2024 NZMS, AMS, AustMS Joint Conference
Schedule and Abstracts

8-13 December, 2024
Auckland, New Zealand

Contents

1 50 years of Communications in Algebra

Monday 14:00-15:30, Room 303-G15

14:00-14:25 Scott Chapman, *Fifty years of Communications in Algebra*

14:30-14:55 Alberto Elduque, *A few exceptional algebras*

15:00-15:25 Siu-Hung Ng, *On Hopf algebras of dimension p^2*

Monday 16:00-17:00, Room 303-G15

16:00-16:25 Luis David Garcia Puente, *Counting lines in a symmetric quintic threefold surface under the action of the group of permutations S_5*

16:30-16:55 Tim Stokes, *An ESN Theorem for Ordered Ehresmann Semigroups*

Tuesday 11:30-12:30, Room 303-G15

11:30-11:55 Jim Coykendall, *Factorization in Monoids and Domains: History and Recent Results*

12:00-12:25 Felix Gotti, *Divisibility and ascending chains of principal ideals*

Tuesday 14:00-15:30, Room 303-G15

14:00-14:25 Sarah Witherspoon, *Taft algebras and Nichols algebras*

14:30-14:55 Lars Christensen, *Limits of perfect complexes*

15:00-15:25 Sylvia Wiegand, *Prime ideals in polynomial-power series rings*

Tuesday 16:00-17:00, Room 303-G15

16:00-16:25 James East, *Transformation representations of diagram monoids*

16:30-16:55 Roger Wiegand, *Semigroups of modules*

Wednesday 10:30-12:00, Room 303-G15

10:30-10:55 Marcel Jackson, *Algebraic models of exponential and combinatorial laws*

11:00-11:25 Dolors Herbera, *A monoid of infinitely generated projective modules and its applications to direct sum decompositions of modules*

11:30-11:55 Hwankoo Kim, *An introduction of w-factor rings and their applications*

Thursday 11:30-12:30, Room 303-G15

11:30-11:55 Azeef Muhammed Parayil Ajmal, *Free idempotent-generated regular *-semigroups*

12:00-12:25 Matthias Fresacher, *Congruence Lattices of Finite Twisted Brauer and Temperley-Lieb Monoids*

Thursday 14:00-15:30, Room 303-G15

14:00-14:25 Chimere Anabanti, *Two characterizations of the smallest non-solvable group*

14:30-14:55 Gyu Whan Chang, *The integral closure of an affine ring*

15:00-15:25 Hyun Seung Choi, *Computing elasticity of certain integral domains*

2 Algebraic Combinatorics and Matroids

Monday 14:00-15:30, Room 303-B09

14:00-14:25 Gregory G. Smith, *Hodge theory for modular matroids*

14:30-14:55 Soohyun Park, *Euler characteristic-like invariants, positivity questions, and matroids*

15:00-15:25 Alexandru Suciu, *On some algebraic and geometric invariants associated to matroids*

Monday 16:00-17:00, Room 303-B09

16:00-16:25 Dominic Searles, *Lifting the dual immaculate functions to the polynomial ring*

16:30-16:55 Matthew Slattery-Holmes, *Peak functions, pattern avoidance, and positivity.*

Wednesday 10:30-12:00, Room 303-B09

10:30-10:55 Takuro Abe, *Solomon-Terao polynomial and Castelnouvo-Mumford regularity of hyperplane arrangements*

11:00-11:25 Leo Jiang, *Topology of real matroid Schubert varieties*

11:30-11:55 Alec Elhindi, *Constructive Torelli Theorem for Regular Matroids*

Thursday 11:30-12:30, Room 303-B09

11:30-11:55 Diane Maclagan, *Tropical Vector Bundles*

12:00-12:25 Huanchen Bao, *Acyclic matchings on Bruhat intervals and totally nonnegative Springer fibres*

Thursday 14:00-15:30, Room 303-B09

14:30-14:55 Nancy Abdallah, *Nets in the Projective Plane and Alexander Duality*

15:00-15:25 Laurentiu Maxim, *A geometric perspective on generalized weighted Ehrhart theory*

Friday 11:30-12:30, Room 303-B09

11:30-11:55 Yang Zhang, *Homology of noncrossing partition lattices*

12:00-12:25 Ryo Uchiumi, *A linear finite group action on a lattice and mod q permutation representation*

Friday 14:00-15:30, Room 303-B09

14:00-14:25 Jacob Matherne, *Chow functions for partially ordered sets*

14:30-14:55 Ian Seong, *Some orbits of a two-vertex stabilizer in a Grassmann graph and a generalization of the Askey-Wilson relations*

15:00-15:25 Nir Gadish, *Surprising representations in cohomology of compacified configurations in graphs*

3 Applied and Computational Topology

Tuesday 11:30-12:30, Room 260-223

11:30-11:55 Sarah Percival, *Bounding the Interleaving Distance of Geometric Graphs with a Loss Function*

12:00-12:25 Eve Cheng, *Investigating Party Structure Shifts in Parliamentary Networks*

Tuesday 14:00-15:30, Room 260-223

14:00-14:25 Robin Belton, *Discrete Level Set Persistence for Finite Discrete Functions*

14:30-14:55 Henry Adams, *Persistent equivariant cohomology*

15:00-15:25 Vanessa Robins, *The Extended Persistent Homology Transform for Manifolds with Boundary*

Tuesday 16:00-17:00, Room 260-223

16:00-16:25 Bei Wang, *Harmonic Chain Barcode and Stability*

16:30-16:55 MUSASHI Koyama, *Computing degree-1 Vietoris-Rips persistent homology more efficiently*

Thursday 11:30-12:30, Room 260-223

11:30-11:55 Peter Bubenik, *Relative Optimal Transport for Topological Data Analysis*

12:00-12:25 Agnese Barbensi, *Topological Optimal Transport for Geometric Cycle Matching*

Thursday 14:00-15:30, Room 260-223

14:00-14:25 Brittany Terese Fasy, *How Strong Are Topological Descriptors?*

14:30-14:55 Arturo Espinosa, *Sequential topological complexity of aspherical spaces and sectional categories of subgroup inclusions*

15:00-15:25 Kang-Ju Lee, *G-Mapper: Learning a Cover in the Mapper Construction*

Friday 11:30-12:30, Room 260-223

11:30-11:55 Adam Onus, *Local systems for periodic data*

12:00-12:25 Nina Otter, *Generalised persistent homology transforms over affine Grassmannians*

Friday 14:00-15:30, Room 260-223

14:00-14:25 Vinay Sipani, *Structural Characterization of Planar-Rips Complexes and Their Graph Equivalents*

14:30-14:55 Kevin Knudson, *Discrete Morse theory on* ΩS^2

15:00-15:25 Nicholas Scoville, *A McCord theorem for Cech closure spaces*

4 Arithmetic Geometry and Number Theory

Monday 14:00-15:30, Room 405-430

14:00-14:10 Bailey Whitbread, *Counting points on character varieties*

14:15-14:25 Stefano Giannini, *Arithmetic geometry of additive character varieties*

14:30-14:40 Tuan Ngo Dac, *On multiple zeta values in positive characteristic*

14:45-14:55 Benjamin Ward, *Difference sets in Diophantine approximation*

15:00-15:10 Chandler (Chip) Corrigan, *A large sieve inequality for moduli generated by a quadratic*

15:15-15:25 Michael Harm, *The Goldbach-Vinogradov theorem with restricted primes*

Tuesday 11:30-12:30, Room 405-430

11:30-11:55 Anthony Várilly Alvarado, *Probabilistic approaches to rational points on algebraic surfaces*

12:00-12:25 Bianca Viray, *Number fields generated by points in linear systems on curves*

Tuesday 14:00-15:30, Room 405-430

14:00-14:25 Jeremy Booher, *Iwasawa theory of Frobenius-torsion class group schemes*

14:30-14:55 Daniel Delbourgo, *Replenishing Euler systems at their bad primes*

15:00-15:10 Timotheus Keanu, *Iwasawa Theory for Supersingular Elliptic Curves over Deformation Local Rings*

15:15-15:25 Jordan Pertile, *On the Euclideanity of Number Fields*

Tuesday 16:00-17:00, Room 405-430

16:00-16:10 Muhammad Afifurrahman, *A uniform formula on the number of integer matrices with given determinant and height*

16:15-16:25 Ali Ebadi, *Expanding on Banks' Results: New Approaches to the Spacing of Zeros of the Riemann Zeta Function*

16:30-16:40 Sebastian Tudzi, *The Generalized Divisor Problem*

16:45-16:55 Chenyan Wu, *Explicit relation between invariants from Eisenstein series and theta lifts, with an application to Arthur packets*

Wednesday 10:30-12:00, Room 405-430

10:30-10:55 Ling Long, *The Explicit Hypergeometric-Modularity Method*

11:00-11:25 Adriana Salerno, *Hypergeometric motives and invertible K3 surface pencils*

11:30-11:55 Alex Ghitza, *Arithmetic of automorphic forms on quaternion algebras*

Friday 11:30-12:30, Room 405-430

11:30-11:55 Madhavan Venkatesh, *Counting points on surfaces in polynomial time.*

12:00-12:25 Felipe Voloch, *Irreducibility of curves over finite fields*

Friday 14:00-15:30, Room 405-430

14:00-14:25 Sam Frengley, *On the geometry of the Humbert surface of square discriminant*

14:30-14:55 Claudia Schoemann, *The kernel of the Gysin homomorphism for positive characteristic*

15:00-15:25 Isabel Vogt, *Conic bundle threefolds differing by a constant Brauer class and connections to rationality*

5 Computability Theory and Applications

Monday 14:00-15:30, Room 303-B07

14:00-14:25 Rodney Downey, *On Presenting Linear Orderings and Boolean Algebras*

14:30-15:20 Matthew Harrison-trainor, *Scott complexity of linear orders*

Monday 16:00-17:00, Room 303-B07

16:00-16:50 Alexander Melnikov, *Computable duality theory*

Tuesday 11:30-12:30, Room 303-B07

11:30-12:50 Elvira Mayordomo, *On information theory in geometric measure theory*

Tuesday 14:00-15:30, Room 303-B07

14:00-14:25 Noam Greenberg, *Embedding uncountable partial orderings into the Turing degrees*

14:30-15:20 Bakh Khoussainov, *Defining algorithmically presented structures in first order logic*

Tuesday 16:00-17:00, Room 303-B07

16:00-16:25 Johanna Franklin, *Fourier series and algorithmic randomness*

16:30-16:55 Guohua Wu, *Reverse Mathematics of Theorems in Lattice Theory*

Wednesday 10:30-12:00, Room 303-B07

10:30-10:55 Paul Shafer, *Complexity of presenting cohesive powers*

11:00-11:50 Andre Nies, *Profinite groups, effective dimension, and randomness*

Thursday 11:30-12:30, Room 303-B07

11:30-12:20 Jun Le Goh, *The complexity of unfriendly partitions in countable graphs*

Thursday 14:00-15:30, Room 303-B07

14:00-14:25 Ellen Hammatt, *Arriving on Time: Punctuality in Structures, Isomorphisms and 1-Decidability*

14:30-15:20 Manlio Valenti, *On the density of the Weihrauch degrees*

Friday 11:30-12:30, Room 303-B07

11:30-11:55 Isabella Scott, *Existential Closure of Subshifts*

12:00-12:25 Keita Yokoyama, *On the hierarchy above* ATR_0

6 Computational Mathematics

Monday 14:00-15:30, Room 402-231

14:00-14:25 Mahadevan Ganesh, *All-Frequency-Stable Continuous and Discrete Models for RCS Computations of Penetrable 3D Scatterers*

14:30-14:55 Huateng Zhu, *Convergence of numerical methods for total variation flow*

15:00-15:25 Andres E Rubiano, *Aposterior error analysis of robust virtual element methods for stress-assisted diffusion problems*

