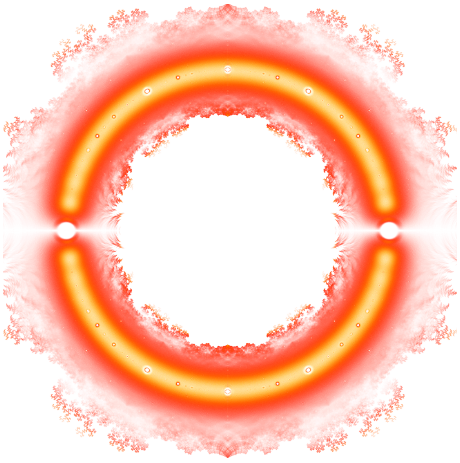

Sixth Annual Meeting of The Australian and New Zealand Association of Mathematical Physics

Takapuna, Auckland

30th January – 1st February 2018

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND
SCIENCE
DEPARTMENT OF MATHEMATICS

THE UNIVERSITY OF AUCKLAND
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Journal of Physics A
Mathematical and Theoretical

APCTP
Asia Pacific Center for Theoretical Physics

ANZIAM

NZMS

Dodd-Walls Centre
for Photonic and Quantum Technologies

Te Pūnaha Matatini
Data ▪ Knowledge ▪ Insight

Conference Overview

Time	Tuesday		Time	Wednesday		Time	Thursday	
8:15	Welcome							
8:30	Plenary 1		8:30	Plenary 3		8:30	Plenary 5	
9:30	Talk	Talk	9:30	Talk	Talk	9:30	Talk	Talk
9:55	Talk	Talk	9:55	Talk	Talk	9:55	Talk	Talk
10:20	Talk	Talk	10:20	Talk	Talk	10:20	Talk	Talk
10:45	Coffee		10:45	Coffee		10:45	Coffee	
11:15	Talk	Talk	11:15	Talk	Talk	11:15	Talk	Talk
11:40	Talk	Talk	11:40	Talk	Talk	11:40	Talk	Talk
12:05	Talk	Talk	12:05	Talk	Talk	12:05	Talk	Talk
12:30	Lunch		12:30	Lunch		12:30	Lunch	
14:00	Plenary 2		14:00	Plenary 4		14:00	Plenary 6	
15:00	Talk	Talk	15:00	Talk	Talk	15:00	Coffee	
15:25	Talk	Talk	15:25	Talk	Talk			
15:50	Coffee		15:50	Coffee				
16:15	Talk	Talk	16:15	Talk	Talk			
16:40	Talk	Talk	16:40	Talk	Talk			
17:05	AGM		17:05	Break				
			18:30	Dinner				

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Organisation

Sponsors

- The Department of Mathematics, University of Auckland
  `https://www.math.auckland.ac.nz/en.html`
- Australian and New Zealand Association of Mathematical Physics (ANZAMP)
  `http://www.anzamp.austms.org.au/`
- The Department of Physics, University of Auckland
  `https://www.physics.auckland.ac.nz/`
- The Dodd-Walls Centre for Photonic and Quantum Technologies
  `http://www.doddwalls.ac.nz/`
- Asia-Pacific Center for Theoretical Physics
  `https://www.apctp.org/`
- Te Pūnaha Matatini
  `http://www.tepunahamatatini.ac.nz/`
- Journal of Physics A: Mathematical and Theoretical
  `http://iopscience.org/jphysa`
- New Zealand Mathematical Society (NZMS)
  `https://nzmathsoc.org.nz/`
- Australia and New Zealand Industrial and Applied Mathematics (ANZIAM)
  `http://www.anziam.org.au/`

Local Organising Committee

- Anna Barry
- Joshua Capel
- Rod Gover (co-chair)
- Pedram Hekmati
- Andrew Keane
- Bernd Krauskopf (co-chair)

Program Committee

- Jörg Frauendiener (University of Otago)
- Rod Gover (University of Auckland)
- Mark Holmes (University of Melbourne)
- Phillip Isaac (University of Queensland)
- Nalini Joshi (University of Sydney)
- Bernd Krauskopf (University of Auckland)
- Jonathan Kress (University of New South Wales)
- Sergei Kuzenko (University of Western Australia)
- Thomas Quella (University of Melbourne)
- Milena Radnovic (University of Sydney)

Executive committee

- Chair: Tim Garoni (Monash University)
- Deputy Chair: Vladimir Mangazeev (Australian National University)
- Treasurer: Jon Links (University of Queensland)
- Secretary: David Ridout (University of Melbourne)

Keynote Speakers

- Vladimir Bazhanov (Australian National University)
- Maria Eugenia Gabach Clement (FaMAF-UNC, IFEG CONICET, Córdoba, Argentina)
- Natasa Pavlovic (University of Texas, USA)
- Tanja Schilling (University of Freiburg, Germany)
- Luc Vinet (Université de Montréal, Canada)
- Jingbo Wang (University of Western Australia)

Venue

The sixth annual meeting of the Australia and New Zealand Association of Mathematical Physics will be held at the Spencer on Byron, Takapuna, New Zealand. The welcome reception, all talks and the conference dinner are all at this venue.

A. J. Guttmann Prize

This prize ($500) is awarded for the most outstanding talk by an ANZAMP student member or recent graduate ANZAMP member (graduated 12 months prior to the meeting) presented at each ANZAMP meeting. The prize is named in honour of Professor Anthony J. Guttmann, who has been, and continues to be, a leading figure in the mathematical physics community in Australia. Among many distinctions, Tony Guttmann has a distinguished research record in statistical mechanics, was President of the Australian Mathematical Society and was one of the leading figures in the establishment of the Australian Mathematical Sciences Institute. Tony is renowned for the guidance and wisdom he offers to his colleagues and students, and he is a tireless advocate of programs for talented students in mathematical physics, and mathematics more generally.

Wifi access

Wifi internet access will be provided at the venue. The connection details are:

Username: `SoB Conference`
Password: `Tiritiri`

Places to eat

Morning and afternoon teas will be provided in the foyer of The Pavilion. Lunch and dinner are not provided as part of the registration.

There are a lot of options for lunch and dinner as the conference venue is located directly in the main shopping/eating area of Takapuna.

To give you an impression of the variety available, a selection of these can be found on:

`http://www.anzamp.austms.org.au/meetings/current/accommodation`

Notice board, meeting rooms, contact information

If you need to contact the local organisers and can't find one in person, please send an email to `anzamp.meeting@gmail.com`.

Updates to the program or important announcements will be posted on a notice board in the foyer of the venue.

Daily Timetables

Below are the are daily timetables for the 2018 ANZAMP meeting. Detail abstracts for the talks listed can be found at the end of the program.

Note that the plenaries will be held upstairs in the Tasman room.

