12.** Optimality conditions for non-smooth, multi-objective, bilevel optimization problems

Chuong Thai Doan (University of New South Wales)

16:00 Tue 12 December 2017 – X5B 136
Dr Chuong Thai Doan

This talk is devoted to study of a non-smooth, multi-objective, bilevel optimization problem, which involves the vector-valued objective functions in both levels of the considered program. We first formulate a relaxation multi-objective formulation for the multi-objective bilevel problem and examine the relationships of solutions between them. We then establish Fritz John (FJ) and Karush–Kuhn–Tucker (KKT) necessary conditions for the non-smooth multi-objective bilevel optimization problem via its relaxation. This is done by studying a related multi-objective optimization problem with operator constraints.

# 14. Mathematical Physics

**14.1.** Squeezed coherent states of one-dimensional anharmonic quantum oscillators

Maia Nikolova Angelova (Deakin University)

15:00 Tue 12 December 2017 – W5A 202
Prof Maia Nikolova Angelova

The motivation of this work is the Lie-algebraic approach to anharmonic quantum oscillators represented by Morse and Poschl–Teller potentials. I will consider the Lie algebraic representations of the Hamiltonians of such oscillators and compare them with the behaviour of the harmonic oscillator. Constructions of ladder operators, quantum bosons, coherent and squeezed coherent states, related to the discrete spectrum of the anharmonic quantum system, will be presented. Properties of diatomic molecules and molecular complexes will be presented in the context of the models.

This work is in collaboration with Veronique Hussin.

**14.2.** Exactly-solved origami statistical mechanics

Michael Assis (The University of Newcastle)

17:30 Wed 13 December 2017 – W5A 202
Michael Assis

Using the methods of exactly-solved models in statistical mechanics, several origami lattice structures are analyzed in terms of their suitability as tunable metamaterials since their defects affect the material's compressibility properties. Defects are analyzed as in terms of a lattice gas and phase transitions are shown rigorously to exist. A comparative study of the ease of formation of defects allows shows which origami structures are better suited for their tuning properties.

**14.3.** Duality in mASEP and tKZ equation

Zeying Chen (AMSI/University of Melbourne)

16:00 Tue 12 December 2017 – W5A 202
Ms Zeying Chen

In stochastic processes, duality is defined by a function that co-varies in time with respect to the evolution of two processes. It can be used to connect processes with many particles to those with few particles, which can be analyzed in great details. We would like to propose a systematic method to construct dualities between the multi-species asymmetric exclusion process (mASEP), via the solutions of the deformed Knizhnik–Zamolodchikov equation.

Using this method, we have derived the self-dualities for any two species ASEP, and reproduces the duality for one species ASEP.

**14.4.** Lattice integrable stochastic processes

Alexandr Garbali (The University of Melbourne)

16:30 Tue 12 December 2017 – W5A 202
Dr Alexandr Garbali

Using a certain twisting procedure $XXZ$-type integrable Hamiltonians can be turned into Markov matrices which define integrable stochastic processes. Integrability provides numerous tools to study non-equilibrium characteristics of these processes giving new insights about their universality class (typically Kardar–Parisi–Zhang). Famous examples of these processes include Asymmetric Simple Exclusion Process (ASEP) and Zero Range Process (ZRP). I will give an algebraic description of ASEP, ZRP and their multi-species generalizations. In the most general setting of the multi-species ZRP process I will discuss the steady state vector and its relation to the Macdonald theory of symmetric functions. This information is important for computing current and density profiles as well as observable quantities.

**14.5.** Integrable structure of products of complex random matrices

Vladimir Mangazeev (Australian National University)

14:00 Tue 12 December 2017 – W5A 202
Dr Vladimir Mangazeev

We consider the squared singular values of the product of standard complex Gaussian matrices. Since the squared singular values form a determinantal point process with a particular Meijer $G$-function kernel, the gap probabilities are given by a Fredholm determinant based on this kernel. It was shown by Strahov that a hard edge scaling limit of the gap probabilities is described by Hamiltonian differential equations which can be formulated as an isomonodromic deformation system similar to the theory of the Kyoto school. We generalize this result to the case of finite matrices by first finding a representation of the finite kernel in integrable form. As a result we obtain the Hamiltonian structure for a finite size matrices and formulate it in terms of a matrix Schlesinger system. The case $M = 1$ reproduces the Tracy and Widom theory which results in the Painlevé $V$ equation for the $(0, s)$ gap probability. Some results for $M = 2$ are also presented.

**14.6.** Lifted worm process for the Ising model

Abrahim Steve Nasrawi (Monash University)

12:00 Thu 14 December 2017 – W5A 202
Mr Abrahim Steve Nasrawi

We construct a lifted worm process for the zero-field ferromagnetic Ising model. We study the dynamic critical behavior of an energy estimator on the complete graph, and compare our findings with reversible processes such as the Prokof'ev–Svistunov worm process. Our results show that the lifted worm process improves the dynamic exponent of the energy estimator.

**14.7.** Protection of topological phases in quantum spin systems by quantum deformed symmetries

Thomas Quella (The University of Melbourne)

16:00 Thu 14 December 2017 – W5A 202
Dr Thomas Quella

We show that topological phases of quantum spin systems may enjoy protection even in the absence of ordinary group symmetries. The relevant mechanism is explained in full detail for the example of 1D spin chains with quantum group ($q$-deformed) symmetry $\mathrm{SO}_q(3)$. We also sketch the generalization to quantum deformations of other continuous Lie groups such as those associated with $\mathrm{SU}(N)$ or $\mathrm{SO}(N)$. Our results provide a complete classification of quantum group symmetry-protected topological phases for real values of $q$.

**14.8.** Duality methods for topological matter

Guo Chuan Thiang (The University of Adelaide)

15:30 Thu 14 December 2017 – W5A 202
Dr Guo Chuan Thiang

Band theory has been used to predict many experimentally realised topological phases, and is underpinned by Pontryagin duality and vector bundle theory. Interestingly, topological insulators and semimetals are exactly Poincare dual to Dirac strings on a torus, and the boundary Fermi arcs found in 2015 are just holographic images of the latter. Furthermore, T-duality simplifies bulk-boundary maps as well as the computation of twisted equivariant K-theory groups classifying crystalline topological phases.

**14.9.** Quantum integrable models and the off-diagonal Bethe ansatz method

Xin Zhang (The University of Melbourne)

14:30 Tue 12 December 2017 – W5A 202
Dr Xin Zhang

The quantum integrable models, which are defined by Yang–Baxter equation, play important roles in a variety of fields. First, we briefly introduce integrability, Yang–Baxter equation, reflection equation, quantum integrable models and several typical methods. With the periodic $XXX$ spin-$\frac{1}{2}$ chain and $XXZ$ spin torus as examples, we show the basic ingredients of the off-diagonal Bethe ansatz method.

**14.10.** Unified correlation function behaviours on high-dimensional tori

Zongzheng Zhou (Monash University)

11:30 Thu 14 December 2017 – W5A 202
Dr Zongzheng Zhou

Above the upper critical dimensions, Ising model, self-avoiding walk (SAW), and simple random walk (SRW) are believed to be in the same universality class. However, for finite-size behaviours on the torus, these models behave differently. For Ising and SAW, asymptotically the correlation function is a power law for short distance and then approaches a plateau for large distance. However, for SRW on any dimensional tori, its Green's function is infinity. In this talk, we will consider a revised random walk whose walk length is a random variable. On the torus, we prove that Green's function of such a random walk has the same behaviour of the correlation functions for Ising and SAW.