Tuesday 11:30-12:30, Room 402-231

11:30-11:55 Aamir Yousuf, *Numerical analysis of a Biot–Kirchhoff–Love poro–thermoelastic plate model*

12:00-12:25 Agus Soenjaya, *Finite element method for a micromagnetic model at elevated temperatures*

Tuesday 14:00-15:30, Room 402-231

14:00-14:25 Kevin Burrage, *Equation learning of ODE systems from Stochastic agent based models using a library of chemical reactions*

14:30-14:55 Elizabeth Harris, *Calculating Minimum Volume Covering Ellipsoids Using Leverage Score Sampling*

15:00-15:25 Jia Jia Qian, *A discrete de Rham scheme for the exterior calculus Einstein's equations*

Tuesday 16:00-17:00, Room 402-231

16:00-16:25 Segundo Villa-fuentes, *A priori and a posteriori error bounds for the fully mixed FEM formulation of poroelasticity with stress-dependent permeability*

16:30-16:55 Tiangang Cui, *Tensor-Train Methods for Sequential State and Parameter Estimation in State-Space Models*

Wednesday 10:30-12:00, Room 402-231

10:30-10:55 John Butcher, *Trees and B-series*

11:00-11:25 Li Zhu, *A New Finite Element Method Wave Propagation on Graphene Sheets*

11:30-11:55 Paul Leopard, *The applicability of equal area partitions of the unit sphere*

Thursday 11:30-12:30, Room 402-231

11:30-11:55 Carsten Carstensen, *Adaptive Computation of Fourth-Order Problems*

12:00-12:25 Anne Boschman, *A Divergence-Preserving Unfitted Finite Element Method for the Darcy Problem*

Friday 11:30-12:30, Room 402-231

11:30-11:55 Sergio Rojas, *Adaptive regularization of rough linear functionals for nonconforming FEM*

12:00-12:25 Emmanuel Adeyefa, *Development of a block bethod for solving multiple order ODEs*

Friday 14:00-15:30, Room 402-231

14:00-14:25 Ritesh Singla, *A Posteriori Error Analysis of Hybrid High-Order Methods for the Elliptic Obstacle Problem*

14:30-14:55 Ricardo Ruiz Baier, *Mixed finite element methods for the coupling of Biot and Poisson-Nernst-Planck equations*

15:00-15:25 Quoc Thong Le Gia, *Bayesian inference calibration of the modulus of elasticity*

7 Computational Methods and Applications of Dynamical Systems

Monday 14:00-15:30, **Room 303-G20**

14:00-14:25 Pablo Aguirre, *Unfolding isola and mushroom bifurcations of limit cycles*

14:30-14:55 Behnaz Rahmani, *Understanding complex oscillations in a model of intracellular calcium dynamics*

15:00-15:30 John Bailie, *Transitions of resonance tongues in periodically forced systems*

Monday 16:00-17:00, **Room 303-G20**

16:00-16:30 Courtney Quinn, *Resonance in Partial Tipping Due to Timescale Variation of Chaotic Forcing*

16:30-16:55 Andrus Giraldo, *Master stability curves for traveling waves*

Tuesday 11:30-12:30, **Room 303-G20**

11:30-11:55 Maciej Capinski, *Arnold Diffusion in the Three Body Problem*

12:00-12:25 Harry Dankowicz, *Parameter Continuation and Uncertainty Quantification Near Stochastically Perturbed Limit Cycles and Tori*

Tuesday 14:00-15:30, **Room 303-G20**

14:00-14:25 Kyoung Hyun Lee, *Phase resetting in two phase-locked coupled Van der Pol oscillators*

14:30-14:55 Jacob Ngaha, *Phase Resetting in the Yamada Model of a Q-Switched Laser*

15:00-15:25 Md. Azmir Ibne Islam, *Dynamics induced by a heteroclinic network comprising five nodes*

Tuesday 16:00-17:00, **Room 303-G20**

16:00-16:25 Sam Doak, *Invariant Manifolds and the Emergence of Wild Chaos*

16:30-16:55 Juan Patiño-Echeverría, *Classification and structure of homoclinic explosions in a four-dimensional Lorenz-like system*

Thursday 11:30-12:30, **Room 303-G20**

11:30-11:55 Irina Mitrea, *On the Neumann Problem for the bi-Laplacian in Infinite Sectors*

12:00-12:25 Caitlin Lienkaemper, *CTLNs as a mean field theory for clustered spiking networks*

Thursday 14:00-15:30, Room 303-G20

14:00-14:25 Prannath Moolchand, *Applications of geometric singular perturbations techniques to investigate multiple timescale dynamics: a case study of the active metabolic oscillatory subsystem in pancreatic beta cells.*

14:30-14:55 Natalia Mcalister, *Computer-assisted proofs for blenders*

15:00-15:25 Zbigniew Galias, *On the density of periodic windows for the Rössler system*

Friday 11:30-12:30, Room 303-G20

11:30-11:55 Lauren Smith, *Data assimilation for networks of coupled oscillators: Inferring unknown model parameters from partial observations*

12:00-12:25 Behrooz Yousefzadeh, *Analysis of non-reciprocity in vibration transmission problems using continuation methods*

Friday 14:00-15:30, Room 303-G20

14:00-14:25 Indranil Ghosh, *Robust chaos in piecewise-linear maps*

14:30-14:55 Dana C'Julio, *Tool for identifying the geometric properties of the emergence of blenders in a three-dimensional Hénon-like map*

15:00-15:25 Yovani Adolfo Villanueva Herrera, *Generic Upper Bounds of Cyclicity Problem*

8 Computational Number Theory and Applications

Monday 14:00-15:30, Room 405-422

14:00-14:10 Tim Trudgian, *M&M's*

14:15-14:25 Nicol Leong, *New unconditional bounds on the reciprocal of the Riemann zeta function*

14:30-14:40 Riddhi Manna, *Sun's conjecture on the summatory function of* $(-2)^{\Omega(n)}$

14:45-14:55 Neea Palojärvi, *On explicit bounds for the Selberg class functions*

15:00-15:25 Brendan Creutz, *Quartic del Pezzo surfaces without quadratic points*

Monday 16:00-17:00, Room 405-422

16:00-16:50 Edgar Costa, *17T7 as a Galois group over Q through Hilbert modular forms*

Tuesday 14:00-15:30, Room 405-422

14:00-14:10 Simon Thomas, *The sum of a prime cubed and a cube-free number*

14:15-14:25 Liang Wang, *Partial sum of the Möbius function under the Riemann hypothesis*

14:30-14:40 Gustav Kjaerbye Bagger, *Hybrid bounds for* x *in terms of* $\omega(x^n - 1)$

14:45-14:55 Chiara Bellotti, *An explicit log-free zero-density estimate for the Riemann zeta-function*

15:00-15:10 Daniel Johnston, *Recent progress in bounding the error term in the prime number theorem*

15:15-15:25 Shashi Chourasiya, *On the explicit version of Ingham's zero density estimate*

Tuesday 16:00-17:00, Room 405-422

16:00-16:25 Eamonn O'Brien, *Challenging problems from group theory*

16:30-16:55 John Voight, *A computational investigation into modular forms attached to rigid surfaces of geometric genus 2*

Wednesday 10:30-12:00, Room 405-422

10:30-10:55 Madeleine Kyng, *Computing zeta functions of algebraic curves using Harvey's trace formula*

11:00-11:10 Victor (Sheng) Lu, *16-Descent on Elliptic Curves*

11:15-11:25 Derek Perrin, *Ordinary Isogeny Graphs with Level Structure*

11:30-11:40 Chao Qin, *Characteristic elements modulo p in noncommutative Iwasawa theory*

11:45-11:55 Stefan Catoiu, *A Number Theoretic Algorithm Leading to the Proof of the GGR Conjecture on Generalized Differentiation*

Thursday 11:30-12:30, Room 405-422

11:30-12:20 Kiran S. Kedlaya, *Towards a database of hypergeometric L-functions*

Thursday 14:00-15:30, Room 405-422

14:00-14:50 Katherine E. Stange, *Respecting CM on elliptic curves: sesquilinear pairings, elliptic nets, biextensions*

15:00-15:25 Jeremy Booher, *Doubly isogenous curves of genus two with a rational action of* D_6

Friday 14:00-15:30, Room 405-422

14:00-14:25 Jung Hee Cheon, *Homomorphic Encryption and Private AI*

14:30-14:55 Mingjie Chen, *Computing the endomorphism ring of supersingular elliptic curve from a full rank suborder*

15:00-15:10 Emily Mcmillon, *Filtering Weak Keys in Quasi-Cyclic Code-Based Cryptosystems*

15:15-15:25 Amin Sakzad, *How to pack a bunch of Kyber ciphertexts?*

9 Computations and applications of algebraic geometry and commutative algebra

Wednesday 10:30-12:00, Room 303-B05

10:30-10:55 Scott Mullane, *The Kodaira classification of the moduli space of pointed hyperelliptic curves*

11:00-11:25 Diane Maclagan, *Toric Bertini theorems in arbitrary characteristic*

11:30-11:55 Gregory Smith, *Cohomology of toric vector bundles*

Thursday 11:30-12:30, Room 303-B05

11:30-11:55 Jörg Frauendiener, *A computational approach to Riemann surfaces with applications in Physics*

12:00-12:25 Elizabeth Gross, *Computational algebraic geometry for evolutionary biology*

Thursday 14:00-15:30, Room 303-B05

14:00-14:25 Christin Bibby, *A Serre spectral sequence for the moduli space of tropical curves*

14:30-14:55 Martin Helmer, *Effective Whitney Stratification and Applications*

15:00-15:25 Arvind Kumar, *Generalized Hamming weights and symbolic powers of Stanley-Reisner ideals of matroids*

Friday 11:30-12:30, Room 303-B05

11:30-11:55 Michael Brown, *Computing sheaf cohomology over noncommutative projective schemes*

12:00-12:25 Prashanth Sridhar, *Noncommutative geometry over dg-algebras*

Friday 14:00-15:30, Room 303-B05

14:00-14:25 Frank Sottile, *The Critical Point Degree of a Bloch Variety*

14:30-14:55 Changho Han, *Extending the Torelli map to alternative compactifications of the moduli space of curves*

15:00-15:25 Anand Deopurkar, *How twisty is that orbit?*

10 Contributed Session A

Monday 14:00-15:30, Room 303-B11

14:00-14:25 Mine Dogucu, *Bayesian Statistics for Undergraduate Students and Their Instructors*

14:30-14:55 Alison Marzocchi, *TEAM Reflection Cycles: Supporting Instructors to Teach Equity-minded Active Mathematics*

15:00-15:25 Tim McDevitt, *A Mathematician Teaches Statistics*

Monday 16:00-17:00, Room 405-430

16:00-16:25 Rowena Ball, *Mathing a better world: Expanding cultural capital in mathematics*

16:30-16:55 Kerri Spooner, *What contributions can interpretive description make as a research methodology in the field of mathematics education?*

Tuesday 11:30-12:30, Room 260-036

11:30-11:55 Emmanuel Ekitela, *Factor Analysis of Infrastructure Output on Economic Growth of Kenya*

12:00-12:25 Maryam Mirzaei, *The integrated model of the production planning and the assignment of warehouse locations to products in an uncertain environment*

Tuesday 14:00-15:30, Room 260-016

14:00-14:25 Meghna Mistri, *"Sharing is caring": A mathematical study on bacterial conjugation*

14:30-14:55 Nathan Hartmann, *History of the Tangent: al-Biruni and his Shadows*

15:00-15:25 Stephen Marsland, *Money, Reputations, and Evolutionary Game Theory*

Tuesday 16:00-17:00, Room 260-016

16:00-16:25 Boris Huang, *On compounded random walks and the space-fractional Fokker-Planck equation*

16:30-16:55 Alyah Alshammari, *Time Domain Vibration Analysis of a Cracked Ice Shelf*

Wednesday 10:30-12:00, Room 260-040

10:30-10:55 Angelyn Lao, *Graph Theoretical Analysis of Biological and Ecological Systems*