Tuesday, Jan. 30, 2018 (Morning)

	Tasman	Kestral
8:15	Welcome	
8:30	Plenary: **Tanja Schilling** (p16) On the“generalized Generalized Langevin Equation” and its application to the crystallization process	
9:30	**Remy Adderton** (p19) The N-1 coupled Temperley-Lieb algebra structure of the N-state super-integrable chiral Potts chain	**Christopher Raymond** (p33) Generalised Galilean W-algebras
9:55	**Yibing Shen** (p35) Ground-state energy for the p + ip pairing Hamiltonian interacting with its environment	**Aiden Suter** (p37) W-algebra Representation Theory
10:20	**Chris Bradly** (p20) Critical exponents of the adsorption transition of lattice polymers in two and three dimensions	**William Stewart** (p36) On the twisted sector of Wess-Zumino-Witten models
10:45	Coffee	
11:15	**Thomas Quella** (p32) Symmetry protected topological phases and selection rules for topological phase transitions	**Arthur Suvorov** (p37) Isospectral neutron stars in general relativity
11:40	**Zimin Li** (p27) A tale of twin peaks: spectral statistics of the quantum Rabi model	**Woei Chet Lim** (p27) Explicit G_1 spike solutions in General Relativity
12:05	**Ellen Powell** (p32) Gaussian multiplicative chaos measures	**Sebastian Schuster** (p34) Blueprint formulae for electromagnetic analogue space-times
12:30	Lunch Break	

Tuesday, Feb. 1, 2018 (Afternoon)

	Tasman	Kestral
14:00	Plenary: **Jingbo Wang** (p17) Quantum Walk and Quantum Computation	
15:00	**Jens Grimm** (p24) Universal finite-size scaling above the upper critical dimension	**Tianshu Liu** (p28) Affine osp(1—2) and its coset construction
15:25	**Qian-Qian Shi** (p35) Dualities and Ground State Phase Diagrams for Quantum Spin-s XYZ Models	**Steve Siu** (p36) Quantum Hamiltonian Reduction for relaxed affine sl2 modules
15:50	Coffee	
16:15	**Sungha Yun** (p39) Free Surface Waves under a Pressure Distribution - Critical Surface Tension Case	**Luca Parisi** (p32) Evolutionary Algorithms for Margin Maximisation of Support Vector Machine
16:40	**Wee Chaimanowong** (p21) Seiberg-Witten Theory and Frobenius Manifolds	**Matt Majic** (p29) Spheroidal harmonics for point source interaction with a sphere
17:05	AGM	

Wednesday, Jan. 31, 2018 (Morning)

	Tasman	Kestral
8:15	Welcome	
8:30	Plenary: **Vladimir Bazhanov** (p15) Towards Canonical Quantization of Non-Linear Sigma-Models	
9:30	**Phillip Isaac** (p25) Number parity effects in a bosonic tunneling model	**Zeying Chen** (p21) Exact solution to 2 species TASEP
9:55	**Jessica Silva** (p35) Thermodynamics and Gravity	**Jeremy Nugent** (p31) Superintegrable systems in 4d
10:20	**Zongzheng Zhou** (p40) Unified correlation function behaviour on high-dimensional tori	**Joshua Capel** (p21) Equitable presentation for the Racah algebra $R(4)$ and orthogonal polynomials for $\mathfrak{su}(1,1)$
10:45	Coffee	
11:15	**Alexandr Garbali** (p23) Lattice integrable stochastic processes	**Andrew Keane** (p26) State-dependent delays in the El Niño Southern Oscillation system
11:40	**Mark Wilson** (p38) Analysing signed networks, Ising spin glass models, and fullerene graphs using the frustration index	**Narrendar RaviChandran** (p33) Bifurcation Analysis of a FitzHugh-Nagumo-based Tetrahedral Neuronal Network Modelled under External Electrical Stimulation
12:05	**Iwan Jensen** (p26) Partition function zeros of the Ising model	**Andrus Giraldo** (p24) Shilnikov-like Chaos in Two Nonlinear Coupled Photonic Nanocavities.
12:30	Lunch Break	

Wednesday, Jan. 31, 2018 (Afternoon)

	Tasman	**Kestral**
14:00	Plenary: **Luc Vinet** (p17) Fractional Revival in Spin Networks and Graphs	
15:00	**Murray Batchelor** (p19) Some correlations in the quantum Ising chain	**Ian Marquette** (p30) Algebraic derivation of spectrum of superintegrable models
15:25	**Kazuya Kawasetsu** (p26) The characters of relaxed highest-weight modules over affine Kac-Moody algebras	**Holger Dullin** (p22) Toric, Semi-toric, and beyond
15:50	Coffee	
16:15	**Jon Links** (p28) Quantum phase diagram for a model of an ultracold gas of atoms and molecules.	**David Ridout** (p34) $sl(3)$ weight modules and higher-rank logarithmic CFT
16:40	**Nicholas Witte** (p39) The Density Matrix for the Ground State of 1-d Impenetrable Bosons in a Harmonic Trap	**Susumu Osawa** (p31) Mass Renormalization in the Nelson Model
17:05	(break)	
18:30	Dinner (Spencer on Byron)	

Thursday, Jan. 31, 2018

	Tasman	Kestral
8:15	Welcome	
8:30	Plenary: **Natasa Pavlovic** (p16) From quantum many particle systems to nonlinear dispersive PDE, and back	
9:30	**Nicholas Beaton** (p19) Partition function zeros of adsorbing walk models	**Paul Zinn-Justin** (p41) Schubert puzzles and quantum integrability
9:55	**Anthony Guttmann** (p25) Eulerian orientations	**Angela Foerster** (p23) Multi-well quantum tunneling models
10:20	**Nathan Clisby** (p22) Monte Carlo studies of dense polymers	**Xin Zhang** (p40) Retrieve the Bethe states of quantum integrable models solved via the off-diagonal Bethe Ansatz
10:45	Coffee	
11:15	**Mark Holmes** (p25) Limiting behaviour of discrete-measure-valued processes	**Andrew Waldron** (p38) Contact Geometry and Quantum Mechanics
11:40	**Vladimir Mangazeev** (p29) Stochastic zero range processes related to $U_q(A_n^{(1)})$	**Paul Norbury** (p31) A new cohomology class on the moduli space of stable curves
12:05	**Huan-Qiang Zhou** (p40) Fidelity Mechanics: Analogues of the Four Thermodynamic Laws and Landauer's Principle	**Makoto Narita** (p30) On Global properties of Gowdy spacetimes in the Brans-Dicke theory
12:30	Lunch Break	

Abstracts

Invited Talks

Vladimir Bazhanov

Wednesday
08:30
Tasman

Towards Canonical Quantization of Non-Linear Sigma-Models

In this talk we revisit the problem of canonical quantization of two-dimensional non-linear sigma models (NLSM) in two dimensions. We unravel the integrable structure of the O(3) NLSM and its one-parameter deformation — the sausage model, by resolving the long-standing "non-ultralocality" problem. Our consideration is based on the continuous version of the the Quantum Inverse Scattering Method enhanced by a powerful ODE/IQFT correspondence, which connects stationary states of Integrable QFT models with special solutions of classical integrable equations. This approach leads to new efficient methods for computation of vacuum eigenvalues of the continuous analogs of quantum transfer-matrices for the O(3)/sausage NLSM.