# 15. Number Theory

**15.1.** $p$-adic Littlewood conjecture: what can potential counter-examples look like?

Dzmitry Badziahin (The University of Sydney)

16:00 Tue 12 December 2017 – W5C 211
Assoc Prof Dzmitry Badziahin

In 2004 de Mathan and Teulie proposed the problem, called $p$-adic Littlewood conjecture, which was supposed to be a 'simpler' version of the classical Littlewood conjecture. It states as follows: for any prime $p$ and any $x \in \mathbb{R}$, one always has

$$\liminf_{q\to\infty} q \times |q|_p \times ||qx|| = 0.$$

Here $||qx||$ means the distance from $qx$ to the nearest integer.

I will describe what is known about the set of the (potential) counterexamples $x$ to the $p$-adic Littlewood conjecture, how small it is and which classes of numbers $x$ are definitely not in it.

**15.2.** Families of $p$-adic automorphic forms on unitary groups

Jessica Fintzen (Institute for Advanced Study)

15:30 Thu 14 December 2017 – W5C 211
Dr Jessica Fintzen

We will start with an introduction to $p$-adic automorphic forms and then discuss a variant of the $q$-expansion principle (called the Serre–Tate expansion principle) for $p$-adic automorphic forms on unitary groups of arbitrary signature. We outline how this can be used to produce $p$-adic families of automorphic forms on unitary groups, which has applications in construction of $p$-adic $L$-functions. This is done via an explicit description of the action of certain differential operators on the Serre–Tate expansion.

The talk is based on joint work with Ana Caraiani, Ellen Eischen, Elena Mantovan and Ila Varma.

**15.3.** Octonions in random matrix theory

Peter Forrester (The University of Melbourne)

14:30 Wed 13 December 2017 – W5C 211
Prof Peter Forrester

The octonions are one of the four normed division algebras, together with the real, complex and quaternion number systems. The latter three hold a primary place in random matrix theory, where in applications to quantum physics they are determined as the entries of ensembles of Hermitian random matrices by symmetry considerations. Only for $N = 2$ is there an existing analytic theory of Hermitian random matrices with octonion entries. We use a Jordan algebra viewpoint to provide an analytic theory for $N = 3$. We then proceed to consider the matrix structure $X^\dagger X$, when $X$ has random octonion entries. Analytic results are obtained from $N = 2$, but are observed to break down in the $3 \times 3$ case.

**15.4.** The Hausdorff measure version of Gallagher's theorem — closing the gap and beyond

Mumtaz Hussain (La Trobe University)

14:30 Tue 12 December 2017 – W5C 211
Dr Mumtaz Hussain

I will present my recent results in the theory of multiplicative Diophantine approximation. In particular, an upper bound on the 'size' of the set of multiplicatively $\psi$-approximable points in $\mathbb{R}^d$ for $d > 1$ in terms of $f$-dimensional Hausdorff measure. This upper bound exactly complements the known lower bound, providing a 'zero-full' law which relates the Hausdorff measure to the convergence/divergence of a certain series in both the homogeneous and inhomogeneous settings. This 'zero-full law' resolves a question posed by Beresnevich and Velani (2015) regarding the 'log factor' discrepancy in the convergent/divergent sum conditions of their theorem. We further prove the analogous result for the multiplicative doubly metric setup.

This is a joint work with David Simmons (York).

**15.5.** An explicit bound for the divisor function

Jeffrey Lay (Australian National University)

15:00 Tue 12 December 2017 – W5C 211
Mr Jeffrey Lay

Landreau proved in 1988 a class of inequalities for the divisor function. We discuss how these can be made explicit and how they may be applied to produce sieving estimates for Gaussian sequences.

**15.6.** Visible points on exponential curves

Simon Macourt (University of New South Wales)

11:30 Thu 14 December 2017 – W5C 211
Mr Simon Macourt

We provide an introduction to the problem of finding the number of visible points on a given curve. We then provide new bounds on the number of visible points on exponential curves modulo a prime for all choices of primes. We also provide one new bound on the number of visible points on exponential curves modulo a prime for almost all primes.

talks continued on next page

**15.7.** Chebotarev's density theorem over finite fields

Stephen Meagher (University of New South Wales)

16:30 Wed 13 December 2017 – W5C 211
Dr Stephen Meagher

Chebotarev's density theorem is well known over number fields. A general version also works for quotient maps between varieties over finite fields and was first proven by Serge Lang in the fifties. We explain the result and give a new proof using twists.

**15.8.** On the irregular primes with respect to Euler polynomials

Min Sha (Macquarie University)

16:00 Thu 14 December 2017 – W5C 211
Dr Min Sha

An odd prime $p$ is called irregular with respect to Euler polynomials if it divides the numerator of one of the numbers $E_1(0), E_3(0), \ldots, E_{p-2}(0)$, where $E_n(x)$ is the $n$-th Euler polynomial. As in the classical case, we link the regularity of primes to the divisibility of some class numbers. Besides, we prove that more than half of primes are irregular with respect to Euler polynomials.

This is joint work with Su Hu and Min-Soo Kim.

**15.9.** Primes and squares — in less than two pages!

Timothy Trudgian (UNSW Canberra)

16:00 Wed 13 December 2017 – W5C 211
Dr Timothy Trudgian

There are more sums of squares than primes. If your favourite problem in primes is too hard, why not make life easy and consider the similar problem with sums of squares? Ah, but life is not always so easy! I shall outline a proof from 1965, which is less than two pages long, and which uses nothing more than first-year calculus. Yet it *still* gives the best known result on an old problem.

**15.10.** Distribution of $\alpha n + \beta$ modulo 1 over some arithmetic set

Kam Hung Yau (University of New South Wales)

15:00 Wed 13 December 2017 – W5C 211
Mr Kam Hung Yau

For any sufficiently small real number $\varepsilon > 0$, we obtain an asymptotic formula for the number of solutions to

$$\|\alpha n + \beta\| < x^{-\varepsilon}$$

where $n \le x$ is square-free with prime factors in $[y, z] \subseteq [1, x]$ for infinitely many real number $x$.

**15.11.** Computing $p$-adic regulators

Yinan Zhang (Australian National University)

12:00 Thu 14 December 2017 – W5C 211
Dr Yinan Zhang

I will give an update on joint work with Tommy Hofmann (TU Kaiserslautern) to calculate valuations of $p$-adic regulators of totally real abelian fields of degree 5 and 7, including challenges faced and interim results.

**15.12.** Mean-value results of Hecke $L$-functions with fixed-order characters

Liangyi Zhao (University of New South Wales)

16:30 Tue 12 December 2017 – W5C 211
Dr Liangyi Zhao

We will present some mean-value results for families of Hecke $L$-functions associated with characters of fixed orders. These include first moment and non-vanishing results for Hecke $L$-functions associated with quadratic and quartic characters, as well as formulas for the distribution of low-lying zeros of the same families of $L$-functions.

These results are joint work with P. Gao.