11:00-11:25 Paco Castaneda Ruan, *Exploring Calcium oscillation patterns in T-lymphocytes using ordinary differential equations*

11:30-11:55 Anet Jorim Norbert Anelone, *Modelling and simulation to advance antiviral therapy for measles*

Thursday 11:30-12:30, Room 303-B11

11:30-11:55 Joshua Stevenson, *Modelling genome rearrangement events*

12:00-12:25 Davide Papapicco, *Slowly, then all at once: Uncovering the dynamics of a catastrophe*

Thursday 14:00-15:30, Room 303-B11

14:00-14:25 Andrew Axelsen, *Covariations between persistent synoptic features and Antarctic sea ice via unsupervised regression learning*

14:30-14:55 Junming Cao, *Noncommutative law of large numbers*

15:00-15:25 Leighton Watson, *Jointly estimating epidemiological dynamics of Covid-19 from case and wastewater data in Aotearoa New Zealand*

Friday 11:30-12:30, Room 303-G15

11:30-11:55 Faris Alsubaie, *Modelling the effects of mechanical properties on mutant cells in an epithelial tissue*

12:00-12:25 Shawn Means, *Electrical Wave Generation and Spatial Organisation in Uterine*

11 Contributed Session B

Monday 14:00-15:30, Room 303-B05

14:00-14:25 Lauren Thornton, *On class operators for the lower radical class and semisimple closure constructions.*

14:30-14:55 Robin Havea, *Development in constructive Banach algebra theory*

15:00-15:25 Dejian Zhou, *Noncommutative Logarithmic Sobolev Inequalities*

Monday 16:00-17:00, Room 303-B11

16:00-16:25 Bekalu Tarekegn Bitew, *Exploring Fuzzy Ideals and Filters in Almost Distributive Fuzzy Lattices*

Tuesday 11:30-12:30, Room 303-G14

11:30-11:55 Geetha Venkataraman, *Exponent-Critical Groups*

12:00-12:25 David Bryant, *A Geometric Introduction to Diversity Theory*

Tuesday 14:00-15:30, Room 260-036

14:00-14:25 Roy Jansen, *How field characteristic impacts ideal structure in the Steinberg algebras of the two- and three-headed snakes*

14:30-14:55 Barry Gardner, *(Cancelled) q-central idempotents and radical classes of rings*

15:00-15:25 Zekarias Gashu Terefe, *Principal Ideals and Filters of an Almost Distributive Fuzzy Lattice.*

Tuesday 16:00-17:00, Room 303-B11

16:00-16:25 Darius Young, *Quotient order density of triangle groups*

16:30-16:55 Melusi Khumalo, *Generalized iterated function system for common attractors in partial metric spaces*

Wednesday 10:30-12:00, Room 260-215

10:30-10:55 Rajko Nenadov, *Near-optimal universality for bounded-degree hypergraphs*

11:00-11:25 Abdul Basit, *Extremal problems for semilinear graphs*

11:30-11:55 Lynnel Naingue, *On Graded Twisted Steinberg Algebras*

Thursday 14:00-15:30, Room 405-430

14:00-14:25 Sebastian Petit, *Codes associated with generalised polygons*

14:30-14:55 Hung-Wen Kuo, *Green's Function and Surface Wave*

15:00-15:25 Haru Negami, *Construction of unitary representations of braid groups*

Friday 11:30-12:30, Room 260-028

11:30-11:55 Mashniah Gazwani, *Length-constrained elastic flow of planar curves inside cones*

12:00-12:25 Eliot Fried, *Shape-preserving everting motions of orientable or nonorientable, unkotted or knotted, bands*

12 Deterministic and Probabilistic Aspects of Dispersive Partial Differential Equations

Monday 16:00-17:00, Room 260-022

16:00-16:50 Soonsik Kwon, *Soliton resolution for Calogero–Moser derivative nonlinear Schrödinger*

Tuesday 11:30-12:30, Room 260-022

11:30-12:20 Zongyuan Li, *Optimal Liouville theorems for conformally invariant PDEs*

Tuesday 16:00-17:00, Room 260-022

16:00-16:50 Kiyeon Lee, *The global dynamics of the Maxwell-Dirac system*

Friday 11:30-12:30, Room 260-022

11:30-12:20 Monica Visan, *The Continuum Calogero-Moser Models*

Friday 14:00-15:30, Room 260-022

14:00-14:50 Zihua Guo, *Global solutions to 3D quadratic nonlinear Schrödinger-type equation*

13 Differential delay equations and their applications

Monday 16:00-17:00, Room 303-B05

16:00-16:25 Tomas Gedeon, *Dynamics of a state-dependent delay-differential equation*

16:30-16:55 Jan Haskovec, *Non-Markovian models of collective dynamics*

Tuesday 11:30-12:30, Room 303-B05

11:30-11:55 Jacques Belair, *Coupled Delayed Feedback Loops in Biological Systems: Stability and Oscillations*

12:00-12:25 Sergiy Shelyag, *Delay-differential equations for glucose-insulin regulation system modelling*

Tuesday 14:00-15:30, Room 303-B05

14:00-14:25 Anatoli Ivanov, *Global Attractivity and Periodicity in a Delay Differential Model*

14:30-14:55 Tibor Krisztin, *Homoclinic orbit for a Mackey-Glass type equation*

15:00-15:25 Ábel Garab, *Discrete Lyapunov functional for a system of differential equations with time-variable and state-dependent delay*

Tuesday 16:00-17:00, Room 303-B05

16:00-16:25 Samuel Bolduc-st-aubin, *Feedback with implicit state-dependent delay:*

16:30-16:55 Renzo Mancini, *Bifurcation analysis of a two-delay model for the Atlantic Meridional Overturning Circulation*

14 Differential geometry and geometric analysis

Monday 14:00-15:30, Room 260-005

14:00-14:50 Ramiro Lafuente, *Ricci flows with symmetry*

15:00-15:25 Xianzhe Dai, *Singular Weyl's law with Ricci curvature bounded below*

Monday 16:00-17:00, Room 260-005

16:00-16:25 Adam Thompson, *Ricci solitons that fibre over hyperbolic surfaces*

16:30-16:55 Stepan Hudecek, *Poisson's equation for G_2-Laplacian on homogeneous spheres*

Tuesday 11:30-12:30, Room 260-005

11:30-12:20 Emma Carberry, *Isothermic Surfaces*

Tuesday 14:00-15:30, Room 260-005

14:00-14:25 Jane Mcdougall, *Rosette harmonic mappings, their generalizations, and deformation to the classical Enneper surface*

14:30-14:55 Thomas Leistner, *Lorentzian homogeneous spaces with indecomposable isotropy*

15:00-15:25 Gerd Schmalz, *On Bochner Kähler manifolds*

Tuesday 16:00-17:00, Room 260-005

16:00-16:25 Stuart Teisseire, *A Monge-Ampere equation on hypersurfaces in projective geometry*

16:30-16:55 Jihun Kim, *Classification of weakly Einstein hypersurfaces in spaces of constant curvature*

Wednesday 10:30-12:00, Room 260-005

10:30-10:55 Artem Pulemotov, *Einstein metrics on homogeneous superspaces*

11:00-11:50 Claude LeBrun, *Einstein Metrics, 4-Manifolds, and Gravitational Instantons*

Thursday 11:30-12:30, Room 260-005

11:30-11:55 Mat Langford, *Curve shortening flow with boundary*

12:00-12:25 Qiyu Zhou, *High Codimension Mean Curvature Flow Of Spacelike Convex Submanifolds With Pseudo Euclidean Background*

Thursday 14:00-15:30, Room 260-005

14:00-14:25 Florian Beyer, *Nonlinear stability of Einstein-matter models near the big bang singularity*

14:30-14:55 Yuri Nikolayevsky, *Indecomposable killing tensors on symmetric spaces*

15:00-15:25 Owen Dearricott, *Integrable systems, Painlevé VI and explicit solutions to the anti-self dual Einstein equation via radicals*

Friday 11:30-12:30, Room 260-005

11:30-11:55 Peter Petersen, *Hodge Numbers for Kaehler-Einstein Manifolds*

12:00-12:25 Michael Albanese, *An aspherical almost complex four-manifold with negative signature*

Friday 14:00-15:30, Room 260-005

14:00-14:25 Jian Wang, *Mass lower bounds for asymptotically locally flat manifolds*

14:30-14:55 Artemis Aikaterini Vogiatzi, *Singularities of High Codimension Mean Curvature Flow in Riemannian Manifolds*

15:00-15:25 Louis Yudowitz, *Dynamical Stability and Instability of Poincare-Einstein Manifolds*

15 Discrete and continuous integrable systems: geometry analysis and applications

Monday 14:00-15:30, Room 260-036

14:00-14:50 Jan de Gier, *Vertex model constructions of symmetric functions and exclusion processes*

15:00-15:25 Vladimir Dragovic, *Ellipsoidal Billiards, Combinatorics, and Polynomial Pell's Equations*

Monday 16:00-17:00, Room 260-036

16:00-16:25 Deniz Bilman, *(Cancelled) General rogue waves of infinite order: exact properties, asymptotic behavior, and effective numerical computation*

16:30-16:55 Andrew Kels, *The decomposability property for lattice equations*

Tuesday 16:00-17:00, Room 260-036

16:00-16:25 Robert Buckingham, *Asymptotic Behavior of Rational Painlevé-V Functions*

16:30-16:55 Andrei Martinez-Finkelshtein, *Flow of the zeros of polynomials under iterated differentiation*

Wednesday 10:30-12:00, Room 260-036

10:30-11:20 Nicholas Witte, *The distribution of zeros of the derivative of the Riemann Zeta function via random unitary matrices*

11:30-11:55 Renjie Feng, *U-statistics for determinantal point processes*

Thursday 11:30-12:30, Room 260-036

11:30-11:55 Tomas Latimer, *A discussion on discrete multiple orthogonal polynomial systems*

12:00-12:25 Baofeng Feng, *Pfaffian solutions to a coupled complex modified KdV equation and its discrete analogues under nonzero boundary condition*

Thursday 14:00-15:30, Room 260-036

14:00-14:25 Anton Dzhamay, *Discrete Painlevé equations from geometric deautonomization of QRT maps.*

14:30-14:55 Yang Shi, *New symmetries of the discrete Painlevé equations from geometric deautonomization of QRT maps*

15:00-15:25 Wen-Xiu Ma, *Nonlocality, integrability and solitons*

Friday 11:30-12:30, Room 260-036

11:30-12:20 Barbara Prinari, *Discrete solitons for the defocusing Ablowitz-Ladik equation with an arbitrarily large background*

Friday 14:00-15:30, Room 260-036

14:00-14:25 Tom Trogdon, *Applications of Riemann–Hilbert problems with theta-function asymptotics*

14:30-14:55 Alexander Stokes, *Geometry of a four-dimensional multiplicative integrable mapping and associated fourth-order discrete Painlevé equations*

15:00-15:25 Eric Zaslow, *Skeins, Clusters and Wavefunctions*

16 Early Career Showcase in Low-Dimensional Topology

Monday 14:00-15:30, Room 260-073

14:00-14:25 Orion Zymaris, *Lipschitz Spinors and Higher Horospheres*

14:30-14:55 John Stewart, *Mapping class groups of manifolds with boundary and the image of the variation operator*

15:00-15:25 Lavender Marshall, *Upsilon invariants for lens spaces*

Monday 16:00-17:00, Room 260-073

16:00-16:25 Rhuaidi Burke, *Observations on the Structure of Small 4-Manifold Triangulations*

16:30-16:55 Lucy Tobin, *Small Triangulations of Simply Connected 4-Manifolds*

Tuesday 11:30-12:30, Room 260-073

11:30-11:55 Damian Lin, *Mutation Invariants of Virtual Alternating Knots*

12:00-12:25 Lecheng Su, *Klein bottly alternating links*

Tuesday 14:00-15:30, Room 260-073

14:00-14:25 Joshua Drouin, *Exotic families of higher intersection embedded spheres*