Maria Eugenia Gabach Clement

Unknown Day
HH:MM

Geometrical inequalities for black holes and ordinary objects.

In this talk we review some of the relations that General Relativity sets among physical parameters of black holes and ordinary objects. These geometrical inequalities show, for instance, that a black hole of given mass can not rotate too fast, or that an ordinary object of given size can not have too much electric charge. We present the well known results in this area and the basic questions that are still unanswered.

Thursday
08:30
Tasman

Natasa Pavlovic

From quantum many particle systems to nonlinear dispersive PDE, and back

Analysis of large systems of interacting particles is a key for predicting and understanding various phenomena arising in different contexts, from physics (in understanding e.g. boson stars) to social studies (when modeling social networks). Since the number of particles is usually very large one would like to understand qualitative and quantitative properties of such systems of particles through some macroscopic, averaged characteristics. In order to identify macroscopic behavior of multi-particle systems, it is helpful to study the asymptotic behavior when the number of particles approaches infinity, with the hope that the limit will approximate properties observed in the systems with a large finite number of particles. An example of an important phenomenon that describes such macroscopic behavior of a large system of particles is the Bose-Einstein condensation (BEC), which is a state of the matter of a dilute Bose gas at very low temperatures when the gas moves as a single particle. Although the BEC was predicted in early days of quantum mechanics by Bose and Einstein, the first experimental realization came in 1995. Mathematical models have been developed to understand such phenomena. Those models connect large quantum systems of interacting particles and nonlinear PDE that are derived from such systems in the limit of the number of particles going to infinity. In this talk we will focus on developments that connect a quantum many particle system of bosons and the nonlinear Schrodinger equation.

Tuesday
08:30
Tasman

Tanja Schilling

On the“generalized Generalized Langevin Equation” and its application to the crystallization process

As a researcher in statistical physics, one may often be interested in reducing the complexity of a many-particle system to the study of a set of relevant observables (for instance, the system could be a undercooled melt and the aim could be to develop a model for the transition to the crystalline phase). If the system is in equilibrium, a systematic way to derive an equation of motion for the “relevant” observables from the microscopic dynamics has been known for some time as the “Mori-Zwanzig” formalism, which leads to the Langevin equation. In contrast, if the dynamics is not stationary, it is not a priori clear which form the equation of motion for an averaged observable will have. We adapt Mori-Zwanzig formalism to derive the equation of motion for a non-equilibrium trajectory-averaged observable as well as for its non-stationary auto-correlation function. We also derive a fluctuation-dissipation-like relation which relates the memory kernel and the autocorrelation function of the fluctuating force. In addition, we show how to relate the Taylor expansion of the memory kernel to experimental data, thus allowing to construct the equation of motion from direct measurements. We finally apply the method to the crystallization process.

Luc Vinet

Wednesday
14:00
Tasman

Fractional Revival in Spin Networks and Graphs

Fractional revival occurs when a wave packet is reproduced periodically at various locations under its time evolution. Engineering this phenemenon can be used to generate entanglement. For instance, if the dynamics of a spin chain can be arranged so that a state initially at one end is revived in a balanced way at both ends, a maximally entangled state is obtained. The situation where there is only one revival site corresponds to state transfer, another important task.

We shall discuss how spin chains can be designed so that fractional revival occurs. A model with next-to-nearest interactions will be presented in this connection. Coherent transport and fractional revival on graphs other than paths will also be discussed. In particular, the relations between quantum walks on graphs of the ordinary and generalized Hamming schemes and certain analytic spin chains will be stressed. The important role played by orthogonal polynomials in the analyses will also be underscored.

Jingbo Wang

Tuesday
14:00
Tasman

Quantum Walk and Quantum Computation

Quantum walk has shown much potential as a general framework for developing novel quantum computation algorithms. The efficiency of these algorithms depends on interference between the multiple paths that are simultaneously traversed by a quantum walker. It also hinges on local interactions and intrinsic quantum correlations such as entanglement, if multiple quantum walkers are involved. As such, quantum walk has become a subject of intense theoretical and experimental studies. An increasingly pressing challenge is to demonstrate quantum supremacy of quantum-walk-based algorithms over classical computation; this requires an efficient decomposition of the quantum walk operators in order to implement the prescribed algorithm on a quantum computer. In this talk, I will discuss the design principles of efficient quantum circuit for quantum walks on a wide range of undirected and directed Graphs, aiming to provide some intuition on how such decomposition is derived.

Contributed Talks

Remy Adderton

Tuesday
09:30
Tasman

The N-1 coupled Temperley-Lieb algebra structure of the N-state super-integrable chiral Potts chain

Australian National University

The N-state super-integrable chiral Potts chain is a remarkable generalisation of the more widely studied quantum Ising chain in a transverse field. In this talk I will show that this N-state model has an algebraic structure given by $N-1$ coupled Temperley-Lieb algebras. This is analogous to the well known relation between the quantum Potts chain and the Temperley-Lieb algebra. Both periodic and open boundary conditions are considered. I will also discuss some representations of the coupled Temperley-Lieb algebra in the one- and two-boundary cases.

Murray Batchelor

Wednesday
15:00
Tasman

Some correlations in the quantum Ising chain

Centre for Modern Physics, Chongqing University and ANU

The quantum Ising chain in a transverse field is arguably one of the most well known exactly solved models. Among the several reasons for this is because the model is solved in terms of free fermions via the Jordan-Wigner transformation. I will describe some calculations for spin correlations in this model with open boundary conditions, and discuss how these results compare with those obtained previously for the more usual periodic boundary conditions. It will become evident that these calculations form the starting point for something more general.

Nicholas Beaton

Thursday
09:30
Tasman

Partition function zeros of adsorbing walk models

University of Melbourne

The zeros of the size-n partition functions for a statistical mechanical model can be used to help understand the critical behaviour of the model as $n \to \infty$. I will discuss recent work on the partition function zeros of adsorbing walk models, including Monte Carlo results of Janse van Rensburg for self-avoiding walks in two and three dimensions, and exact results by the two of us for adsorbing Dyck paths.

Tuesday
10:20
Tasman

Chris Bradly

Critical exponents of the adsorption transition of lattice polymers in two and three dimensions

University of Melbourne

Adsorption of polymers to a surface is a well-studied problem with applications to adhesion, surface coating, chromatography and wetting. For polymers grafted to an attractive surface there is a phase transition between a high-termperature desorbed phase, where the polymer is extended in the d-dimensional bulk, and a low-temperature adsorbed phase, where the polymer is restricted to the $(d-1)$-dimensional surface. The critical behaviour of the transition between these phases is governed by several exponents including the crossover exponent ϕ and shift exponent $1/\delta$. In particular, it is believed that ϕ may be a superuniversal exponent, having the exact value 1/2 in all dimensions. However, recent numerical evidence for the three-dimensional case challenges this notion, suggesting that $\phi \neq 1/2$ and also that $\phi \neq 1/\delta$, in contrast to the two-dimensional case. Unfortunately, the many results of numerical studies appear to be inconsistent with each other and thus the value of these exponents is still an open question.