# 16. Partial Differential Equations

**16.1.** Non-classical symmetry solution of nonlinear reaction–diffusion: soil–water with plant roots

Philip Broadbridge (La Trobe University)

15:00 Tue 12 December 2017 – C5A 229
Prof Philip Broadbridge

For nonlinear reaction–diffusion equations in $n$ spatial dimensions, there is a single restriction relating nonlinear diffusivity to nonlinear reaction, that always allows non-classical symmetry reduction to a linear PDE. This allows us to construct a class of unsteady solutions for water flow in unsaturated soil, with logistic plant-root extraction terms.

**16.2.** Fluid structure system with boundary conditions involving the pressure

Jean-Jerome Casanova (Monash University)

16:30 Tue 12 December 2017 – C5A 229
Mr Jean-Jerome Casanova

We study a coupled fluid-structure system involving boundary conditions on the pressure. The fluid is described by the incompressible Navier–Stokes equations in a 2D rectangular-type domain where the upper part of the domain is described by a damped Euler–Bernoulli beam equation. Existence and uniqueness of local strong solutions without assumptions of smallness on the initial data is proved.

**16.3.** Global dynamics of generalized logistic equations

Daniel Daners (The University of Sydney)

14:00 Tue 12 December 2017 – C5A 229
Daniel Daners, Julián López-Gómez

We consider a parameter dependent parabolic population model with diffusion and degenerate logistic term allowing for refuges for the population. The aim is to remove quite restrictive geometric and smoothness conditions on the refuge commonly used in the existing literature. The key is a simplified construction of a supersolution that does not make use of any structure of the refuge.

**16.4.** Generalized Strichartz estimates for Schrödinger equation

Zihua Guo (Monash University)

16:00 Tue 12 December 2017 – C5A 225
Mr Zihua Guo

In this talk I will talk about the Strichartz estimates for the Schrödinger type equations.

**16.5.** A strong maximum principle on cones

Daniel Hauer (The University of Sydney)

16:30 Wed 13 December 2017 – C5A 229
Dr Daniel Hauer

In this talk, I present a new strong maximum principle of harmonic functions on cones with a Lipschitz continuous boundary and state some interesting applications to the regularity of such functions on polyhedral domains.

**16.6.** Geometric asymptotics

Nalini Joshi (The University of Sydney)

15:00 Fri 15 December 2017 – C5A 229
Prof Nalini Joshi

I will report on results obtained with Duistermaat, Howes and Radnovic for the completeness and connectedness of asymptotic behaviours of solutions of the first, second and fourth Painlevé equations in the limit $x \to \infty$, $x \in \mathbb{C}$. We prove that the complex limit set of solutions is non-empty, compact and invariant under the flow of the limiting autonomous Hamiltonian system, that the infinity set of the vector field is a repellor for the dynamics and obtain new proofs for solutions near the equilibrium points of the autonomous flow. The results rely on a realization of Okamoto's space; i.e., the space of initial values compactified and regularized by embedding in $\mathbb{P}^2$ through an explicit construction of nine blow-ups.

**16.7.** A class of optimal transportation problems on the sphere

Qirui Li (Australian National University)

16:00 Wed 13 December 2017 – C5A 229
Dr Qirui Li

Optimal transportation problems have attracted much attention in last decade. The cost function is always assumed to be bounded. In this talk, we will consider a class of optimal transportation problems on the sphere with unbounded cost functions. We will also discuss their applications in geometric optics and in convex geometry.

**16.8.** Bergman–Toeplitz operators on weakly pseudoconvex domains

Jiakun Liu (University of Wollongong)

14:00 Fri 15 December 2017 – C5A 229
Dr Jiakun Liu

In this talk, we prove that for a large class of pseudoconvex domains of finite type, the Bergman–Toeplitz operator $T_\psi$ with symbol $\psi$ maps from $L^p$ to $L^q$ continuously, provided $\psi$ is bounded by

$K^{1/q-1/p}$ on diagonal with $1 < p \le q < \infty$, where $K$ is the Bergman kernel.

This is a joint work with Tran-Vu Khanh and Phung Trong Thuc.

**16.9.** Variationality of PDEs

Geoffrey Prince (Australian Mathematical Sciences Institute)

16:00 Thu 14 December 2017 – C5A 229
Prof Geoffrey Prince

When can a system of PDEs be expressed in variational form? And what can we say about the uniqueness of such variational forms? I will import some concepts from the ODE case to frame the problem and make some conjectures.

This is joint work with Olga Rossi and Thoan Do.

**16.10.** Stability theory for semigroups using $(L^p, L^q)$ Fourier multipliers

Jan Rozendaal (Australian National University)

14:30 Fri 15 December 2017 – C5A 229
Dr Jan Rozendaal

In this talk I will discuss some recent advances in the stability theory for evolution equations. Motivated by applications to rates of energy decay for damped wave equations, in recent years there has been a surge of interest in polynomial decay for $C_0$-semigroups. One would like to determine in a quantitative manner how spectral properties of a semigroup generator correspond to decay rates of the associated semigroup. We will relate this problem to operator-valued Fourier multiplier theory and determine the optimal correspondence in the Hilbert space setting.

This talk is based on joint work with M. Veraar (Delft University of Technology), and D. Seifert (Oxford University) and R. Stahn (TU Dresden).

**16.11.** The Sylvester equation and the elliptic Korteweg–de Vries system

Yingying Sun (The University of Sydney)

14:30 Tue 12 December 2017 – C5A 229
Dr Yingying Sun

In this talk, I will introduce the Sylvester equation and the elliptic potential Korteweg–de Vries system which is a multi-component extension of the potential Korteweg–de Vries equation. We obtain solutions to the Sylvester equation first and apply the results to construct solutions to the elliptic potential Korteweg–de Vries system via generalised Cauchy matrix method. The construction involves solving the matrix elliptic curve equation by using Toeplitz matrix techniques, and analysing the solution of the Sylvester equation in terms of Jordan normal forms. Furthermore, we analyse the dynamics of the soliton solutions, which reveals some new features of the elliptic system in comparison to the non-elliptic case.

**16.12.** Volume preserving flow by powers of $k$-th mean curvature

Yong Wei (Australian National University)

15:30 Thu 14 December 2017 – C5A 229
Dr Yong Wei

We consider the flow of closed convex hypersurfaces in Euclidean space with the speed given by any positive power of the $k$-th mean curvature plus a global term chosen to impose a constraint involving the enclosed volume and the mixed volume of the evolving hypersurface. We prove that if the initial hypersurface is strictly convex, then the solution of the flow exists for all time and converges smoothly to a round sphere as the time goes to infinity. No curvature pinching assumption is required on the initial hypersurface.

This is joint work with Ben Andrews.

**16.13.** Recent progress on classical solutions for compressible isentropic Navier–Stokes equations with degenerate viscosities and vacuum

Shengguo Zhu (Monash University)

16:00 Tue 12 December 2017 – C5A 229
Dr Shengguo Zhu

In this talk, I will present our recent progress on the well-posedness of classical solutions for multi-dimensional compressible isentropic Navier–Stokes equations with density dependent viscosities in a power law and vacuum, which is a long-standing open problem due to the very high degeneracy caused by the vacuum for this system. Some related open problems of high mathematical interest for this system will also be mentioned.