14:30-14:55 Jin Miyazawa, *A gauge theoretic invariant of embedded surfaces in 4-manifolds and exotic P^2-knots*

15:00-15:25 Gordana Matic, *Some four-genus bounds and unknotting by full twists*

Tuesday 16:00-17:00, Room 260-073

16:00-16:25 Em Thompson, *On the complexity of hyperbolic knots obtained by Dehn filling the 'magic manifold'*

16:30-16:55 Finn Thompson, *Computing the Heegaard Genus of 3-Manifold Triangulations*

Wednesday 10:30-12:00, Room 260-073

10:30-10:55 Alexander Elzenaar, *Deformations of 3-orbifold holonomy groups and applications*

11:00-11:25 Joshua Howie, *Essential checkerboard surfaces for some m-almost alternating links*

11:30-11:55 Dionne Ibarra, *From ideal to one-vertex triangulations*

Thursday 11:30-12:30, Room 260-073

11:30-11:55 Connie On Yu Hui, *Volume bounds for hyperbolic rod complements in the 3-torus*

12:00-12:25 Corbin Reid, *Non-existence of upper volume bounds for classes of links on incompressible surfaces*

Thursday 14:00-15:30, Room 260-073

14:00-14:25 Jonathan Spreer, *Sampling triangulations of manifolds using Monte Carlo methods*

14:30-14:55 Shintaro Fushida-Hardy, *Pseudo-Trisections of Four-Manifolds with Boundary*

15:00-15:25 Christopher Tuffley, *Weakly linked embeddings of pairs of complete graphs in* $\mathbb{R}^3$

Friday 11:30-12:30, Room 260-073

11:30-11:55 Jeroen Schillewaert, *Braid groups, elliptic curves, and resolving the quartic*

12:00-12:25 Neil Hoffman, *Growth in the complexity of arithmetic invariants of 3-manifolds*

Friday 14:00-15:30, Room 260-073

14:00-14:25 Daniele Celoria, *Fun with simplicial homology*

14:30-14:55 Liam Kahmeyer, *A Homotopy Invariant of Image Simple Fold Maps to Oriented Surfaces*

15:00-15:25 Michelle Strumila, *An operad of decorated cobordisms*

17 Engagement with mathematics through communication and outreach

Monday 14:00-15:30, Room 260-040

14:00-14:25 Susan James, *Developing a Successful Outreach Program*

14:30-14:55 Cait Pryse, *Taking Research from Academia to Broader Audiences*

15:00-15:25 Yudhistira Bunjamin, *Seven years of Peter's Party Planning Problems*

Monday 16:00-17:00, Room 260-040

16:00-16:25 Sean Gardiner, *Optimising workshop and problem design to maximise engagement and independent discovery*

16:30-16:55 Louis Yudowitz, *A "Soft" Framework for Designing Outreach About Mathematical Thinking*

Tuesday 11:30-12:30, Room 260-040

11:30-12:25 Jeanette McLeod, *Maths Craft: An Unexpected Journey*

Tuesday 14:00-15:30, Room 260-040

14:00-14:25 Phil Wilson, *Maths Craft in a Box*

14:30-14:55 Kate Barnard, *Just don't say "maths" - the Puzzle Café and other innovative mathematics engagement*

15:00-15:25 Cindy Huang, *Enhancing Mathematics Engagement through Learner-Centred Experiences*

Tuesday 16:00-17:00, Room 260-040

16:00-16:55 Dominic Maderazo, *Workshop: A Combinatorial Game*

Thursday 14:00-15:30, Room 260-009

14:00-14:25 Geetha Venkataraman, *Popularising and Strengthening Mathematics Learning: Some Experiments and Experiences*

14:30-14:55 Denis Collins, *The sound of symmetry: collaboration between mathematics and musicology for new creative works and community outreach*

15:00-15:25 Artem Pulemotov, *Sounding Lie groups*

18 Ergodic Theory and Dynamical Systems

Monday 14:00-15:30, Room 303-G23

14:00-14:25 Sakshi Jain, *Optimal linear response for SDE via kernel perturbations*

14:30-14:55 Claire Postlethwaite, *Exotic behaviour near heteroclinic networks*

15:00-15:25 Agnieszka Zelerowicz, *Lorentz gases on quasicrystals*

Monday 16:00-17:00, Room 303-G23

16:00-16:25 Maxence Phalempin, *Rare events for a collision model over a lattice*

16:30-16:55 Nalini Joshi, *Bi-elliptic integrable maps*

Tuesday 11:30-12:30, Room 303-G23

11:30-11:55 Aaron Brown, *Absolute continuity of stationary measures*

12:00-12:25 David Groothuizen Dijkema, *Analysing dynamics near heteroclinic networks with a projected map*

Tuesday 14:00-15:30, Room 303-G23

14:30-14:55 Yuri Kifer, *Strong Iterated Limit Theorems for Dynamical Systems*

15:00-15:25 Riddhi Shah, *Dynamics of actions of automorphisms of a Lie group on certain compact spaces and applications to lattices*

Tuesday 16:00-17:00, Room 303-G23

16:00-16:25 Dong Chen, *Equilibrium states for non-uniformly hyperbolic geodesic flows*

16:30-16:55 Hinke M Osinga, *Blenders, attractors, and their carpet property*

Wednesday 10:30-12:00, Room 303-G23

10:30-10:55 Marisa Cantarino, *Blenders and robust transitivity for a family of derived from Anosov maps on T3*

11:00-11:25 David Simpson, *Explicit constructions for chaotic attractors of piecewise-linear maps*

11:30-11:55 Warwick Tucker, *Relative equilibria for the n-body problem*

Thursday 11:30-12:30, Room 303-G23

11:30-11:55 Solly Coles, *Ricci flow and the Anosov property*

12:00-12:25 Marty Golubitsky, *Infinitesimal Homeostasis*

Thursday 14:00-15:30, Room 303-G23

14:00-14:25 Gerardo Gonzalez Robert, *Diophantine approximation in integer bases*

14:30-14:55 Cecilia González Tokman, *Characterisation and perturbations of the Lyapunov-Oseledets spectrum for a class of random dynamical systems*

15:00-15:25 Anima Nagar, *Relations in Topological Dynamics*

Friday 11:30-12:30, Room 303-G23

11:30-11:55 Bernd Krauskopf, *An abundance of heterodimensional cycles via period doubling*

12:00-12:25 Bryna Kra, *Infinite configurations in large sets of integers*

Friday 14:00-15:30, Room 303-G23

14:00-14:25 Gary Froyland, *Quenched statistics for piecewise-continuous random dynamical systems: thermodynamic formalism, open dynamics, extreme value theory, and hitting time distributions.*

14:30-14:55 Rodney Nillsen, *Sums involving reciprocals of orbit points In the binary dynamical system*

19 Functional Analysis and Operator Algebras

Monday 14:00-15:30, Room 260-055

14:00-14:25 Lisa Orloff Clark, *Semi-Cartan Subalgebras and Twisted Groupoid C*-Algebras*

14:30-14:55 Michael Kelly, *Generalised Twisted Groupoids and their C*-Algebras*

15:00-15:25 Becky Armstrong, *Twisted groupoids that are not induced by 2-cocycles*

Monday 16:00-17:00, Room 260-055

16:00-16:25 Ryan Thompson, *Actions of Inverse Semigroups and their Étale Groupoids*

16:30-16:55 Sarah Reznikoff, *Some Combinatorial Cartan subalgebras*

Tuesday 11:30-12:30, Room 260-055

11:30-11:55 Hongyin Zhao, *Diagonal operators, Hausdorff measure and non-commutative symmetric spaces*

12:00-12:25 Nathan Brownlowe, *Self-similar quantum groups*

Tuesday 14:00-15:30, Room 260-055

14:00-14:25 Anne Thomas, *Trees and related species*

14:30-14:55 Victor Wu, *From directed graphs of groups to Kirchberg algebras*

15:00-15:25 Christian De Nicola Larsen, *Analytic properties of groups via Vaughan Jones' technology*

Tuesday 16:00-17:00, Room 260-055

16:00-16:25 Daniel Czapski, *Kruglov's operator in semifinite von Neumann algebras equipped with free independence*

Wednesday 10:30-12:00, Room 260-055

10:30-10:55 Mahya Ghandehari, *On Fourier-Stieltjes Algebras of Locally Compact Groupoids*

11:00-11:25 Jimeng Lu, *Pisier's Question: Steinberg Theorem Revisited*

Thursday 11:30-12:30, Room 260-055

11:30-11:55 Ivan Todorov, *Isomorphisms of quantum graphs*

12:00-12:25 Bill Helton, *Perfect quantum strategies for XOR games*

Thursday 14:00-15:30, Room 260-055

14:00-14:25 Galina Levitina, *Helton-Howe formula for singular traces*

14:30-14:55 Paul Muhly, *Applications of W*-categories to noncommutative function theory*

15:00-15:25 Thomas Scheckter, *Noncommutative Martingales in Continuous Time*

Friday 11:30-12:30, Room 260-055

11:30-11:55 Ilija Tolich, *Stably finite and purely infinite crossed products*

12:00-12:25 John Quigg, *The ladder method*

Friday 14:00-15:30, Room 260-055

14:00-14:25 Rufus Willett, *Representation stability and K-theory*

20 Functional analysis and partial differential operators

Monday 14:00-15:30, Room 260-020

14:00-14:25 Boris Baeumer, *Maximal Regularity for Stochastic Parabolic Volterra Integral Equations*

14:30-14:55 Jonathan Mui, *Regularity preserving perturbations for operator semigroups*

15:00-15:25 Iveta Semorádová, *PT-symmetric oscillators with one-center point interactions*

Monday 16:00-17:00, Room 260-020

16:00-16:50 Irina Mitrea, *Distinguished Coefficient Tensors for Second Order Elliptic Differential Operators and Applications to Boundary Value Problems*

Tuesday 11:30-12:30, Room 260-020

11:30-12:20 Patrick Guidotti, *Connecting the Dots*

Tuesday 14:00-15:30, Room 260-020

14:00-14:25 Daniel Daners, *The logistic equation on rough domains*

14:30-14:55 Simon Goodwin, *Dirichlet-to-Neumann Operators via Layer Potentials*

15:00-15:25 Tom ter Elst, *Commutator estimates and Poisson bounds for Dirichlet-to-Neumann operators with variable coefficients*

Tuesday 16:00-17:00, Room 260-020

16:00-16:50 Florica Cîrstea, *Existence and classification of solutions for nonlinear elliptic equations with singular potentials*

21 Groups and Geometry

Monday 14:00-15:30, Room 260-092

14:00-14:25 Marcus Chijoff, *The Scale Function Values of (P)-closed Groups Acting On Trees*

14:30-14:55 Max Carter, *Recent progress in the representation theory of totally disconnected locally compact groups*

15:00-15:25 Ryan Seelig, *Finitely presented simple groups that act on the circle, but not in a piecewise linear way*

Monday 16:00-17:00, Room 260-092

16:00-16:50 Jessica Purcell, *Geometry and combinatorics of 3-manifold triangulations*

Tuesday 11:30-12:30, Room 260-092

11:30-12:20 Marston Conder, *Recent discoveries about finite quotients of triangle groups*

Tuesday 14:00-15:30, Room 260-092

14:00-14:50 Piotr Przytycki, *Trees, fixed points, and the Cremona group*

15:00-15:25 Pratyush Mishra, *Girth Alternative for groups acting on CAT(0) cube complex*

Tuesday 16:00-17:00, Room 260-092

16:00-16:25 Ari Markowitz, *Deciding discreteness of groups of 2x2 matrices over local fields*

16:30-16:55 Roman Gorazd, *Which trees are almost isomorphic to cocompact trees?*