We present new numerical results for simulations of lattice polymers in the presence of an impermeable adsorbing surface. We use the flatPERM algorithm - an athermal, flat histogram, chain-growth method - to simulate polymers modelled as self-avoiding walks and trails on a bounded lattice. To avoid bias from different lattice models we look at self-avoiding walks on the hex, square and cubic lattices and self-avoiding trails on the square and cubic lattices, in all cases up to length 1024.

For each of these lattice models we use finite-size scaling analysis to explore several different ways of estimating the critical temperature and hence the critical exponents. The resulting spread in values for ϕ and $1/\delta$ around the expected value of 1/2 indicates that there is a significant systematic error in finite-size simulations of lattice polymers at the adsorption transition. This far exceeds the statistical error usually reported. We conclude that in three dimensions the numerical evidence does not preclude the possibility that $\phi = 1/\delta = 1/2$.

Joshua Capel

Wednesday
10:20
Kestral

Equitable presentation for the Racah algebra $R(4)$ and orthogonal polynomials for $\mathfrak{su}(1,1)$

University of New South Wales

This talk will briefly discuss how the Racah polynomials naturally arise as the interbasis expansion coefficients between different positive discrete representations of the Racah algebra $R(3)$, and how this generalises to the Racah algebra $R(4)$. This gives rise to the bivariate Racah polynomials discover by Tratnik [1991] which are diagonalised by a three-term and nine-term operator, but it also gives rise to some newer bivariate Racah polynomials diagonalised by a 9-term and 6-term operator (Joint work with Sarah Post).

Wee Chaimanowong

Tuesday
16:40
Tasman

Seiberg-Witten Theory and Frobenius Manifolds

The University of Melbourne

In 2004, Dubrovin proposed a connection between Seiberg-Witten theory and Frobenius manifolds. More precisely, a certain Frobenius manifold was constructed such that its odd period coordinates are related to A and B-periods on a Seiberg-Witten curve. However, it is not well-understood why such a connection exists. In this talk, I will explore how one might arrive at a Frobenius manifold naturally from Seiberg-Witten theory and how we might generalize this result.

Zeying Chen

Wednesday
09:30
Kestral

Exact solution to 2 species TASEP

University of Melbourne

The exact solution to the single species totally asymmetric simple exclusion process (TASEP) has been discovered in 1997, known as the Schützs formula. In this talk, we would like to give the solution to the two species TASEP, by using the Bethe ansatz. We will derive the Green's function to the two species TASEP, and some asymptotic observable obtained by using this Green's function.

Thursday
10:20
Tasman

Nathan Clisby

Monte Carlo studies of dense polymers

Swinburne University of Technology

I will describe how to efficiently implement connectivity changing moves which allow for rapid Monte Carlo sampling of dense polymer configurations, such as Hamiltonian paths. I will then give an overview of some important features of dense polymers, such as the occurrence of long-range correlations within the chains and the effect of entanglement on dynamics, and explain how efficient Monte Carlo algorithms will help us to understand them.

Wednesday
15:25
Kestral

Holger Dullin

Toric, Semi-toric, and beyond

Holger Dullin School of Mathematics and Statistics University of Sydney

Toric integrable systems with their momentum maps whose images are rational polytopes are well understood. More recently San Vu Ngoc and Alvaro Pelayo classified semi-toric system in two degrees of freedom with additional singularities of focus-focus type. I will briefly review both toric and semi-toric systems. Then I will show that semi-toric systems can always be deformed such that the global circle action remains intact, but the focus-focus point is replaced by an elliptic-elliptic point and possibly additional singularities, some of which are hyperbolic (joint work with Alvaro Pelayo [1]). This deformation is inspired by the Hamiltonian Hopf bifurcation, well known in dynamical systems. This mechanism can be used to deform toric systems into semi-toric systems, and also to deform semi-toric systems into hyperbolic semi-toric systems. I will discuss some examples of such deformations (joint work with Joachim Worthington [2]) and the behaviour of the joint spectrum of the corresponding integrable quantum systems.

[1] Holger R. Dullin and Alvaro Pelayo. Generating hyperbolic singularities in semi-toric systems via Hopf bifurcations. Journal of Nonlinear Science, 26(3), pp 787-811, 2016.

[2] Holger R. Dullin and Joachim Worthington. The polygonal invariant of a deformed spin-oscillator with hyperbolic singularities. (in preparation)

Angela Foerster

Thursday
09:55
Kestral

Multi-well quantum tunneling models

Instituto de Fisica Universidade Federal do Rio Grande do Sul Brazil

In this work we present a general construction of integrable models for boson tunneling in multi-well systems [1], with a particular emphasis in the three and four well cases. Algebraic aspects of this construction are discussed. As an application we show how to engineer an atomtronic switching device by breaking the integrability of the triple well system [2]. This is done by acting with an external field in one of the wells. By increasing its value allows for tuning the system from the switched-on configuration through to switched-off, with a precise level of control.

[1] Quantum integrable multi-well tunneling models, L. Ymai, A. Tonel, A. Foerster, J .Links, J. Phys. A50 (2017) 264001

[2] Control of tunneling in a triple-well system: an atomtronic switching device K. Wilsmann, L. Ymai, A. Tonel, J. Links and A. Foerster, arXiv:1710.05831

Alexandr Garbali

Wednesday
11:15
Tasman

Lattice integrable stochastic processes

University of Melbourne

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.

Wednesday
12:05
Kestral

Andrus Giraldo

Shilnikov-like Chaos in Two Nonlinear Coupled Photonic Nanocavities.

The University of Auckland

Recent experiments have shown that two coupled photonic crystal (PhC) nanocavities exhibit spontaneous symmetry breaking and bistable behaviour. In particular, bistability has been extensively studied in the last decades due to its usefulness for optical memories and logical switching. Theoretically, bistability and symmetry breaking have been observed in the Bose–Hubbard model, which describes the dynamics of the two coupled PhC nanocavities.

We consider an extension of the Bose–Hubbard model for the slowly varying amplitudes A and B of the electric fields in each nanocavity. It is given as a set of two complex ordinary differential equations determined by a photon lifetime τ, linear couplings between the cavities κ and γ, a detuning from the cavity resonance δ, and a coherent driving term f. Previous work on this model has centered in delimiting regions in the (κ, f)-parameter plane where symmetric and asymmetric continuous-wave solutions exist.