**17.1.** Bursty Markovian arrival processes

Azam Asanjarani (AMSI/University of Melbourne)

16:30 Wed 13 December 2017 – W5C 232
Dr Azam Asanjarani, Dr Yoni Nazarathy

We call a Markovian arrival process (MAP) *bursty* if both the squared coefficient of variation of inter-event times and the asymptotic index of dispersion of counts are greater than unity. The simplest bursty MAP is a Hyper-exponential renewal process (H-renewal process). Here, applying Matrix analytic methods (MAM), we establish further classes of MAPs as bursty MAPs: the Markov modulated Poisson process (MMPP), the Markov Transition counting process (MTCP) and the Markov switched Poisson process (MSPP). Of these, MMPP has been used most often in applications, but as we illustrate, MTCP and MSPP may serve as alternative models of bursty traffic.

**17.2.** Sampling via regenerative chain Monte Carlo

Zdravko Botev (University of New South Wales)

16:00 Tue 12 December 2017 – W5C 232
Dr Zdravko Botev

Markov chain Monte Carlo (MCMC) is a well-known method for approximate simulation from probability densities. The method relies on constructing a convergent Markov chain — a discrete-time process belonging to the more general family of regenerative processes. In this talk we introduce an alternative sampling method that relies purely on a convergent regenerative chain, which is not necessarily Markovian. We call this new method regenerative chain Monte Carlo (RCMC). Using the total variation discrepancy, we analyze the convergence of MCMC and RCMC samplers of length $t$. We find that, while traditional MCMC samplers converge at an exponentially fast rate, the RCMC sampler converges at the polynomial rate of $O(1/t^2)$. We argue that, despite this slower theoretical rate, the RCMC sampler is a viable alternative to MCMC.

**17.3.** Stochastic integration in quasi-Banach spaces

Petru A. Cioica-Licht (University of Otago)

15:00 Tue 12 December 2017 – W5C 232
Mr Petru A. Cioica-Licht

The goal of this talk is to motivate the development of a stochastic integral in quasi-Banach spaces and to sketch how it can be done. The main difficulty comes from the fact that, other than Banach spaces, quasi-Banach spaces are not locally convex. If time permits, I will also present an application of this theory to the analysis of the regularity of stochastic partial differential equations.

This is joint work with Mark C. Veraar (TU Delft) and Sonja G. Cox (University of Amsterdam)

**17.4.** The branching-ruin number and the critical parameter of once-reinforced random walk on trees

Andrea Collevecchio (Monash University)

15:30 Thu 14 December 2017 – W5C 232
Dr Andrea Collevecchio

The motivation for this paper is the study of the phase transition for recurrence/transience of a class of self-interacting random walks on trees, which includes the once-reinforced random walk. For this purpose, we define a quantity, that we call the branching-ruin number of a tree, which provides (in the spirit of Furstenberg, 1970, and Lyons, 1990) a natural way to measure trees with polynomial growth. We prove that the branching-ruin number of a tree is equal to the critical parameter for the recurrence/transience of the once-reinforced random walk. We define a sharp and effective (i.e. computable) criterion characterizing the recurrence/transience of a larger class of self-interacting walks on trees, providing the complete picture for their phase transition.

**17.5.** Duality and convergence for binomial markets with friction

Yan Dolinsky (Monash University)

15:00 Fri 15 December 2017 – W5C 232
Assoc Prof Yan Dolinsky

We prove limit theorems for the super-replication cost of European options in a Binomial model with friction. The dual representation for the super-replication cost in these models are obtained and used to prove the limit theorems. In particular, the existence of the liquidity premium for the continuous-time limit is proved.

**17.6.** Measure-valued population processes and their asymptotics

Jie Yen Fan (Monash University)

11:30 Thu 14 December 2017 – W5C 232
Ms Jie Yen Fan

Population process in a general setting, where each individual reproduces and dies depending on its age and type as well as the composition of the entire population, offers a more realistic framework to population modelling. Formulating the population process as a measure-valued stochastic process allows us to incorporate such dependence. We consider a family of such age-

and type-structure dependent population processes indexed by some parameter $K$, which may represent the carrying capacity, and give the asymptotic behaviour as $K$ increases; namely, the law of large numbers and the central limit theorem.

This is joint work with Kais Hamza, Peter Jagers and Fima Klebaner.

**17.7.** Spatial decomposition for Brownian motion and SLE curves

Laurence Field (Australian National University)

16:00 Thu 14 December 2017 – W5C 232
Dr Laurence Field

Decomposition of a stochastic process in spatial terms is a way of representing the process in terms of its derived measures conditioned to pass through specific points, which have natural weights and can usually be understood in terms of a Girsanov change of measure.

We begin with some simple examples of such decompositions in the case of Brownian motion before exhibiting results that can be obtained for the Schramm–Loewner evolution (SLE), the paradigmatic conformally invariant non-crossing random curve in two dimensions. We also indicate the application of these methods to the construction of loop measures.

**17.8.** General bootstrap random walks

Kais Hamza (Monash University)

15:00 Wed 13 December 2017 – W5C 232
Assoc Prof Kais Hamza

Given the increments of a simple symmetric random walk $(X_n)_n$, we exhibit the most general way of recycling these increments into a simple symmetric random walk, $(Y_n)_n$, adapted to the filtration of $(X_n)_n$. We study the long term behavior of a suitably normalized two-dimensional process $(X_n, Y_n)$. In particular, we provide sufficient conditions for this process to converge to a two-dimensional Brownian motion (possibly degenerate). We also discuss cases in which the limit is not Brownian.

Joint work with Andrea Collevecchio, Meng Shi and Ruth Williams.

**17.9.** The long-term behaviour of an occupancy process

Liam S. Hodgkinson (University of Queensland)

16:30 Tue 12 December 2017 – W5C 232
Mr Liam S. Hodgkinson

Treating a complex network as a large collection of interacting entities has become a standard modelling paradigm to account for the effects of heterogeneity in real-world systems. Unfortunately, the increased precision realised by this approach often comes at the expense of tractability, particularly when estimating and predicting the long-term behaviour of the system. In this talk, I shall consider this problem for a broad category of discrete time Markovian 'occupancy processes', where each of $n$ entities possess one of two states: 'occupied' and 'unoccupied'. By appealing to deterministic and normal approximations of the process, I will present a limit theorem which, under certain assumptions, establishes that an occupancy process tends towards an approximate Gaussian random field equilibrium in $O(\log n)$ time.

**17.10.** Random initial conditions in differential equations

Fima Klebaner (Monash University)

14:00 Tue 12 December 2017 – W5C 232
Prof Fima Klebaner

We give a result for approximation of non linear stochastic processes as solutions of non linear differential equations with random initial conditions. Solutions of ordinary differential equations as limits of stochastic processes with a small noise on finite time intervals is a classical result of Kurtz (1970). We show that when intervals increase to infinity then a similar approximation holds, however the initial condition of the resulting differential equations is random $H(W)$. The randomness comes from an almost sure limit $W$ of an approximating linear stochastic process, and enters a deterministic function $H(x)$, obtained from the deterministic flow. In some cases the function $H$ can be given explicitly. This result has applications in biology, such as PCR and Evolution models.