Wednesday 10:30-12:00, Room 260-092

10:30-11:20 Bertrand Remy, *L^p-cohomology of Lie groups*

11:30-11:55 Kai-Uwe Bux, *The Boone–Higman conjecture for groups acting on locally finite trees*

Thursday 11:30-12:30, Room 260-092

11:30-12:20 Alan Reid, *Profinite rigidity*

Thursday 14:00-15:30, Room 260-092

14:00-14:50 Barbara Baumeister, *Extended Weyl groups*

15:00-15:25 Marco Amelio, *(Cancelled) Non-split sharply 2-transitive groups in positive odd characteristic and geometric small cancellation methods*

Friday 11:30-12:30, Room 260-092

11:30-11:55 Jordan Bounds, *Garside shadows in some rank 3 affine Coxeter groups*

12:00-12:25 Yeeka Yau, *A pair of Garside shadows*

Friday 14:00-15:30, **Room 260-092**

14:00-14:25 Sira Busch, *Lines in geometries associated with finite buildings*

14:30-15:20 Hendrik Van Maldeghem, *Weyl substructures, polar kangaroos and uniclass automorphisms of spherical buildings*

22 Groups, actions and computations

Monday 14:00-15:30, Room 260-051

14:00-14:50 James Wilson, *Verifiable categorification of Characteristic subgroups*

15:00-15:25 Geertrui Van de Voorde, *The probability of two subspaces spanning a classical space*

Monday 16:00-17:00, Room 260-051

16:00-16:25 Anton Baykalov, *Imprimitive permutation groups of rank 3*

16:30-16:55 Luke Morgan, *Finite simple groups have many classes of p-elements*

Tuesday 11:30-12:30, Room 260-051

11:30-12:20 Alexander Hulpke, *Arithmetic and Algorithms for formal extensions*

Tuesday 14:00-15:30, Room 260-051

14:00-14:25 Jianbei An, *Weight subgroups of quasi-isolated blocks of finite exceptional groups*

14:30-14:55 Jie Du, *The q-Schur algebra of type D*

15:00-15:25 Mikko Korhonen, *Maximal solvable subgroups*

Tuesday 16:00-17:00, Room 260-051

16:00-16:50 Melissa Lee, *Computing the anatomy of the Monster*

Wednesday 10:30-12:00, Room 260-051

10:30-10:55 Meizheng Fu, *Elementary abelian p-subgroups and their local structure in classical groups*

11:00-11:25 Dorde Mitrović, *Exponential graph growth via eigenspaces of graphs over finite fields*

11:30-11:55 Jerry Shen, *The complexity of the epimorphism problem with virtually abelian targets*

Thursday 11:30-12:30, Room 260-051

11:30-12:25 Youming Qiao, *Isomorphism problems for some algebraic structures: algorithms, complexity, and cryptography*

Thursday 14:00-15:30, Room 260-051

14:00-14:50 Anne Thomas, *Hypergraph index and divergence in Coxeter groups*

15:00-15:25 Andre Nies, *The trivial units property and the unique product property for torsion free groups*

Friday 11:30-12:30, **Room 260-051**

11:30-11:55 Murray Elder, *On the complexity of the epimorphism problem for finitely presented groups*

12:00-12:25 Alan Reid, *Strongly dense representations of surface groups*

Friday 14:00-15:30, **Room 260-051**

14:00-14:25 Gabriel Verret, *Density of quotient orders in groups and applications to locally-transitive graphs*

14:30-15:20 Persi Diaconis, *Computational Polya Theory revisited*

23 Harmonic analysis and Hamiltonian PDE

Monday 14:00-15:30, Room 260-028

14:00-14:50 Kenji Nakanishi, *Classification of global dynamics around multi-solitons for the nonlinear Klein-Gordon equation*

15:00-15:25 Gong Chen, *Asymptotic stability of the sine-Gordon kink outside symmetry*

Monday 16:00-17:00, Room 260-028

16:00-16:50 Thierry Laurens, *A priori estimates for generalized KdV equations in* H^{-1}

Tuesday 11:30-12:30, Room 260-028

11:30-12:20 Satoshi Masaki, *Asymptotic behavior of solutions to systems of cubic NLS equations in 1D*

Tuesday 14:00-15:30, Room 260-028

14:00-14:50 Timothy Candy, *The non-relativistic limit for the cubic Dirac equation*

15:00-15:25 Barbara Prinari, *Local and global well-posedness for the Maxwell-Bloch equations with inhomogeneous broadening*

Tuesday 16:00-17:00, Room 260-028

16:00-16:25 Po-Lam Yung, *Discrete Strichartz estimates in low dimensions*

16:30-16:55 Yunfeng Zhang, *On the modified KdV equation in modulation spaces*

Wednesday 10:30-12:00, Room 260-028

10:30-11:20 Gino Biondini, *Spectral theory, semiclassical limits and soliton gases for the focusing nonlinear Schrodinger equation with periodic boundary conditions*

11:30-11:55 Maria Ntekoume, *Homogenization for the nonlinear Schrödinger equation with sprinkled nonlinearity*

Thursday 11:30-12:30, Room 260-028

11:30-12:20 Shiwu Yang, *Asymptotic decay for defocusing semilinear wave equations*

Thursday 14:00-15:30, Room 260-028

14:00-14:25 John Holmes, *Viscous Burgers' equation on the half-line*

14:30-15:20 Benjamin Dodson, *Scattering for the conformal wave equation*

24 Index Theory in Geometry and Mathematical Physics

Monday 14:00-15:30, Room 260-022

14:00-14:25 Rod Gover, *Conformal Yang-Mills renormalisation and higher Yang-Mills energies*

14:30-14:55 Thorsten Hertl, *Concordances in Positive Scalar Curvature and Index Theory*

15:00-15:25 Changliang Wang, *Positive mass theorem and positive scalar curvature for singular metrics*

Tuesday 14:00-15:30, Room 260-022

14:00-14:25 Diarmuid Crowley, *The topology of G_2-moduli spaces*

14:30-14:55 Chris Pirie, *The Equivariant Fried Conjecture for Suspension Flow*

15:00-15:25 Simone Cecchini, *Rigidity of spin fill-ins with non-negative scalar curvature*

Wednesday 10:30-12:00, Room 260-022

10:30-10:55 Tsuyoshi Kato, *Homotopy type of finitely propagated unitary operators and its applications*

11:00-11:25 Guo Chuan Thiang, *Fractional index and exact quantization*

11:30-11:55 Graeme Wilkin, *From Kleinian singularities to rational elliptic surfaces*

25 Industrial Mathematics

Monday 14:00-15:30, Room 402-211

14:00-14:25 Shaun Hendy, *The effect of incorporating infectious disease dynamics into a social cost–benefit framework for COVID-19 policy decisions*

14:30-14:55 Suncica Canic, *Mathematical design of a bioartificial pancreas*

15:00-15:25 Graeme Wake, *Unusual nonlocal calculus assists cancer cell growth treatments*

Monday 16:00-17:00, Room 402-211

16:00-16:25 Tim Wilson, *How to Predict and Quantify the Impacts of Radical Tobacco Policies in New Zealand*

16:30-16:55 Dragan Mirkovic, *Radiation Transport Problem in Proton Therapy of Cancer*

Tuesday 11:30-12:30, Room 402-211

11:30-11:40 Parul Tiwari, *Data-Driven Water Quality Modelling and Prediction for New Zealand Rivers: A Predictive Approach to Environmental Sustainability*

11:45-11:55 Melanie Roberts, *Advancing the MERGE Gully Erosion Model to inform gully remediation in protection of the Great Barrier Reef*

12:00-12:10 James Winchester, *Online Estimation for Dairy Processing*

12:15-12:25 Melissa Louise Smith, *When Bike Lanes Are Not Enough: An Application of Network Analysis to Low Stress Cycling Infrastructure in Aotearoa New Zealand Cities*

Tuesday 14:00-15:30, Room 402-211

14:00-14:25 Alona Ben-Tal, *Mathematical modelling of pressure dynamics within the skull and its influence on arterial blood pressure control*

14:30-14:55 Alys Clark, *Mathematical modelling to understand the effect of mask design on non-invasive ventilation*

15:00-15:25 Hammed Olawale Fatoyinbo, *Modelling the Dynamics of Infectious Bursal Disease in Poultry: A Sero-Epidemiological Approach*

Tuesday 16:00-17:00, Room 402-211

16:00-16:25 Hiroyuki Ochiai, *A mathematician meets computer graphics*

16:30-16:55 Jody McKerral, *Modelling of three-component complex conflict with decision-making, host population support and resource redistribution*

Wednesday 10:30-12:00, Room 402-211

10:30-10:55 Kenji Kajiwara, *Towards Geometry of Aesthetic Shape: Klein Geometry, Integrability and Self-Affinity*

11:00-11:25 Alex Tam, *Predicting patterns in ionic liquid films*

11:30-11:55 Anthony Kearsley, *Increasing sensitivity of analytical chemistry measurements using (very) applied mathematics.*

Thursday 11:30-12:30, Room 402-211

11:30-11:55 Alex Tam, *The UniSA Mathematics Clinic: How to build an industrial mathematics ecosystem*

12:00-12:25 Winston Sweatman, *Mathematics-in-Industry Study Groups in New Zealand and Furth of the Motu*

Thursday 14:00-15:30, Room 402-211

14:00-14:25 Pooja Dhiman, *An Innovative Approach to Cost Optimization: Prioritizing Key Systems and Subunit Ranking to Enhance Overall Performance of coffee machine*

14:30-14:55 John Holmes, *Partial differential equations from quantitative finance and their analysis*

15:00-15:25 Mark McGuinness, *Microwaving Ore to Detect Moisture Content*

Friday 11:30-12:30, Room 402-211

11:30-11:55 Tammy Lynch, *Modelling growth and metabolism of methanogens and other anaerobic microbial communities*

12:00-12:25 Simon Watt, *Performance analysis of the activated sludge model number 1 in a two reactor cascade*

Friday 14:00-15:30, Room 402-211

14:00-14:25 Catherine Hassell Sweatman, *Modelling hot water cylinder usage in order to manage peak load for a residential energy distributor in New Zealand*

14:30-14:55 John D. Mahony, *On the evaluation of a class of integrals involving the product of a Bessel function, a trigonometric function and a polynomial term.*

26 Mathematical methods in continuum mechanics and wave theory

Tuesday 14:00-15:30, Room 401-307

14:00-14:50 Kenneth Golden, *From micro to macro in modeling sea ice*

15:00-15:25 Yvonne Stokes, *Stability in the drawing of fibres with internal structure*

Wednesday 10:30-12:00, Room 401-307

10:30-10:40 Rehab Aljabri, *Time-Dependent Modeling of a Circular Ice Shelf*

10:45-10:55 Carl Vu, *The fluid dynamics of intrusions*

11:00-11:10 Afnan Aldosri, *Time Dependent Wave Propagation in Waveguides with Rectangular Scattering Regions*

11:15-11:25 Chaudry Masood Khalique, *Solutions and conservation laws of a nonlinear (3+1)-dimensional fifth-order partial differential equation*

11:30-11:55 Mike Meylan, *Efficient Numerical Solution of the Wave Equation as Matrix Multiplication.*

Thursday 11:30-12:30, Room 401-307

11:30-11:55 Eliot Fried, *Complete orthonormal sequences for representing general three-dimensional states of residual stress*

12:00-12:25 Tet Chuan Lee, *Modelling the shear stress experienced by the placental surface*

Thursday 14:00-15:30, Room 401-307

14:00-14:50 Dimitrios Mitsotakis, *Nonlinear and dispersive waves in a basin: Theory and numerical analysis*

15:00-15:25 Luke Bennetts, *Dynamic strains on ice shelves resulting from flexural and extensional motions forced by ocean wave packets*

Friday 11:30-12:30, Room 401-307

11:30-11:55 Sarah Wakes, *A dynamic vegetation roughness model for coastal dune systems*