Our work focusses on the overall dynamics of this extended Bose–Hubbard and, in particular, the existence and disappearance of self-pulsations. As more energy is pumped into the system, represented by an increase of the coherent driving term f, self-pulsations arise from Hopf bifurcations, which then disappear in sequences of homoclinic bifurcations. In particular, we find chaotic Shilnikov bifurcations and the appearance of chaotic attractors. They imply complicated dynamics taking place in the individual cavities, or both of them simultaneously. We present the overal changes of this system, from simple to chaotic dynamics, as a function of the coherent driving term and the detunning from the cavity resonance. More specifically, we present the bifurcation diagram in the (f, δ)-plane as the other parameter values are fixed at experimental values. Our global bifurcation analysis of the two coupled photonic crystal nanocavities predicts types of (chaotic) dynamics well within the range of future experiments.

Tuesday
15:00
Tasman

Jens Grimm

Universal finite-size scaling above the upper critical dimension

Monash University

Finite-size scaling (FSS) is a fundamental physical theory within statistical mechanics, describing the asymptotic approach to the thermodynamic limit of finite systems in the neighbourhood of a critical phase transition. It is well-known that models of critical phenomena typically possess an upper critical dimension, d_c, such that in dimensions $d \geq d_c$, their thermodynamic behaviour is governed by critical exponents taking simple mean-field values. In contrast to the simplicity of the thermodynamic behaviour, the theory of FSS in dimensions above d_c is surprisingly subtle, and remains the subject of ongoing debate. In this talk, we will clarify recent claims regarding the correct FSS behaviour on hypercubic lattices with free and periodic boundaries, and provide a consistent scaling picture for both boundary conditions. Our findings are supported by Markov-chain Monte Carlo simulations of the Ising model and self-avoiding walk on five-dimensional hypercubic lattices.

Anthony Guttmann

Thursday
09:55
Tasman

Eulerian orientations

The University of Melbourne

Eulerian orientations are a class of maps with structure. 4-valent Eulerian orientations are a particular case of the 6-vertex model when all vertices are equally weighted. We discuss the solution of this problem, as well as the more general case when orientations are counted by edges.

Mark Holmes

Thursday
11:15
Tasman

Limiting behaviour of discrete-measure-valued processes

U. Melbourne

We'll give a survey of ongoing and previous work of various authors describing the limiting behaviour of the voter model, critical lattice trees, and other statistical mechanics models in high dimensions.

Phillip Isaac

Wednesday
09:30
Tasman

Number parity effects in a bosonic tunneling model

The University of Queensland

We present a bosonic tunneling model and analyse it along a critical line in parameter space. In this special case, the energy spectrum is computed analytically, and several key features are discussed which on the particle number being odd or even.

Wednesday
12:05
Tasman

Iwan Jensen

Partition function zeros of the Ising model

Flinders University

We present selected results from our recent studies of the partition function zeros of the Ising model on several lattices, with various boundary conditions, with and without a magnetic field and bond/site disorder. Apart from lots of pretty pictures we will also present some precise quantitative results.

Wednesday
15:25
Tasman

Kazuya Kawasetsu

The characters of relaxed highest-weight modules over affine Kac-Moody algebras

The University of Melbourne

The relaxed highest-weight modules over affine Kac-Moody algebras play an important role in the Creutzig-Ridout Verlinde formula for admissible affine vertex algebras. In this talk, we compute the characters of the irreducible relaxed highest-weight modules over the affine Kac-Moody algebra $\hat{sl}_2$ induced from the dense irreducible modules over sl_2, using Mathieu's coherent families. We show that the characters are "coherent", that is, they are the product of a q-series and a formal delta function in z. If time allows, we will also consider the characters of relaxed highest-weight modules over $o\hat{s}p(1|2)$ and $\hat{sl}_3$.

Wednesday
11:15
Kestral

Andrew Keane

State-dependent delays in the El Niño Southern Oscillation system

University of Auckland

Delay differential equations (DDEs) have been used successfully in the past to model climate systems at a conceptual level. An important aspect of these models is the existence of feedback loops that feature a delay time, usually associated with the time required to transport energy through the atmosphere and/or oceans across the globe. So far, the values of the delays are generally assumed to be constant. Recent studies have demonstrated that even simple DDEs with nonconstant delay times, which change depending on the state of the system, can produce surprisingly rich dynamical behaviour. Here, we identify physical arguments for the existence of such state-dependent delays in a DDE model for the El Niõ Southern Oscillation climate system. We then conduct a bifurcation analysis by means of continuation software to investigate the effects of state-dependent delays on the dynamics of the system.

Zimin Li

Tuesday
11:40
Tasman

A tale of twin peaks: spectral statistics of the quantum Rabi model

Australian National University

The quantum Rabi model describes the interaction between light and matter, more specifically, between a two-level atom (qubit) and a single bosonic mode of a quantised light field. A key parameter in the model is the strength of the coupling between the qubit and the light field. The quantum Rabi model is of newfound interest as a number of experiments and quantum simulations have begun to probe the physics of the previously elusive ultrastrong and deep strong coupling regimes where the much simpler Jaynes-Cummings model no longer applies. Recent studies have revealed that the energy spectrum of this model is made up of three distinct regimes: (i) the perturbative ultrastrong coupling regime which comprises the Jaynes-Cummings model, (ii) a region where non-perturbative ultrastrong and non-perturbative deep strong coupling regimes coexist, and (iii) the perturbative deep strong coupling regime. In this talk I will discuss progress on calculating the spectral statistics of the energy level spacings in this model and how the spectral statistics relates to this classification of three distinct regimes. I will also discuss results for the probability distribution of an analogous mathematical model. Our results give a more or less complete understanding of the spectral properties of the quantum Rabi model.

Woei Chet Lim

Tuesday
11:40
Kestral

Explicit G_1 spike solutions in General Relativity

University of Waikato

We present a family of new explicit solutions of Einstein's field equations with stiff fluid. They admit one spacelike Killing vector field, and are generated by applying Stephani's transformation (i.e. stiff fluid version of Geroch's transformation) on Bianchi type V spatially homogeneous solutions. The most interesting phenomenon exhibited is the intersecting spikes near the initial singularity.

Wednesday
16:15
Tasman

Jon Links

Quantum phase diagram for a model of an ultracold gas of atoms and molecules.

School of Mathematics and Physics The University of Queensland Australia

I will give a description of the quantum phase diagram for a model describing the interconversion of bosonic atoms and homonuclear diatomic molecules. The analysis will include semiclassical approximations, results from direct numerical diagonalisation, and exact formulae obtained from Bethe Ansatz techniques.

Tuesday
15:00
Kestral

Tianshu Liu

Affine osp(1—2) and its coset construction

The University of Melbourne

Conformal field theory is an essential tool of modern mathematical physics with applications to string theory and to the critical behaviour of statistical lattice models. The symmetries of a conformal field theory include all angle-preserving transformations. In two dimensions, these transformations generate the Virasoro algebra, a powerful symmetry that allows one to calculate observable quantities analytically. The construction of one family of conformal field theories from the affine Kac-Moody algebra sl(2) were proposed by Kent in 1986 as a means of generalising the coset construction to non-unitary Virasoro minimal models, these are known as the Wess-Zumino-Witten models at admissible levels. This talk aims to illustrate, with the example of the affine Kac-Moody superalgebra osp(1—2) at admissible levels, how the representation theory of a vertex operator superalgebra can be studied through a coset construction. The method allows us to determine key aspects of the theory, including its module characters, modular transformations and fusion rules.