**17.11.** Invariance principle for biased bootstrap random walks

Yunxuan Liu (Monash University)

14:30 Wed 13 December 2017 – W5C 232
Mr Yunxuan Liu

Our main goal is to study a class of processes whose increments are generated via cellular automata rule. Given the increments of a simple biased random walk, a new sequence of (dependent) Bernoulli random variables is produced. It is built, from the original sequence, according to cellular automata rule. Equipped with these two sequences, we construct two more according to the same cellular automata rule. The construction is repeated a fixed number of times yielding an infinite array $(\{-K,\dots,K\}\times\mathbb{N})$ of (dependent) Bernoulli random variables. Taking partial sums of these sequences, we obtain a $(2K+1)$

-dimensional process whose increments belong to the state space $\{-1,1\}^{2K+1}$.

The aim of the paper is to study the long-term behavior of this process. In particular, we establish transience/recurrence properties and prove an invariance principle. The limiting behavior of these processes depends strongly on the direction of the iteration and exhibits few surprising features.

**17.12.** On a class of bivariate phase-type distributions and its applications in risk theory

Oscar Peralta (Technical University of Denmark)

12:00 Thu 14 December 2017 – W5C 232

Mr Oscar Peralta, Dr Bo Friis Nielsen, Dr Mogens Bladt

A multivariate phase-type (MPH*) distributed vector can be characterised in terms of joint rewards from a single underlying Markov jump process which in turn generates a phase-type distribution. In this talk we exhibit a bivariate phase-type distribution in MPH* which admits any given phase-type marginals and any given (feasible) correlation between its entries; its construction is based on elementary ideas regarding order statistics. Applications of such a class of distributions in risk modelling are discussed.

**17.13.** Convergence to extremal processes for Lévy processes with slowly varying canonical measure

Tanja Schindler (Australian National University)

14:00 Fri 15 December 2017 – W5C 232

Ross Maller, Tanja Schindler

A classical result by Feller states that a random walk with regularly varying tails with exponent $\alpha \in (0,2)$ lies in the domain of attraction of an $\alpha$-stable law. Kasahara extended this result to the case $\alpha = 0$ in the following way. On the one hand, taking an $\alpha$ stable sum process to the power of $\alpha$ and letting $\alpha$ tend to zero, this process converges to the reciprocal of an exponential random variable. On the other hand, considering the normed sum process for a random variable with slowly varying tails, this process converges to the reciprocal of an exponential random variable as well.

We transfer the results of Kasahara to continuous time processes for a small time parameter. Furthermore, we generalise these results to trimmed versions of Lévy processes; i.e., we remove a fixed number of largest jumps from the original process.

This is work in progress with Ross Maller.

**17.14.** Bootstrap random walk

Meng Shi (Monash University)

14:00 Wed 13 December 2017 – W5C 232

Miss Meng Shi

Consider a one-dimensional simple random walk $X$. We form a new simple symmetric random walk $Y$ by taking sums of products of the increments of $X$ and study the two-dimensional walk $(X,Y)$. We show that it is recurrent and when suitably normalized converges to a two-dimensional Brownian motion with independent components; this independence occurs despite the functional dependence between the pre-limit processes. The process of recycling increments in this way is repeated and a multi-dimensional analog of this limit theorem together with a transience result are obtained.

**17.15.** Exploiting asymptotic structure for efficient rare-event estimation for sums of random variables

Thomas Taimre (University of Queensland)

16:00 Wed 13 December 2017 – W5C 232

Dr Thomas Taimre, Patrick Laub

We consider the problem of estimating the right-tail probability of a sum of random variables when the density of the sum is not known explicitly, but whose asymptotic behaviour is known. We embed this asymptotic structure into a simple importance sampling estimator, in which we consider the radial and angular components of the distribution separately. The estimator and procedure are applicable in both the heavy- and light-tailed settings, as well as for dependent and independent summands. We illustrate the approach with a series of examples.

**17.16.** Green's function of a random length random walk on the torus

Zongzheng Zhou (Monash University)

14:30 Fri 15 December 2017 – W5C 232

Dr Zongzheng Zhou

It was generally believed that above upper critical dimensions, the thermodynamic behaviour of the correlation functions of Ising model and self-avoiding walk (SAW) behave the same as the Green's function of the simple random walk (SRW). However, this connection naturally broke on the torus. For Ising and SAW on the high-dimensional torus, asymptotically the correlation function is a power-law for the short distance and reaches a plateau for the large distance. However, Green's function for SRW on the torus is infinity since it is recurrent on any dimensions. In this talk, we will repair this broken connection by considering a random-length random walk.

# 18. Representation Theory

**18.1.** Auslander–Dlab–Ringel algebras and Ringel duality

Kevin Coulembier (The University of Sydney)

14:00 Tue 12 December 2017 – W5A 205
Dr Kevin Coulembier

I will introduce a new class of quasi-hereditary algebras, containing in particular the Auslander–Dlab–Ringel (ADR) algebras. We show that this new class of algebras is preserved under Ringel duality, which determines in particular explicitly the Ringel dual of any ADR algebra. As a special case of this theory, it follows that under very restrictive conditions an ADR algebra is Ringel dual to another one, which provides an alternative proof for a recent result of Conde and Erdmann.

**18.2.** On the Moy–Prasad filtration and super-cuspidal representations

Jessica Fintzen (Institute for Advanced Study)

15:00 Tue 12 December 2017 – W5A 205
Dr Jessica Fintzen

The Moy–Prasad filtrations of $p$-adic groups play an important role in the representation theory of $p$-adic groups. We will introduce the Moy–Prasad filtration and its quotients and indicate how they form representations over the residue field. We will then present new descriptions of these Moy–Prasad filtration representations that are in some sense independent of the residue-field characteristic. As an application, we will explain how these results lead to new super-cuspidal representations.

**18.3.** On the classification of toroidal circle planes

Duy Ho (University of Canterbury)

16:00 Wed 13 December 2017 – W5A 205
Dr Duy Ho

We consider the problem of classifying toroidal circle planes with respect to the dimension of their automorphism groups. With tools from topology, we prove that these groups are Lie groups of dimension at most 6. From the results on flat Minkowski planes by Schenkel, we classify planes whose automorphism group has dimension at least 4.

In the case of dimension 3, we propose a framework for the full classification based on all possible geometric invariants of the automorphism group. When the group fixes exactly one point, we characterise two cases completely with a new family of planes called (modified) strongly hyperbolic planes and the family constructed by Artzy and Groh. Using these results, we determine the automorphism group of the planes constructed by Polster.

**18.4.** Blattner's conjecture as an index theorem

Peter Hochs (The University of Adelaide)

16:00 Tue 12 December 2017 – W5A 205
Dr Peter Hochs

Let $G$ be a semisimple Lie group with discrete series, and $K < G$ a maximal compact subgroup. Blattner's conjecture, as proved by Hecht and Schmid, is a combinatorial formula for the multiplicities of the irreducible representations of $K$ in the restriction to $K$ of a discrete series representation of $G$. In work with Yanli Song, we show that these multiplicities and the expressions for them given by Blattner's conjecture, are both indices of elliptic differential operators. By showing that these two indices are equal, we find a new proof of Blattner's conjecture.