12:00-12:25 Miguel Moyers, *Elasticity mediated yielding of an elasto-viscoplastic fluid in a plane channel flow*

Friday 14:00-15:30, Room 401-307

14:00-14:25 Christopher Lustri, *Complex Singularities in Analytically-Continued Nonlinear PDE Solutions*

14:30-14:55 Yury Stepanyants, *Highly localized horseshoe ripplons and solitons in positive dispersion media*

15:00-15:25 Brendan Harding, *Challenges in modelling particle laden flow as a continuum in an inertial microfluidics setting*

27 Mathematical Physics

Monday 14:00-15:30, Room 260-221

14:00-14:50 Sergei Gukov, *Fully-connected lattice models and 3-manifolds*

15:00-15:25 Yvan Saint-aubin, *Bound quiver algebras that are Morita-equivalent to the one-boundary Temperley-Lieb algebras*

Monday 16:00-17:00, Room 260-221

16:00-16:25 Joshua Celeste, *The cohomology of knotted semimetals*

16:30-16:55 Ethan Fursman, *Partial Reduction for W-Algebras*

Tuesday 11:30-12:30, Room 260-221

11:30-11:55 Joseph McGovern, *Non-realistic black holes, non-hypergeometric equations, and non-accessible invariants*

12:00-12:25 Justine Fasquel, *Connecting W-algebras and their representations*

Tuesday 14:00-15:30, Room 260-221

14:00-14:25 Jessica Hutomo, *Correlation functions of conserved higher-spin supercurrents in 4D N=1 SCFT*

14:30-14:55 Remy Adderton, *The coupled Temperley-Lieb algebra and planar parafermions in $\mathbb{Z}_N$ clock models.*

15:00-15:25 Cengiz Gazi, *Duality for ASEP on the half line*

Tuesday 16:00-17:00, Room 260-221

16:00-16:25 Willem Jacobus Petrus Van Tonder, *Eigenstates of an Integrable XY Model*

16:30-16:55 Eve Cheng, *Topological analysis of the complex SSH model*

Thursday 11:30-12:30, Room 260-009

11:30-11:55 Andrew Kels, *Two-component boundary Yang-Baxter maps*

12:00-12:25 Qiuye Jia, *The second microlocalization and the non-relativistic limit of Klein-Gordon equations*

28 Mathematics Education

Monday 14:00-15:30, Room 260-115

14:00-14:25 Tanya Evans, *Traditional lectures versus active learning – a false dichotomy?*

14:30-14:55 Carolyn Kennett, *Comparing the effectiveness of different modes of attendance in a maths preparation course for medical science students*

15:00-15:25 Paul Fijn, *Evaluating Next-Generation Technology-enabled Tutorial Spaces for Small-group classes*

Monday 16:00-17:00, Room 260-115

16:00-16:10 Huayu Gao, *Exploring Gender Differences in Tertiary Mathematics-Intensive Fields: A Critical Review of Social Cognitive Career Theory*

16:15-16:25 Adriana Zanca, *Automated mathematics assessment: should I use it and how?*

16:30-16:40 Huixin Gao, *Student Explanation Strategies in Tertiary Mathematics and Statistics Education: A Scoping Review*

16:45-16:55 Dush Bandarawickrama, *A Comparative Study of Probability and Statistics High School Curricula between Australia and South Asia*

Tuesday 11:30-12:30, Room 260-115

11:30-11:55 Doug Corey, *Grouping Calculus Students by Video Watching Behavior and the Effect of Group Membership on Learning*

12:00-12:25 Chris Gordon, *Does self-paced online learning prepare a student for first-year mathematics?*

Tuesday 14:00-15:30, Room 260-115

14:00-14:25 Sang Hyun Kim, *Exploring Student Preferences for Collaboration in Mathematics: A Scale Validation Study*

14:30-14:40 Matthew Voigt, *"I'm Better at This Than You" - Does AI's Thematic Analysis Outshine Human Expertise in STEM Education Research?*

14:45-14:55 Bibhya Sharma, *The Status of Mathematics in the South Pacific*

15:00-15:25 Minglin Zhou, *Effect of 'student-lecturing' teaching model on eighth grade students' attitude towards mathematics*

Tuesday 16:00-17:00, Room 260-115

16:00-16:50 Widodo Samyono, *Unlocking Curiosity and Building Resilience: Engaging Students in Biocalculus with Inquiry-Based AI Tools for Effective Hybrid Learning*

Wednesday 10:30-12:00, Room 260-115

10:30-10:55 Poh Hillock, *Redesigning First-Year Mathematics for Student Success*

11:00-11:25 Marcel Derkum, *Pedagogical Practices: PISA 2022 data analysis of inquiry-based and teacher-directed approaches*

11:30-11:55 Tanya Saxena, *Analysing the impact of streaming in New Zealand primary schools through multilevel models using TIMSS data*

Thursday 11:30-12:30, Room 260-115

11:30-11:55 Raymond Vozzo, *An assessment of active learning in large first year maths courses*

12:00-12:10 Neea Palojärvi, *On misconceptions in the Math Kangaroo Finland*

12:15-12:25 M.G.M Khan, *A Study on Mathematics Anxiety and its Effect on Mathematics Performance of School Students in Fiji*

Thursday 14:00-15:30, Room 260-115

14:00-14:50 Edgar Fuller, *Measuring the Effects of Active Learning on Student Learning Outcomes in Calculus Using a Randomized Trial*

15:00-15:25 Fu Ken Ly, *Bridging Assumed Knowledge Gaps with Technology: Implementing a University-Wide Mathematics Diagnostic Tool*

Friday 11:30-12:30, Room 260-115

11:30-11:55 Bartek Ewertowski, *The mathematical ekklesia: active learning inspired by the ancients*

12:00-12:25 Jan Denniel Escaño, *Assessing the Impact of Blended Learning Mathematics Intervention on Civil Engineering Students' Performance: A Post-Pandemic Evaluation Using Hierarchical Linear Modeling and Sensitivity Analysis*

Friday 14:00-15:30, Room 260-115

14:00-14:50 Ernesto Calleros, *Developing and Refining a Framework to Identify the Language Demands and Resources for Multilingual Students in Inquiry-Based Undergraduate Mathematics Courses*

15:00-15:25 Sushita Sharma, *Measuring Student Readiness for Remote Learning in Times of Emergencies and Crisis.*

29 Mathematics of nonlinear diffusion processes

Monday 14:00-15:30, Room 260-018

14:00-14:50 Amy Novick-Cohen, *Surface Diffusion: Some new results and approaches*

15:00-15:25 Phil Broadbridge, *Exact solutions to multidimensional nonlinear reaction-diffusion. Part 1: Conditionally integrable nonlinear reaction-diffusion-convection applied to irrigation*

Monday 16:00-17:00, Room 260-018

16:00-16:50 Fernando Pereira Duda, *Extending Beyond Fickian Diffusion with Continuum Thermodynamics as a Guide*

Tuesday 11:30-12:30, Room 260-018

11:30-12:20 Bronwyn Hajek, *Nonlinear backward diffusion, an exact solution, and regularisation options*

Tuesday 14:00-15:30, Room 260-018

14:00-14:50 Yoshihiro Tonegawa, *Some recent results on existence and regularity of Brakke flow*

15:00-15:25 Phil Broadbridge, *Exact solutions to multidimensional nonlinear reaction diffusion. Part 2: Nonlinear reaction-diffusion applied to fisheries and Cahn-Hilliard phase fields*

Tuesday 16:00-17:00, Room 260-018

16:00-16:50 Shinya Okabe, *A gradient flow for the ideal energy under a length constraint*

Wednesday 10:30-12:00, Room 260-018

10:30-11:20 Juncheol Pyo, *Solitons of the mean curvature flow*

Thursday 11:30-12:30, Room 260-018

11:30-12:20 Simon Blatt, *Analyticity of Solutions to Fractional Partial Differential Equations*

Thursday 14:00-15:30, Room 260-018

14:00-14:50 Chun-chi Lin, *Higher-order Riemannian spline interpolation problems: a unified approach by gradient flows*

Friday 11:30-12:30, Room 260-018

11:30-12:20 Michal Benes, *Motion and Transport in Curve Dynamics*

Friday 14:00-15:30, Room 260-018

14:00-14:50 Yong Wei, *Tensor maximum principle and its applications*

30 Microlocal analysis and inverse problems

Monday 14:00-15:30, Room 260-009

14:00-14:50 Maarten De Hoop, *Geometry, spectral analysis and inverse problems on gas giants*

15:00-15:25 Qiuye Jia, *Geometric inverse problems on asymptotically conic manifolds: a microlocal approach*

Monday 16:00-17:00, Room 260-009

16:00-16:25 Colin Fox, *The finite-rank property of inverse problems and computation*

16:30-16:55 Madelyne Brown, *The growth of Fourier coefficients of restricted eigenfunctions*

Tuesday 11:30-12:30, Room 260-009

11:30-11:55 Hiroyuki Chihara, *Geodesic X-ray transform and streaking artifacts on*

12:00-12:25 Rohit Kumar Mishra, *2D V-line Tensor Tomography with Some Numerical Simulation*

Tuesday 14:00-15:30, Room 260-009

14:00-14:50 Plamen Stefanov, *Recent results on Lorentzian scattering rigidity*

15:00-15:25 Richard Huber, *The Range of Projection Pair Operators*

Wednesday 10:30-12:00, Room 260-009

10:30-10:55 Amal Alghamdi, *Computational Uncertainty Quantification for Inverse problems in Python (CUQIpy)*

11:00-11:25 Daniela Calvetti, *Computational techniques for recovering singularities, with application to X-ray tomography*

11:30-11:55 Stephen McDowall, *Luminescent Solar Concentrators*

Friday 11:30-12:30, Room 260-009

11:30-12:20 Gunther Uhlmann, *The Calderon Problem for Nonlocal Operators*

Friday 14:00-15:30, Room 260-009

14:00-14:25 Anuj Abhishek, *Operator Networks in Inverse Problems : Direct and Bayesian Inversion*

14:30-14:55 Erkki Somersalo, *Bridging the gap between continuous and discrete inverse problems*

31 New directions in pattern formation

Tuesday 11:30-12:30, Room 303-B11

11:30-11:55 Carlo Laing, *Moving bumps in theta neuron networks*

12:00-12:25 Edgar Knobloch, *Snaking of time-dependent localized structures*

Tuesday 14:00-15:30, Room 303-B11

14:00-14:25 Rodrigues Bitha, *Spontaneous symmetry breaking in a coupled photonic crystal dimer with two interacting light fields*

14:30-14:55 Behrooz Yousefzadeh, *Pattern formation in coiling of falling viscous threads*

15:00-15:25 Christopher Lustri, *Stokes' phenomenon, discretization, and discrete integrability*

Friday 11:30-12:30, Room 303-B11

11:30-11:55 Vanessa Robins, *Topological data analysis of self-assembled point patterns formed in molecular dynamics simulation*

12:00-12:25 Daniele Avitabile, *Uncertainty Quantification for Neurobiological Networks*

Friday 14:00-15:30, Room 303-B11

14:00-14:25 Eliot Fried, *Chemical pattern formation on the surface of an elastic solid*

14:30-14:55 Andreas Kempa - Liehr, *Complex bound states of dissipative solitons in three-component reaction-diffusion systems*

32 Optimisation

Monday 14:00-15:30, Room 402-221

14:00-14:50 Christiane Tammer, *Optimality conditions in optimization under uncertainty*

15:00-15:25 Li Chen, *Robust Optimization with Moment-Dispersion Ambiguity*

Monday 16:00-17:00, Room 402-221

16:00-16:25 Queenie Yingkun Huang, *Piecewise sum-of-squares-convex moment optimisation via semi-definite programs*

16:30-16:55 Tan Nhat Pham, *A proximal splitting algorithm for generalized DC programming with applications in signal recovery*

Tuesday 11:30-12:30, Room 402-221

11:30-11:55 Lien Nguyen, *Second-order dynamical systems with fixed-time convergence*