Matt Majic

Tuesday
16:40
Kestral

Spheroidal harmonics for point source interaction with a sphere

Victoria University of Wellington

We propose a powerful approach to solve Laplace's equation for point sources near a spherical object. The central new idea is to use prolate spheroidal solid harmonics, which are separable solutions of Laplace's equation in spheroidal coordinates, instead of the more natural spherical solid harmonics. Using electrostatics as an example, we motivate this choice and show that the resulting series expansions converge much faster. This improvement is discussed in terms of the singularity of the solution and its analytic continuation. The benefits of this approach are further illustrated for a specific example: the calculation of modified decay rates of light emitters close to nanostructures in the quasistatic approximation. We expect the general approach to be applicable with similar benefits to the solution of Laplace's equation for other geometries and to other equations of mathematical physics.

We will also discuss the extension to the internal potential involving radially inverted offset prolate spheroidal harmonics.

PHYSICAL REVIEW E 95, 033307 (2017), arXiv:1711.09551 (internal solution)

Vladimir Mangazeev

Thursday
11:40
Tasman

Stochastic zero range processes related to $U_q(A_n^{(1)})$

The Australian National University

We show that the quantum R matrix for symmetric tensor representation of the $U_q(A_n^{(1)})$ algebra satisfies the sum rule required for its stochastic interpretation. It gives rise to an integrable zero range process of n classes of particles in one dimension. For n=2 we investigate how finitely many first class particles fixed as defects influence the grand canonical ensemble of the second class particles. By using the matrix product stationary probabilities involving infinite products of q-bosons, exact formulas are derived for the local density and current of the second class particles in the large volume limit.

Wednesday
15:00
Kestral

Ian Marquette

Algebraic derivation of spectrum of superintegrable models

The University of Queensland, School of Mathematics and Physics

Quadratic and more generally finitely generated polynomial algebras appear to be naturally related with integrals of quantum superintegrable models. These models have many properties that make them interesting from mathematics and physics perspective. In particular they are connected with various special special function and orthogonal polynomials. In recent years, it has been shown that two dimensional models are related to the full Askey scheme of orthogonal polynomials, exceptional orthogonal polynomials, Painleve transcendents. I will review some recent results on higher dimensional superintegrable systems and their symmetry algebras that take the form of higher rank polynomial algebras with an embedded structure. I will also discuss how the spectrum can be derived.

Thursday
12:05
Kestral

Makoto Narita

On Global properties of Gowdy spacetimes in the Brans-Dicke theory

National Institute of Technology, Okinawa College

Recent results show that standard singularity theorem that holds when an energy condition is applied in general relativity also holds when that energy condition is applied to the Bakry-Emery-Ricci tensor which naturally arises in the scalar-tensor theory of gravity. The theory is one of the generalized theories of gravitation and is a low energy effective superstring theory. Thus it is important to investigate global behavior of solutions to the gravitational field equations in the theory. We study the global properties of the Gowdy spacetime generated by Cauchy data on T^3 in the Brans-Dicke theory which is one of the scalar-tensor theory of gravity. We show that the past boundaries of the maximal Cauchy developments of Gowdy initial data sets are asymptotically velocity-terms dominated singularities. The Kretschmann scalar blows up on the boundary. Thus the maximal Cauchy development cannot extend beyond the boundary and our result shows that the validity of the strong cosmic censorship conjecture.

Paul Norbury

Thursday
11:40
Kestral

A new cohomology class on the moduli space of stable curves

University of Melbourne

We define a collection of cohomology classes on the moduli space of curves. We prove that a generating function for the intersection numbers involving these new cohomology classes is a tau function of the KdV hierarchy. This is analogous to the theorem conjectured by Witten and proven by Kontsevich that a generating function for intersection numbers on the moduli space of curves is a tau function of the KdV hierarchy.

Jeremy Nugent

Wednesday
09:55
Kestral

Superintegrable systems in 4d

UNSW

In this talk we investigate pp wave metrics and their superintegrability properties.

Susumu Osawa

Wednesday
16:40
Kestral

Mass Renormalization in the Nelson Model

Kyushu University

The asymptotic behavior of the effective mass $m_{\text{eff}}(\Lambda)$ of the so-called Nelson model in quantum field theory is considered, where Λ is an ultraviolet cutoff parameter of the model. Let m be the bare mass of the model. It is shown that for sufficiently small coupling constant $|\alpha|$ of the model, $m_{\text{eff}}(\Lambda)/m$ can be expanded as $m_{\text{eff}}(\Lambda)/m = 1 + \sum_{n=1}^{\infty} a_n(\Lambda)\alpha^{2n}$. A physical folklore is that $a_n(\Lambda) = O([\log \Lambda]^{(n-1)})$ as $\Lambda \to \infty$. It is rigorously shown that $0 < \lim_{\Lambda\to\infty} a_1(\Lambda)$.

Tuesday
16:15
Kestral

Luca Parisi

Evolutionary Algorithms for Margin Maximisation of Support Vector Machine

Auckland Bioengineering Institute (ABI), University of Auckland

The capability of support vector machines to classify highly non-linear, multi-dimensional data heavily relies on the choice of kernel cost parameters. Appropriate kernel function parameters influence the determination of the decision boundary. Support vector machine uses hyperplanes as a decision boundary for data classification. Particularly, the selection of an optimal hyperplane determines the accuracy, sensitivity and specificity of such learning-based classification algorithms. Given that evolutionary algorithms can help minimise the cost function, we have formulated a mathematical approach that uses evolutionary algorithms to optimise kernel function parameter selection of support vector machines. This algorithmic implementation can lead to a considerable improvement in maximising the margin of the optimal hyperplane, accounting for higher true positive and true negative rates, thus maximising the classification accuracy.

Tuesday
12:05
Tasman

Ellen Powell

Gaussian multiplicative chaos measures

ETH Zurich

I will talk about recent progress in the construction of general Gaussian multiplicative chaos measures. In particular, I will discuss new universality results in the critical regime, and also some special constructions when the underlying Gaussian field is a multiple of the Gaussian free field.

Tuesday
11:15
Tasman

Thomas Quella

Symmetry protected topological phases and selection rules for topological phase transitions

The University of Melbourne School of Mathematics and Statistics

We show that phase transitions between different symmetry protected topological phases are constrained to obey certain selection rules. This is explained for Haldane phases of SU(N) spin chains which lead to selection rules for renormalization group flows between SU(N) WZW models.