**18.5.** Examples of mesopelagic Langlands correspondence

Masoud Kamgarpour (University of Queensland)

15:30 Thu 14 December 2017 – W5A 205
Dr Masoud Kamgarpour

The aim of the geometric Langlands program is to associate to every connection on a curve a 'Hecke eigensheaf' on the moduli of bundles. There has been a lot of progress in the case of regular and logarithmic connections. However, the case of irregular connections is less explored. I will explain that the Beilinson–Drinfeld machinery for producing Hecke eigensheaves goes through for certain irregular connections on the projective line. Our approach uses crucially Xinwen Zhu's generalisations of BD's machinery to the wild case.

**18.6.** Linear braids

Anthony Licata (Australian National University)

16:00 Thu 14 December 2017 – W5A 205
Assoc Prof Anthony Licata

The Artin groups associated to Coxeter groups have a distinguished collection of elements, which we refer to as linear braids. The linear braids are closely related to elements in the associated Coxeter group, and they have some interesting algebraic combinatorics and homological algebra associated to them. In the talk, we'll introduce these elements and state some conjectures concerning them.

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**18.7.** Gerstenhaber structure of a class of special biserial algebras

Bregje Pauwels (Australian National University)

14:30 Tue 12 December 2017 – W5A 205
Mx Bregje Pauwels

I will talk about a recent computation of the Gerstenhaber structure on the Hochschild cohomology ring of a certain class of finite dimensional algebras. The algebras we consider are self-injective special biserial algebras given by quiver and relations over a field. In particular, we show that the Lie algebra of degree 1 elements embeds into a direct sum of Virasoro algebras, and provide a decomposition of the degree-$n$ cohomology as a module over the degree-1 cohomology.

This is joint work with Joanna Meinel, Van Nguyen, Maria Julia Redondo and Andrea Solotar.

**18.8.** Langlands duality for real groups

Kari Vilonen (The University of Melbourne)

15:00 Wed 13 December 2017 – W5A 205
Prof Kari Vilonen

I will explain Langlands duality for real groups.

This is joint work with Roman Bezrukavnikov.

**18.9.** The representation theory of symplectic singularities

Ben Webster (University of Waterloo)

14:00 Wed 13 December 2017 – W5A 205
Ben Webster

There are a lot of non-commutative algebras out there in the world, so if you want to study some of them, you have to have a theory about which are especially important. One class I find particularly interesting are non-commutative algebras which are 'almost' commutative and thus can be studied with algebraic geometry, giving a rough dictionary between certain non-commutative algebras and certain interesting spaces. This leads us to a new perspective on some well-known algebras, like universal enveloping algebras, and also to new ones we hadn't previously considered.

**18.10.** Two-block Springer fibers and Springer representations in type D

Arik Wilbert (University of Bonn/MPI Bonn)

11:30 Thu 14 December 2017 – W5A 205
Dr Arik Wilbert

We explain how to construct an explicit topological model for every two-block Springer fiber of type $D$. These so-called topological Springer fibers are homeomorphic to their corresponding algebro-geometric Springer fiber. They are defined combinatorially using cup diagrams which appear in the context of finding closed formulas for parabolic Kazhdan–Lusztig polynomials of type $D$ with respect to a maximal parabolic of type $A$. As an application it is discussed how the topological Springer fibers can be used to reconstruct the famous Springer representation in an elementary and combinatorial way.

**18.11.** Stabilisers of eigenvectors in complex reflection groups

Sinead Wilson (The University of Queensland)

12:00 Thu 14 December 2017 – W5A 205
Ms Sinead Wilson

Complex reflection groups are finite subgroups of unitary groups which are generated by complex reflections. They are a generalisation of real reflection groups. The invariant theory of irreducible real reflection groups is encoded in the eigenvalues of certain elements, called Coxeter elements, and conversely, Kostant showed (in the case of Weyl groups) that Coxeter elements are characterised by a certain property of their eigenvalues. Kostant's result was refined by Kamgarpour, who gives a more precise relation between the eigenvalues of any element and the stabilisers of the corresponding eigenvectors. In this talk, we discuss a generalisation of Kamgarpour's result to complex reflection groups.

**18.12.** Chevalley groups and finite geometry

Jon Xu (The University of Melbourne)

16:30 Wed 13 December 2017 – W5A 205
Mr Jon Xu

In this talk, I will describe a relationship between incidence structures and ovoids (from finite geometry), and Chevalley groups and flag varieties (from representation theory). The motivation for establishing this relationship is the work of Tits and Steinberg on the Suzuki–Tits ovoid. Through this relationship, the classical ovoid in the Hermitian surface is precisely related to certain points of a flag variety of a twisted Chevalley group. The rational normal curve in the projective plane, the elliptic quadric in projective space, and the Suzuki–Tits ovoid also have similar interpretations. In each of these examples we explicitly determine which points of the ovoid lie in each Schubert cell of a corresponding flag variety.

This is joint work with Arun Ram and John Bamberg.

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**18.13.** Towards a construction of higher dimensional loop Grassmannians

Yaping Yang (The University of Melbourne)

16:30 Tue 12 December 2017 – W5A 205
Ivan Mirkovic, Yaping Yang, Gufang Zhao

I will talk about a construction of higher dimensional loop Grassmannians, in the framework of local spaces over Hilbert scheme of points. The notion of local spaces is a refined version of the factorization space of Beilinson–Drinfeld. This construction has many applications, examples including loop Grassmannians associated to Kac–Moody groups, geometric Langlands duality in higher dimensions. In dimension 1, this construction yields the recent reconstruction by Ivan Mirkovic of the usual loop Grassmannians from semi-infinite orbits. During my talk, I will mainly focus on the construction applied to dimension 2. I will briefly mention difficulties in dimension 3.

This talk is based on my joint work with Ivan Mirkovic and Gufang Zhao.

**18.14.** The second fundamental theorem of invariant theory for the orthosymplectic supergroup

Yang Zhang (The University of Sydney)

17:00 Wed 13 December 2017 – W5A 205
Yang Zhang

In this talk, we will introduce a natural symmetric group action on the morphism spaces of Brauer category. Hence as a particular morphism space, the Brauer algebra encodes the $\mathbb{C}\mathrm{Sym}$-module structure. Using the representation theory of symmetric group, we obtain a diagrammatic description for the kernel of the surjective algebra homomorphism $F_r : B_r(m-2n) \to \mathrm{End}_{\mathrm{OSp}(V)}(V^{\otimes r})$ from the Brauer algebra $B_r(m-2n)$ onto the endomorphism algebra $\mathrm{End}_{\mathrm{OSp}(V)}(V^{\otimes r})$ over the orthosymplectic supergroup $\mathrm{OSp}(V)$ with $V = \mathbb{C}^{m|2n}$. This amounts to the second fundamental theorem of invariant theory for $\mathrm{OSp}(V)$.

# 19. Stochastic Models and Applications

**19.1.** Comparing multivariate spectral densities

Andrew Grant (Macquarie University)

16:30 Wed 13 December 2017 – W5A 203
Mx Andrew Grant

In this talk we present a test for determining whether two or more independent multivariate time series are from stochastic processes with the same spectral density, or the same spectral shape. Existing methods are nonparametric and are based on comparing smoothed periodograms of the time series. The parametric test we introduce is based on fitting long-order vector autoregressions and comparing the model parameters using a likelihood ratio procedure. The theoretical properties of the estimation procedures will be discussed and the behaviour of the test statistic demonstrated through simulation studies.