12:00-12:25 Dominic Keehan, *Epi-Consistent Approximation of Stochastic Dynamic Programs*

Tuesday 14:00-15:30, Room 402-221

14:00-14:25 James Foster, *Galois connections, adjoints and duality in optimisation*

14:30-14:55 Sione Paea, *Information Architecture (IA): Multidimensional scaling and K-means analysis for small and large card sorting datasets*

15:00-15:25 Vinesha Peiris, *Kolmogorov-Arnold theorem and its applications*

Tuesday 16:00-17:00, Room 402-221

16:00-16:25 Yingying Yang, *An Exact Method for the Bi-objective p-median Max-sum Diversity Problem*

16:30-16:55 Liam MacDonald, *A Generic Scheme for Quadratic Minimisation*

Wednesday 10:30-12:00, Room 402-221

10:30-10:55 Nam Ho-Nguyen, *A projection-free method for solving convex bilevel optimization problems*

11:00-11:25 Bethany Caldwell, *The Douglas–Rachford algorithm for inconsistent problems*

11:30-11:55 Vivek Shiuram, *Comparative Analysis of Local Minima Prevention Algorithms: LbCS-RRT, Ant Colony Optimization in Continuous Domain (ACOR), and StepAhead Firefly Algorithm (SAFA)*

Thursday 11:30-12:30, Room 402-221

11:30-12:20 Russell Luke, *Convergence Theory for Expansive Markov Chains*

Thursday 14:00-15:30, Room 402-221

14:00-14:25 Sona Taheri, *Solving constrained difference of convex (DC) optimisation problems*

14:30-14:55 Scott Lindstrom, *On tight error bounds for conic optimisation*

15:00-15:25 Simon Marshall, *GNLS: an R Program for Errors-in-Variables Fitting*

Friday 11:30-12:30, Room 402-221

11:30-11:55 Adil Bagirov, *A hybrid method for solving constrained DC optimization problems*

12:00-12:25 Minh N. Dao, *Doubly relaxed forward-Douglas–Rachford splitting for the sum of two nonconvex and a DC function*

Friday 14:00-15:30, Room 402-221

14:00-14:25 Neil Dizon, *Wasserstein Distributionally Robust Optimization with Piecewise SOS-Convexity*

14:30-14:55 Matthew Tam, *A decentralised algorithm for min-max problems*

33 Probability and Mathematical Statistics

Monday 14:00-15:30, Room 260-098

14:00-14:25 Mark Holmes, *All in!*

14:30-14:55 Susan Holmes, *Generative probabilistic models for experimental design, teaching statistics and goodness of fit testing.*

15:00-15:25 Alexis Kagan, *The trace of a random walk in random environments on trees*

Monday 16:00-17:00, Room 260-098

16:00-16:10 Hugh Entwistle, *A double-choice secretary problem with a random horizon*

16:15-16:25 Binghao Wu, *On the exponential integrability of the derivative of intersection and self-intersection local time for Brownian motion and related processes*

16:30-16:40 Vincent Liang , *On time-dependent boundary crossing probabilities of diffusion processes as differentiable functionals of the boundary*

16:45-16:55 Illia Donhauzer, *Superpositions of continuous autoregressive random fields*

Tuesday 11:30-12:30, Room 260-098

11:30-11:55 Peter Taylor, *Lattice and Non-Lattice Markov Additive Models*

12:00-12:25 Ruth Williams, *Biochemical reaction networks and reflected diffusions*

Tuesday 14:00-15:30, Room 260-098

14:00-14:25 Sandra Palau, *Coalescent point process of branching trees in a varying environment*

14:30-14:55 Juan Carlos Pardo, *On the speed of coming down from infinity for branching processes with pairwise interactions*

15:00-15:25 Conrad Burden, *Coalescence for Feller diffusions*

Tuesday 16:00-17:00, Room 260-098

16:00-16:25 Conor Kresin, *A New Computationally Efficient and Consistent Estimator for Spatiotemporal Point Process Data*

16:30-16:55 Tilman Davies, *Gettn' Freqky with Spatial Point Patterns*

Wednesday 10:30-12:00, Room 260-098

10:30-10:55 Frederi Viens, *Pearson's correlation statistic for a pair of Brownian motions: a Wiener chaos approach to its discrete-time asymptotics.*

11:00-11:25 Tim Garoni, *Critical speeding-up in high-dimensional dynamical percolation*

Thursday 11:30-12:30, Room 260-098

11:30-11:55 Steven Evans, *B cell phylodynamics*

12:00-12:25 Krzysztof Burdzy, *Optimal shape domain for the torsion problem*

Thursday 14:00-15:30, Room 260-098

14:00-14:25 Leah South, *Assessing moment convergence using polynomial Stein kernels*

14:30-14:55 Chris Drovandi, *Simulation-based Inference and Model Misspecification*

15:00-15:25 Sarat Moka, *Efficient Rare-Event Simulation for Random Geometric Graphs via Importance Sampling*

Friday 11:30-12:30, Room 260-098

11:30-11:55 Georgy Sofronov, *Multiple Stopping Problems*

12:00-12:25 Jie Yen Fan, *Mimicking*

Friday 14:00-15:30, Room 260-098

14:00-14:25 Budhi Arta Surya, *Fitting phase-type distribution with covariates*

14:30-14:40 Matthew Sutton, *Enhanced MCMC: Fully Adaptive Sampling with PDMP Samplers*

14:45-14:55 Qingwei Liu, *Normal approximation of subgraphs counts in the random-connection model*

15:00-15:10 Renjie Feng, *Extreme gap problems for classical random matrices*

15:15-15:25 Simon Marshall, *The Wrapped Hyperbolic Secant Distribution and its Binary Mixtures*

34 Recent advances in geometric PDE

Monday 14:00-15:30, Room 260-057

14:00-14:50 Ben Andrews, *Tumbling stones and curvature flows*

15:00-15:25 Susan Scott, *The Abstract Boundary (a-boundary) for Space-Time and its Applications*

Monday 16:00-17:00, Room 260-057

16:00-16:10 Alexander Bednarek, *Global Ricci Curvature Behaviour for the Kahler-Ricci Flow with Finite Time Singularities*

16:15-16:25 Chris Stevens, *Wellposedness of the initial boundary value problem for the conformal Einstein field equations*

16:30-16:40 Areeba Merriam, *Numerical Implementation of the Friedrich-Nagy Initial Boundary Value Problem*

16:45-16:55 Lachlan Campion, *Numerically extending the Generalised Conformal Field Equations to include energy and momentum.*

Tuesday 11:30-12:30, Room 260-057

11:30-12:20 Guofang Wei, *The volume entropy rigidities for RCD spaces*

Tuesday 14:00-15:30, Room 260-057

14:00-14:25 Lee Kennard, *From sectional to Ricci curvature via symmetry*

14:30-14:55 Xavier Ramos Olive, *Ricci Curvature on Graphs*

15:00-15:25 Pablo Suárez-Serrato, *Zero entropy on entire Grauert tubes*

Tuesday 16:00-17:00, Room 260-057

16:00-16:25 Louis Yudowitz, *Semi-Continuity of the Morse Index for Ricci Shrinkers*

16:30-16:40 Malik Tuerkoen, *Fundamental Gap Estimates in Various Geometries*

16:45-16:55 Sophie Chen, *Counterexample to the second eigenfunction having one zero for a non-local Schrödinger operator*

Wednesday 10:30-12:00, Room 260-057

10:30-10:40 Louie Bernhardt, *Linear waves on the expanding region of Schwarzschild de Sitter spacetimes: forward asymptotics and scattering from infinity*

10:45-10:55 Mia Boothroyd, *The Einstein-Maxwell-Scalar Field Problem in T2 and Gowdy symmetry.*

11:00-11:10 Elliot Marshall, *Past Instability of FLRW Solutions to the Einstein-Euler-Scalar Field Equations*

11:15-11:25 Joseph Galinski, *Angular Momentum in General Relativity*

11:30-11:40 Sebenele Thwala, *Towards non-linear scattering of gravitational waves*

11:45-11:55 Breanna Camden, *The Physical interpretation of the Newman-Penrose constants and Newman's H-space*

Thursday 11:30-12:30, Room 260-057

11:30-12:20 Peter Petersen, *New vanishing results for Kaehler manifolds*

Thursday 14:00-15:30, Room 260-057

14:00-14:25 Casey Blacker, *Geometric and algebraic reduction of multisymplectic manifolds*

14:30-15:20 Todd Oliynyk, *Stable and unstable behaviour in relativistic fluids on cosmological spacetimes*

Friday 11:30-12:30, Room 260-057

11:30-11:55 Bogdan Suceava, *There Are Five Classes of Fundamental Inequalities in the Geometry of Submanifolds*

12:00-12:25 Adrian Vajiac, *Hypertwined Regularity and Applications*

Friday 14:00-15:30, Room 260-057

14:00-14:25 Cale Rankin, *A geometric approach to the Ma–Trudinger–Wang estimates*

14:30-14:55 Peter Olanipekun, *Recent Progress on the Willmore Energy of Four Dimensional Submanifolds*

15:00-15:25 Timothy Buttsworth, *Rigorous machine-learning-assisted existence of O(3)xO(10)-invariant Einstein metrics on* S^{12}

35 Recent advances in mathematical fluid dynamics

Tuesday 16:00-17:00, Room 401-311

16:00-16:25 Tsuyoshi Yoneda, *Effectiveness of Littlewood-Paley theory in the study of turbulence and machine learning*

16:30-16:55 Noah Vinod, *Well-posedness for a Magnetohydrodynamical Model with Intrinsic Magnetisation*

Wednesday 10:30-12:00, Room 401-311

10:30-10:55 Agnieszka Swierczewska-Gwiazda, *Compressible magnetohydrodynamics driven by non-conservative boundary conditions*

11:00-11:25 Angel Castro, *Unstable vortices and non-uniqueness for 2D Euler and gSQG*

11:30-11:55 Piotr Gwiazda, *Some remark about relative entropy method for long time asymptotic in fluid dynamics*

Thursday 11:30-12:30, Room 401-311

11:30-11:55 Javier Gomez-Serrano, *Existence of non convex V-states*

12:00-12:25 Marco Sammartino, *Dissipative 2D MHD equations with L^1 vorticity and current*

Thursday 14:00-15:30, Room 401-311

14:00-14:25 Joonhyun La, *Wave turbulence and some well-posedness results*

14:30-14:55 Kengo Deguchi, *Analysis of Coherent Structures in Shear Flows*

15:00-15:25 Vincent Martinez, *Upper bound estimates on the dimension of the global attractor for the 2D NSE on the beta-plane*

Friday 11:30-12:30, Room 401-311

11:30-11:55 Alexey Cheskidov, *Non-uniqueness for fluid equations*

12:00-12:25 In-jee Jeong, *On the rate of vortex stretching for axisymmetric flows without swirl*

Friday 14:00-15:30, Room 401-311

14:00-14:25 Khonatbek Khompysh, *An inverse source problem for Navier-Stokes-Voigt system*

14:30-14:55 Shixiao Wang, *The dynamics of the quasi-Keplerian flow*

15:00-15:25 Wojciech Ozanski, *Instantaneous continuous loss of regularity for the SQG equation*

36 Recent developments in data science and machine learning

Monday 14:00-15:30, Room 402-220

14:00-14:25 Ting Wang, *Finding the number of latent states in hidden Markov models using information criteria*

14:30-14:55 Hien Nguyen, *Lp Approximation Rates for Location-Scale Mixture Densities and Implications to Adaptive Least-Squares Estimation*

15:00-15:25 Tian-Yi Zhou, *Optimal Classification-based Anomaly Detection with Neural Networks: Theory and Practice in Cybersecurity*

Monday 16:00-17:00, Room 402-220

16:00-16:25 Caroline Wormell, *EDMD errors in chaotic and random dynamics: qualitatively similar but quantitatively different*