Narrendar RaviChandran

Wednesday
11:40
Kestral

Bifurcation Analysis of a FitzHugh-Nagumo-based Tetrahedral Neuronal Network Modelled under External Electrical Stimulation

Department of Mechanical Engineering, University of Auckland

Recent advances in minimally invasive brain stimulation have allowed to treat nervous system disorders more effectively. In this study, we developed a mathematical model of a FitzHugh-Nagumo-based simplistic representation of a cortical neuronal network, modelled as a tetrahedron. Cortical fast spiking neurons are bi-stable resonators, undergoing Andronov-Hopf bifurcation. The effects of an external electrical stimulation were computationally modelled on such a neuronal network and studied via a bifurcation analysis. The activation dynamics of a single axon was represented by ordinary differential equations, as a codimension-1 bifurcation case. The external stimulation perturbed the neuronal network, inducing individual neurons to transit from their resting state to an excited one, causing action potential. Although bifurcation analysis has been conducted on single and two-neuron models extensively, the proposed mathematical model provides further understanding on the dynamic behaviour of multi-neuronal networks. Furthermore, such tetrahedral neuronal models can have direct scalability for improving physiological accuracy in representing cortical activity. Ultimately, this study shows potential of computational models for testing the effectiveness of deep brain stimulation.

Christopher Raymond

Tuesday
09:30
Kestral

Generalised Galilean W-algebras

The University of Queensland

We consider two dimensional conformal field theories from the perspective of their symmetry algebras. The Galilean contraction is a technique for constructively generating new algebraic structures from known symmetry algebras. We outline a generalisation of the contraction method which leads to new infinite families of CFTs, and discuss some properties of the resulting theories.

Wednesday
16:15
Kestral

David Ridout

$sl(3)$ weight modules and higher-rank logarithmic CFT

University of Melbourne

Rational conformal field theories (CFTs), such as the Wess-Zumino-Witten (WZW) models, are generally constructed from irreducible highest-weight modules. On the other hand, logarithmic CFTs are constructed from modules that are not all irreducible but also need not be highest-weight.

Non-highest-weight modules appear, in particular, for the logarithmic analogues of the WZW models, sometimes called the fractional level WZW models. Recently, we have obtained a fairly complete picture of the modules arising for fractional level $sl(2)$ models. In this talk, I will try to outline this picture and discuss current work that aims to extend this to the $sl(3)$ case.

Tuesday
12:05
Kestral

Sebastian Schuster

Blueprint formulae for electromagnetic analogue space-times

School of Mathematics and Statistics Victoria University of Wellington

Research on astrophysical and other general relativistic space-times is often stymied by the smallness of the most interesting effects. However, borrowing wave equations from other areas of physics, as long as it is possible to describe them in geometric terms, it is also possible to formulate analogue spacetimes – analogues of these astrophysical scenarios which may be easier to analyze. Laboratory experiments are now starting to get first results from experiments based on this analogue spacetime approach. Here we present an algorithm for generating such analogue spacetimes in the context of electromagnetic media. This allows us to demonstrate how (using on-demand bespoke permittivity, permeability and magneto-electric effects) to mimic any given space-time.

Yibing Shen

Tuesday
09:55
Tasman

Ground-state energy for the p + ip pairing Hamiltonian interacting with its environment

The University of Queensland

We first study the p + ip Hamiltonian isolated from its environment and consider the case of large particle number. A continuum limit approximation is applied to compute the ground-state energy. We discuss the evolution of the solution curve, and the limitations of this approach. We then consider an alternative approach which generalises to accommodate interaction with the environment.

Qian-Qian Shi

Tuesday
15:25
Tasman

Dualities and Ground State Phase Diagrams for Quantum Spin-s XYZ Models

Centre for Modern Physics, Chongqing University

Dualities and ground state phase diagrams are discussed for quantum XYZ chains with arbitrary spin s. It is shown that dualities reproduce the ground state phase diagrams for quantum half-integer spin XYZ chains, such as spin s=1/2, 3/2, but not for quantum integer spin XYZ chains, such as spin s=1, 2, in which the so-called symmetry protected topological phase–Haldane phase occurs. Dualities discussed for the one-dimensional quantum XYZ chains with aritrary spin s may be extended to quantum XYZ models with arbitrary spin s on a bipartite lattice in any spatial dimensions, such as square and honeycomb lattices.

Jessica Silva

Wednesday
09:55
Tasman

Thermodynamics and Gravity

School of Mathematics and Statistics Victoria University of Wellington

Tolman's relation, for the temperature of a self-gravitating fluid, is broadly accepted within the general relativity community. However that's still an intriguing concept since it contradicts naive versions of the zeroth law of thermodynamics. Based on that, we will discuss how thermodynamics emphasises the great distinction between gravity and other forces.

Tuesday
15:25
Kestral

Steve Siu

Quantum Hamiltonian Reduction for relaxed affine sl2 modules

University of Melbourne

The Virasoro algebra and its representation theory is central to the study of Conformal Field Theory. It is known that the highest-weight modules of the Virasoro algebra can be obtained from the affine sl2 highest-weight modules through the Quantum Hamiltonian Reduction. In this talk we will discuss a possible generalisation of this result by considering the Quantum Hamiltonian Reduction of the relaxed highest-weight modules of affine sl2.

Tuesday
10:20
Kestral

William Stewart

On the twisted sector of Wess-Zumino-Witten models

University of Melbourne

In this talk I will introduce the Wess-Zumino-Witten (WZW) models of two dimensional conformal field theory. I will focus on the integrable representations of affine Lie algebras that appear in the spectrum of a WZW model at positive integer level. I will then construct the twisted sector of the WZW models using outer automorphisms of finite dimensional simple Lie algebras. The resulting symmetry algebra is a twisted affine Lie algebra. I will analyse the restrictions imposed by singular vectors on the allowed modules in the twisted sector. For the affine sl(3) WZW model at positive integer levels, I will demonstrate that the allowed modules are restricted to the integrable highest weight A(2,2)-modules. If time permits, I will extend these arguments to a general WZW model at positive integer level and propose that the allowed modules in the twisted sector are likewise restricted to the integrable highest weight modules of the corresponding twisted affine Lie algebra.

Aiden Suter

Tuesday
09:55
Kestral

W-algebra Representation Theory

MPhil student at The University of Queensland.

2-dimensional conformal quantum field theories (CFTs) have an infinite-dimensional symmetry algebra known as the Virasoro algebra. Affine W-algebras were first studied as generalisations of the Virasoro algebra and were created by including additional fields which were compatible with the Virasoro field. The W_3-algebra is an example of such an algebra and is generated by the Virasoro field and an additional "W" field. Key physical properties of CFTs are determined by correlation functions which are constructed from representations of the symmetry algebra for the theory. In my research, we are interested in systematically constructing non-simple indecomposable representations of the W_3-algebra which are of interest in the study of logarithmic CFT. We aim to achieve this by two methods. The first is to generalise similar constructions for the Virasoro algebra which has been more extensively studied. The other is to use the vertex operator algebra (VOA) formalism of W-algebras. In particular we employ the use of the Zhu algebra - an associative algebra constructed from a VOA which shares the same representations as the VOA.