**19.2.** Multiple change-point detection in an AR(1) Process: comparison of different methods

Lijing Ma (Macquarie University)

17:00 Wed 13 December 2017 – W5A 203
Miss Lijing Ma, Dr Georgy Sofronov

The multiple change-point detection problem in time series analysis, which may also be called a segmentation or break-point problem, can be found in many different applications. As data are collected over time, the statistical properties such as the mean or the variance are more likely to change along with data and it becomes very important to identify the unknown number and locations of change-points in a time series process. Many change-point detection methods rely on the independent assumption, which could lead to inaccurate estimation of change-points, so there is a clear need to develop segmentation methods for dependent time series. In this talk, we consider the cross-entropy algorithm with minimum description length information criterion to deal with this problem. We compare a number of best performing computational methods with our proposed method for estimating unknown parameters of autoregressive data with several structural breaks. We provide extensive numerical experiments including artificially generated data and real time series example to illustrate the usefulness of our method.

**19.3.** Modelling multivariate financial time series with variance gamma innovations

Thanakorn Nitithumbundit (The University of Sydney)

16:00 Wed 13 December 2017 – W5A 203
Mr Thanakorn Nitithumbundit

Modelling multivariate financial time series returns data is challenging since it exhibits properties such as high kurtosis and slight skewness which cannot be captured using the normal distribution. On the other hand, the variance gamma (VG) distribution can capture these properties in a parsimonious way. In this talk, we propose the vector autoregressive moving average model with VG innovations to also capture the persistence from the autocorrelations and cross-correlations while also briefly explaining the unbounded likelihood problem related to the parameter estimation involving the VG distribution. The model is then applied to multiple cryptocurrency returns.

**19.4.** Binary segmentation methods for spatial clustering

Nishanthi Raveendran (Macquarie University)

17:30 Wed 13 December 2017 – W5A 203
Nishanthi Raveendran, Georgy Sofronov

In this talk we present a method for spatial clustering, which is one of important problems in spatial data analysis. The aim is to identifying the boundaries of domains and their number. The problem arises in various applications including disease surveillance, spatial epidemiology, population genetics, landscape ecology and crime analysis. In this study we focus on identifying homogeneous domains in ecological datasets. We use binary data indicating the presence or absence of a certain plant species which are observed over a two-dimensional lattice. We develop new methods based on the binary segmentation algorithm which is a well-known multiple change-point detection method. We apply our algorithms to both artificial and real datasets to illustrate their usefulness. Our results show that the proposed methodologies are effective in identifying multiple domains in spatial data.

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**19.5.** More sensitive mixture detection using the empirical moment-generating function

Michael Stewart (The University of Sydney)

14:30 Wed 13 December 2017 – W5A 203
Dr Michael Stewart

The 'higher criticism' method of mixture detection, first proposed by Donoho and Jin (2004), has been adapted and developed in a wide range of applied settings including multiple testing and feature selection in classification problems. It has been shown to possess a rough 'optimality' property. We provide a higher-order power analysis and show that in fact in the normal location mixture problem higher criticism does not attain the 'best possible' power in an asymptotic sense, but a similar test that uses the empirical moment-generating function does. We give a very brief outline of the theory behind this result.

**19.6.** Homogeneous wavelet expansions of some fractional Gaussian fields

Justin Wishart (Macquarie University)

15:00 Wed 13 December 2017 – W5A 203
Dr Justin Wishart

Homogeneous, and ideally also non-homogeneous, wavelet expansions of finite dimensional fractional Brownian motion and fractional Brownian sheets are discussed. An example of multivariate signal processing will be considered in the presence of of fractional Brownian motion/sheets. Time permitting, some convergence rates and risk bounds will be discussed.

# 20. Topology

**20.1.** $E_3$-algebra structure on the Davydov–Yetter deformation complex

Michael Batanin (Macquarie University)

16:00 Wed 13 December 2017 – W5A 103
Assoc Prof Michael Batanin

We show that the Davydov–Yetter deformation complex of a tensor category has a natural $E_3$-algebra structure.

**20.2.** Representations of fibered 3-manifolds using flags

Alex Casella (The University of Sydney)

15:00 Wed 13 December 2017 – W5A 103
Mr Alex Casella

In 2007, Fock and Goncharov use ideal triangulations and flag structures to parametrise representations of the fundamental group of a punctured surface into $\mathrm{PGL}(m,\mathbf{C})$. When restricted to $\mathrm{PGL}(3,\mathbf{R})$, one recovers the holonomies of convex projective structures. In this talk, we recall the basics of this machinery and show a potential extension to fibered 3-manifolds. As a consequence, we recover a CR-structure on the figure-eight knot complement due to Falbel.

**20.3.** The topological period–index conjecture for almost complex 6-manifolds

Diarmuid Crowley (The University of Melbourne)

14:00 Tue 12 December 2017 – W5A 103
Diarmuid Crowley

The period–index conjecture for functions fields is a deep outstanding problem in algebraic geometry. Recently Antieau and Williams formulated a topological version of the period index conjecture and proved that counter examples to the topological period index conjecture could lead to counter examples to the (algebraic) period–index conjecture.

In this talk I report on joint work with Mark Grant where we investigate the topological period–index conjecture for almost complex 6-manifolds.

**20.4.** Contractibility of nerve of classifiers and application to the Turchin–Dwyer–Hess theorem (with Michael Batanin)

Florian Martin Laurent De Leger (Macquarie University)

16:30 Wed 13 December 2017 – W5A 103
Mr Florian Martin Laurent De Leger

A result of Dwyer–Hess and Turchin asserts that there is a weak equivalence of double loop space of homotopy mapping spaces from associativity operad $\mathscr{Ass}$ to any non-symmetric operad $\mathbf{O}$ with $\mathbf{O}(0) = \mathbf{O}(1) = 1$ and the homotopy mapping space of weak $\mathscr{Ass}$-bimodule maps from $\mathscr{Ass}$ to $\mathbf{O}$. We will explain how this result is equivalent to the contractibility of the nerves of certain categories defined by universal property. We will also give a brief sketch of the proof of this contractibility.

**20.5.** Geometric triangulations of knot complements

Sophie Ham (Monash University)

16:30 Tue 12 December 2017 – W5A 103
Miss Sophie Ham

To date, it remains an open conjecture that every knot complement has a geometric triangulation. This conjecture has been proved for a class of knots known as 2-bridge knots. However, it is not known for many additional classes of knots. We are interested in proving this conjecture for a large class of knots called highly-twisted knots. These knots are built from a class of links known as fully-augmented links.

In this talk, we discuss some of the properties of fully-augmented links. Since highly-twisted knots are obtained by Dehn filling fully-augmented links, we are also interested in triangulations of Dehn fillings. This has been studied in detail by Guerituad and Schleimer. We discuss their main result and describe a certain combinatorial triangulation of a solid torus. We then extend their result to the Borromean rings. We end with a discussion of possible extensions.