Arthur Suvorov

Tuesday
11:15
Kestral

Isospectral neutron stars in general relativity

University of Melbourne

In 1966, Kac posed the mathematical problem of 'can one hear the shape of a drum?'. The problem effectively asks whether or not knowledge of the spectrum of the Laplace operator ('hearing' the quasi-normal frequencies) allows one to uniquely identify the geometry of the space ('drum'). The answer turns out to be no, meaning that one cannot always uniquely determine the geometry by listening to the quasi-normal modes; several drums may sound the same.

In general relativity, axial perturbations of a neutron star are modelled by solving the Laplace-Beltrami (wave) equation over the background Tolman-Oppenheimer-Volkoff spacetime. As for the drum problem, we show that two static neutron stars, with distinct fluid profiles, can admit the same quasi-normal mode spectrum. We discuss possible implications of this with regards to identifying neutron star properties from gravitational wave and quasi-normal mode observations.

Thursday
11:15
Kestral

Andrew Waldron

Contact Geometry and Quantum Mechanics

Department of Mathematics, U. C. Davis

We present a generally covariant approach to quantum mechanics. Generalized positions, momenta and time variables are treated as coordinates on a fundamental "phase-spacetime" manifold. Dynamics are encoded by giving phase-spacetime a contact structure. BRST quantization then yields a physical Hilbert space whose elements satisfy a parallel transport equation on a certain vector bundle over phase-spacetime. The inner product of solutions both reproduces and generalizes the Wigner functions of standard quantum mechanics.

Wednesday
11:40
Tasman

Mark Wilson

Analysing signed networks, Ising spin glass models, and fullerene graphs using the frustration index

Department of Computer Science, University of Auckland

Structural balance in networks with positive and negative edges has become a focus in graph theory and network science. In signed networks, the frustration index determines distance of a network from a state of structural balance making it a key measure for analysing positive and negative interactions under different contexts. Originally suggested decades ago, the complexity involved in computing the frustration index has restricted its usage. We develop new discrete optimisation models to compute this measure in decent-sized instances. Our extended optimisation models include several speed-up techniques involving prioritised branching and valid inequalities that improve the branch and bound algorithm. The speed-up techniques make our models capable of processing graphs with thousands of nodes and edges in seconds on inexpensive hardware.

We discuss some applications of the proposed models in sociology, physics, chemistry, finance, international relations, and biology. The frustration of such signed networks has different meanings and interpretations depending on the context. Our datasets include several social networks and biological networks that are modelled as signed graphs. We also discuss numerical results on the frustration index in networks of formal alliances and antagonisms between countries as well as financial portfolio networks. Molecular graphs of carbon and Ising spin glass models are among other applications of this NP-hard graph optimisation problem. The findings unify the applications of a graph-theoretical measure in understanding complex structures in several fields of research.

Aref S, Mason AJ, Wilson MC. An exact method for computing the frustration index in signed networks using binary programming. Preprint arXiv:1611.09030 (2016).

Aref S, Mason AJ, Wilson MC. Computing the line index of balance using integer programming optimisation. Preprint arXiv:1710.09876 (2017).

Nicholas Witte

Wednesday
16:40
Tasman

The Density Matrix for the Ground State of 1-d Impenetrable Bosons in a Harmonic Trap

Massey University, Institute of Fundamental Sciences

We study the problem of the density matrix $\rho(x, y)$ of a system of N bosons interacting in one dimension with an infinite contact potential - the impenetrable Bose gas - in their ground state and confined within a harmonic trap. We do this by recasting the problem as an orthogonal polynomial system (OPS) on $\mathbb{R}$ with a deformed Gaussian weight. Employing tools from the theory of OPS with semi-classical weights we explicitly construct a number of ways to characterise ρ such as recurrence relations $N \mapsto N+1$ and partial differential equations with respect to x, y. In the process we identify an integrable system here, which turns out to be a specialisation of the degenerate, two-variable Garnier system $L(1, 1, 3; 2)$. With no additional effort we investigate this system in its full generality with parameters μ, ν, N deriving the Lax pairs of spectral and deformation derivatives, and the Bäcklund transformations $N \mapsto N \pm 1$, $\mu \mapsto \mu \pm 1$ and $\nu \mapsto \nu \pm 1$. Having constructed these tools we can employ a variety of asymptotic methods to address the question of the tendency to condense in 1 dimension.

Sungha Yun

Tuesday
16:15
Tasman

Free Surface Waves under a Pressure Distribution - Critical Surface Tension Case

Korea University

We consider forced surface waves under a pressure distribution on an incompressible, inviscid fluid in a two dimensional channel on a horizontal rigid flat bottom and nonzero surface tension on the free surface. It has been known that a nondimensional wave speed, called Foude number, is near 1 and a nondimensional surface tension, called Bond number, is near 1/3, the KdV theory fails and a time dependent fifth order KdV equation, called Kawahara equation, can be derived to model the wave motion on the free surface. In this paper a time dependent Kawahara equation with a forcing is studied both theoretically and numerically. Existence theorem and new types of numerical results are presented.

Thursday
10:20
Kestral

Xin Zhang

Retrieve the Bethe states of quantum integrable models solved via the off-diagonal Bethe Ansatz

University of Melbourne

Based on the inhomogeneous T-Q relation constructed via the off-diagonal Bethe Ansatz, a systematic method for retrieving the Bethe-type eigenstates of integrable models without obvious reference state is developed by employing certain orthogonal basis of the Hilbert space. With the XXZ spin torus model and the open XXX spin-1/2 chain as examples, we show that for a given inhomogeneous T-Q relation and the associated Bethe Ansatz equations, the constructed Bethe-type eigenstate has a well-defined homogeneous limit.

Thursday
12:05
Tasman

Huan-Qiang Zhou

Fidelity Mechanics: Analogues of the Four Thermodynamic Laws and Landauer's Principle

Centre for Modern Physics, Chongqing University

Fidelity mechanics, a scheme to investigate critical phenomena in quantum many-body physics, is formulated as an analogue of the four laws in thermodynamics and black hole mechanics, thus unveiling a formal connection between critical points and black holes.

Rich physics is unveiled even for prototypical models in quantum many-body systems, such as one-dimensional quantum XY model,quantum transverse Ising chain in a longitudinal field and quantum XYZ chain.

Wednesday
10:20
Tasman

Zongzheng Zhou

Unified correlation function behaviour on high-dimensional tori

Monash University

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 project, we work on repairing this broken connection by considering a random-length random walk.

Paul Zinn-Justin

Thursday
09:30
Kestral

Schubert puzzles and quantum integrability

The University of Melbourne

About 10 years ago, I suggested the idea that Schubert calculus, a branch of enumerative geometry that deals with configurations of vector subspaces of a vector space, could be interpreted as a "scattering process" in a quantum integrable model. These ideas beautifully came to fruition in recent collobaration with A. Knutson. I shall describe how a broad class of problems generalizing Schubert's original setting are solved by "puzzles", which are nothing but partition functions in disguise of some integrable models, based on the series of algebras A_2, D_4, E_6, E_8.