**20.6.** Contact manifolds with boundary

Joan Licata (Australian National University)

14:00 Wed 13 December 2017 – W5A 103
Dr Joan Licata

Contact geometry — the odd-dimensional analogue of symplectic geometry — equips $(2n+1)$-dimensional manifolds with additional geometric structure. When $n = 1$, this leads to geometric refinements of questions classically studied by low-dimensional topology. In this talk, I'll describe some of the challenges and successes of extending this story from closed manifolds to manifolds with boundary, highlighting existing results by a variety of researchers and also more recent work in progress with Mathews and with Vertesi.

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**20.7.** Knot invariants and cluster algebras

Daniel Mathews (Monash University)

16:00 Tue 12 December 2017 – W5A 103
Dr Daniel Mathews

Cluster algebras are a type of commutative ring appearing across mysteriously many different areas of mathematics, with numerous intriguing properties. Recently, cluster algebras have been noticed arising in certain knot invariants. We'll discuss some of these developments.

**20.8.** Classifying 8-dimensional E-manifolds

Csaba Nagy (The University of Melbourne)

15:00 Tue 12 December 2017 – W5A 103
Mr Csaba Nagy

A manifold $M$ is called an E-manifold if it has homology only in even dimensions; i.e., we have $H_{2k+1}(M;Z) = 0$ for all $k$. Examples include complex projective spaces and complete intersections. We consider some 8-dimensional simply-connected E-manifolds. Those that have Betti numbers $b_2 = r$ and $b_4 = 0$, and fixed second Stiefel–Whitney class $w_2 = w$ form a group $\Theta(r,w)$. This group acts on the set of E-manifolds with $b_2 = r$ and $w_2 = w$, and the set of orbits is classified by the classical cohomological invariants.

In this talk I will review the classification of the set of orbits and the calculation of $\Theta(r,w)$. I will also report on the $Q$-form conjecture, which allows us to study the orbits.

**20.9.** A new cohomology class in the moduli space of stable curves

Paul Norbury (The University of Melbourne)

16:00 Thu 14 December 2017 – W5A 103
Prof Paul Norbury

I will define a cohomology class in the moduli space of stable curves. It shares many beautiful properties analogous to properties of intersection numbers on the moduli space proven in the Witten–Kontsevich theorem. Applications of this new cohomology class to various enumerative problems will be given.

**20.10.** Metrics with prescribed curvature on generalised flag manifolds

Artem Pulemotov (The University of Queensland)

12:00 Thu 14 December 2017 – W5A 103
Dr Artem Pulemotov

We will discuss the problem of recovering a Riemannian metric from its Ricci curvature. Primarily, we will talk about the solvability of this problem on generalised flag manifolds, a type of homogeneous spaces that admit a convenient description in terms of Dynkin diagrams.

This is based on joint work with Mark Gould (The University of Queensland).

**20.11.** An action of the Grothendieck–Teichmüller group

Marcy Robertson (The University of Melbourne)

11:30 Thu 14 December 2017 – W5A 103
Dr Marcy Robertson

The Grothendieck–Teichmüller group is an explicitly defined group first introduced by Drinfeld which is closely related to (and conjecturally equal to) the absolute Galois group. The idea was based on Grothendieck's suggestion that one should study the absolute Galois group by relating it to its action on the Teichmüller tower of fundamental groupoids of the moduli stacks of genus $g$ curves with $n$ marked points.

In this talk, we give a re-imagining of the genus-zero Teichmüller tower in terms of a profinite completion of the framed little 2-discs operad. Using this reinterpretation, we show that the homotopy automorphisms of this model for the Teichmüller tower is isomorphic to the (profinite) Grothendieck–Teichmüller group. We then show a non-trivial action of the absolute Galois group on our tower. This talk will be aimed at a general audience and will not assume any previous knowledge of the Grothendieck–Teichmüller group or operads.

This is joint work with Pedro Boavida de Brito and Geoffroy Horel.

**20.12.** Higher Teichmüller theory on closed and finite-area surfaces using techniques of Fock and Goncharov

Dominic Tate (The University of Sydney)

14:30 Wed 13 December 2017 – W5A 103
Mr Dominic Tate

In 2007 Fock and Goncharov devised an elegant means of parameterising the space of framed convex projective structures on a non-compact surface $S$ of negative Euler characteristic. This is a generalization of the classical Teichmüller space which has been the subject of extensive study in the field of geometric topology and complex analysis and more recently, cluster algebras and dynamical systems.

I use the work of Fock and Goncharov to present a new proof of Marquis' (2011) result showing that the dimension of the subspace of convex projective structures on $S$, where $S$ has $n > 0$ ends and genus $g > 0$, is $16g - 16 + 6n$. To this end I explore elementary proofs of Marquis' results in determining conditions for a set to have finite area in Hilbert geometry and the relation between this geometry and the $\mathrm{SL}(3,\mathbb{R})$-character variety.

This is part of a joint project with Alex Casella and Stephan Tillmann.

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### **20.13.** Twisted Donaldson invariants

Hang Wang (The University of Adelaide)

15:30 Thu 14 December 2017 – W5A 103

Dr Hang Wang

Donaldson's polynomial invariants are topological invariants for compact closed four manifolds and have important applications in smooth structures for four manifolds. We introduce the notion of twisted Donaldson invariants by implementing fundamental groups in the construction of Donaldson's invariants, together with 'examples and applications' when the fundamental group is the group of integers.

This is joint work with T. Kato and H. Sasahira.

# 21. LaTeX and beyond

**21.1.** The *Register!* conference registration system

John Banks (The University of Melbourne)

12:00 Thu 14 December 2017 – W5C 221
Dr John Banks

*Register!* was originally created to handle registrations for a small meeting held at La Trobe University in 2006, and then upgraded for the 2007 AustMS Annual Meeting. It has gradually evolved since that time. It has so far been used for 39 mathematics meetings including all AustMS Annual Meetings since 2007, except for the 2008 meeting which was a joint meeting held in New Zealand. It allows conference participants to register and submit their abstracts in LaTeX. Abstracts are automatically typeset and become available for display on the conference web site along with conference participation, events participation, the conference timetable and so on. In addition to general registration administration, session management and conference timetabling, conference administrators use *Register!* to create the LaTeX code for the conference booklet. This represents a huge saving in the amount of work required to produce the conference booklet.

This talk is intended primarily for participants who have used the system or expect to use it in future. It will start with an overview of the history and functionality of *Register!*. It is envisaged that this will be sufficiently brief to allow plenty of time for questions, discussion and proposal of ideas for future development.

**21.2.** Automated assessment by means of computer algebra, LaTeX and PDF forms

Dmitry Demskoi (Charles Sturt University)

15:30 Thu 14 December 2017 – W5C 221
Dr Dmitry Demskoi

I will explain a method of creating mathematics assessments using a computer algebra system (e.g., Maple). The method requires some programming by the lecturer to generate individualised assessments that can also be automatically marked. I will explore the potential benefits of this method to both students and teaching staff.

**21.3.** Authoring 'Tagged PDF' documents with LaTeX

Ross Moore (Macquarie University)

11:30 Thu 14 December 2017 – W5C 221
Dr Ross Moore

'Tagged PDF' is at the basis of modern PDF standards, in particular those supporting 'Accessibility'. As yet there are no standard LaTeX packages for this, yet it is possible to create some documents that validate against the modern standards PDF/A (Archivability) and PDF/UA (Universal Accessibility). In this talk I will present such examples, using them to demonstrate some of the advantages that come with tagging both content and structure within a PDF document.

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