16:30-16:55 Junhong Lin, *On Convergence of Adam for Stochastic Optimization*

Tuesday 11:30-12:30, Room 402-220

11:30-11:55 Susan Wei, *Leveraging free energy in pretraining model selection for improved fine-tuning*

12:00-12:25 Niya Chen, *Hybrid Model Using Realized Conditional Autoregressive Expectile Models and*

Tuesday 14:00-15:30, Room 402-220

14:00-14:25 Gerlind Plonka, *The Multichannel Blind Deconvolution Problem in Parallel MRI*

14:30-14:55 Simon Foucart, *Optimal Recovery of Multivalued Functions*

15:00-15:25 HRUSHIKESH MHASKAR, *A super-resolution approach to classification*

Tuesday 16:00-17:00, Room 402-220

16:00-16:25 Martin Hazelton, *Efficient Fibre Sampling for Statistical Linear Inverse Problems*

16:30-16:55 Benoit Liquet, *Best Subset Selection via Continuous Optimization*

Wednesday 10:30-12:00, Room 402-220

10:30-10:55 Minh Ha Quang, *Infinite-dimensional statistical distances for functional data analysis*

11:00-11:25 Sakshi Arya, *Single-Index Batched Contextual Bandits*

11:30-11:55 Markus Holzleitner, *On Polynomial Functional Regression*

Thursday 11:30-12:30, Room 402-220

11:30-11:55 Daohong Xiang, *Coefficient-based lq- regularized direct learning for estimating individual treatment rule*

12:00-12:25 Jun Fan, *Learnability of neural networks under heavy-tailed noise*

Thursday 14:00-15:30, Room 402-220

14:00-14:25 Ding-Xuan Zhou, *The role of structures in neural networks*

14:30-14:55 Zhengchu Guo, *Online Learning in Reproducing Kernel Hilbert Space*

15:00-15:25 Yiming Ying, *Optimal Rates for Gradient Descent Methods with Two-layer ReLU Networks*

Friday 11:30-12:30, Room 402-220

11:30-11:55 Fabian Dunker, *Regularized maximum likelihood for density estimation in structural models*

12:00-12:25 Lei Shi, *Learning Operators with Stochastic Gradient Descent in General Hilbert Spaces*

Friday 14:00-15:30, Room 402-220

14:00-14:25 Ata Kaban, *Efficient learning with projected histograms*

14:30-14:55 Xin Guo, *Capacity dependent analysis for functional online learning algorithms*

37 Representation Theory and Tensor Categories

Monday 14:00-15:30, Room 303-G14

14:00-14:25 Daniel Nakano, *Category O for Lie superalgebras*

14:30-14:55 Eric Jankowski, *The Super Combinatorics of Normal Toric Supervarieties*

15:00-15:25 Vera Serganova, *Supergroups and finite groups in positive characteristic*

Monday 16:00-17:00, Room 303-G14

16:00-16:25 Tom Goertzen, *Representation theory of crystallographic groups and combinatorics of interlocking assemblies*

16:30-16:55 Eloise Little, *Balanced systems of cell representations for affine Hecke algebras*

Tuesday 14:00-15:30, Room 303-G14

14:00-14:25 David Ridout, *Irreducible weight $\mathfrak{sl}_3$-modules with infinite multiplicities*

14:30-14:55 Gavrilo Šipka, *Orthogonal Yangians and Evaluation Homomorphisms*

15:00-15:25 Paul Zinn-Justin, *The exceptional series and the Yang–Baxter equation*

Wednesday 10:30-12:00, Room 303-G14

10:30-10:55 Sophie Kriz, *Interpolated Group Theory*

11:00-11:25 Joseph Newton, *Finite symmetric and exterior algebras in tensor categories*

11:30-11:55 Nate Harman, *Interpolation Categories for Classical Groups*

Thursday 11:30-12:30, Room 303-G14

11:30-11:55 Ian Le, *Demazure weaves for reduced plabic graphs*

12:00-12:25 Sinead Wilson, *Parabolic subgroups of Artin groups via categorification. Preliminary report.*

Thursday 14:00-15:30, Room 303-G14

14:00-14:25 Pinhas Grossman, *Quadratic fusion categories*

14:30-14:55 Bregje Pauwels, *Approximation in triangulated categories*

15:00-15:25 John Huerta, *Poincaré duality for families of supermanifolds*

Friday 11:30-12:30, Room 303-G14

11:30-11:55 Oded Yacobi, *Periodic braids and slicings*

12:00-12:25 Leonardo Maltoni, *Morse Theoretic Gaussian Elimination for Rouquier Complexes*

Friday 14:00-15:30, Room 303-G14

14:00-14:25 Dominic Searles, *0-Hecke–Clifford supermodules from diagrams*

14:30-14:55 Mengfan Lyu, *Generalized Temperley-Lieb algebras and their diagram presentation*

15:00-15:25 Jonathan Kujawa, *Affine and Cyclotomic A-webs*

38 Singularities

Monday 16:00-17:00, Room 260-024

16:00-16:50 Yang Zhang, *Noncrossing algebras and (co)homology complexes for Milnor fibres*

Tuesday 11:30-12:30, Room 260-024

11:30-12:20 Alexandru Suciu, *On the topology of the Milnor fibration of a complex hyperplane arrangement*

Tuesday 14:00-15:30, Room 260-024

14:00-14:50 Graham Denham, *Cohomology jump loci for Schubert arrangements*

15:00-15:25 Christin Bibby, *Supersolvable posets and fiber-type arrangements*

Tuesday 16:00-17:00, Room 260-024

16:00-16:50 Luca Fabrizio Di Cerbo, *On the Geometry of Symmetric Products of Curves*

Wednesday 10:30-12:00, Room 260-024

10:30-11:20 Yongqiang Liu, *BNSR invariants and the tropical variety of jump loci*

11:30-11:55 Michael Eastwood, *A very special sextic*

Thursday 11:30-12:30, Room 260-024

11:30-12:20 Mark Perrin, *Semialgebraic Geometry - Modifying Thom's Lemma*

Thursday 14:00-15:30, Room 260-024

14:00-14:50 Xiping Zhang, *The Characteristic Cycle of Restricted Constructible Functions*

Friday 11:30-12:30, Room 260-024

11:30-12:20 Eva Elduque, *On plane curve complements with certain fundamental groups*

Friday 14:00-15:30, Room 260-024

14:00-14:50 Moisés Herradón Cueto, *Hodge theory of abelian covers of algebraic varieties*

39 Special Functions, q-Series and Beyond

Monday 14:00-15:30, Room 401-312

14:00-14:50 Ae Ja Yee, *Partition ranks and cranks from a combinatorial point of view*

15:00-15:25 Michael Schlosser, *Rook equivalence and a multisum extension of the Sears* $_4\phi_3$ *transformation*

Monday 16:00-17:00, Room 401-312

16:00-16:25 Heng Huat Chan, *Ramanujan's theory of elliptic functions to the cubic base*

16:30-16:55 Jang Soo Kim, *Lecture hall graphs and the Askey scheme*

Tuesday 11:30-12:30, Room 401-312

11:30-12:20 Ken Ono, *q-analogues of multiple zeta functions: Partitions detect prime numbers*

Tuesday 14:00-15:30, Room 401-312

14:00-14:50 Eleanor McSpirit, *Modularity and Resurgence*

15:00-15:25 Shashank Kanade, *Remarks on the conjectures of Capparelli, Meurman, Primc and Primc*

Tuesday 16:00-17:00, Room 401-312

16:00-16:25 Gaurav Bhatnagar, *Expansion formulas for elliptic hypergeometric series*

16:30-16:55 Pieter Roffelsen, *On q-Painlevé VI transcendents, connection problems and Segre surfaces*

Wednesday 10:30-12:00, Room 401-312

10:30-11:20 Nalini Joshi, *On q-difference Painlevé equations and their Riemann–Hilbert problems*

11:30-11:55 Owen Goff, *The q-Onsager algebra and the quantum torus*

Thursday 11:30-12:30, Room 401-312

11:30-12:20 Ling Long, *Hypergeometric Functions and Modular Forms*

Thursday 14:00-15:30, Room 401-312

14:00-14:25 Andrei Martínez-Finkelshtein, *Hypergeometric Polynomials with Free Probability Tools*

14:30-14:55 Theo Assiotis, *Moments of characteristic polynomials of random matrices*

15:00-15:25 Brandt Kronholm, *Formulas for integer partition functions and the usefulness of a forgotten technique.*

Friday 11:30-12:30, Room 401-312

11:30-12:20 Greta Panova, *Hook-length formulas for skew shapes via complex integrals and vertex models*

Friday 14:00-15:30, Room 401-312

14:00-14:25 Tuan Ngo Dac, *On special functions and twisted L-series*

14:30-14:55 Andrew Kels, *Lens elliptic gamma function and extensions of elliptic hypergeometric integrals*

15:00-15:25 Howard S. Cohl, *Transformations and summations for basic bilateral hypergeometric series*

40 Stochastic and Deterministic Inverse Problems

Monday 14:00-15:30, Room 260-223

14:00-14:25 Xin Guo, *Learning Green's functions from data*

14:30-14:55 Madhu Gupta, *Nonlinear Reconstruction of Optical Parameters in Photoacoustic Tomography*

15:00-15:25 Oliver Maclaren, *Identifiability and reparameterisation methods for inverse problems*

Monday 16:00-17:00, Room 260-223

16:00-16:25 Alex De Beer, *Ensemble Kalman Methods for Large-Scale Geophysical Inverse and Optimal Experimental Design Problems*

16:30-16:55 Marie Graff, *Recent advances on the Adaptive Eigenspace Inversion method: Bayesian formalism*

Thursday 11:30-12:30, Room 260-040

11:30-11:55 Kate Lee, *Variational Bayes inference for gravitational wave detector*

12:00-12:25 Nathan Waniorek, *Hierarchical Bayesian inverse problems: a high-dimensional statistics viewpoint*

Thursday 14:00-15:30, Room 260-040

14:00-14:25 Yunan Yang, *Stochastic Inverse Problem: stability, regularization, and Wasserstein gradient flow*

14:30-14:55 Tiangang Cui, *Intrinsic Subspaces of High-Dimensional Inverse Problems and Where to Find Them*

15:00-15:25 Colin Fox, *Posterior exploration for high-contrast EIT with Cleveland prior*

Friday 11:30-12:30, Room 260-040

11:30-11:55 Stuart Hawkins, *A neural-network surrogate Bayesian algorithm for the Helmholtz inverse-shape problem*

12:00-12:25 Ruanui (Ru) Nicholson, *On joint inversion in the Bayesian framework: is ignorance always bliss?*

Friday 14:00-15:30, Room 260-040

14:00-14:25 Philipp Wacker, *Nested Sampling for Rare Event Estimation*

14:30-14:55 Bamdad Hosseini, *Solving inverse problems using transport maps*

15:00-15:25 Ali Mohammad-Djafari, *Physics Informed Deep Neural Networks for Dynamical system identification and Inverse problems*

41 Stochastic Differential Equations

Monday 14:00-15:30, Room 260-016

14:00-14:25 Erika Hausenblas, *Stochastic Landau-Lifshitz-Gilbert equations (SLLGEs) driven by a rough path*

14:30-14:55 Xi Geng, *Long-time Behaviour of Stochastic Heat Equations in the Hyperbolic Space*

15:00-15:25 Wawan Hafid Syaifudin, *The Laplace transform of first exit time of geometric Brownian motion with affine drift*

Monday 16:00-17:00, Room 260-016

16:00-16:25 Clayton McDonald, *The harmonic measure distribution function and stopping times of complex Brownian motion*

Tuesday 11:30-12:30, Room 260-016

11:30-12:20 Andrzej Swiech, *Finite dimensional projections of Hamilton-Jacobi-Bellman equations in spaces of probability measures*

Wednesday 10:30-12:00, Room 260-016

10:30-10:55 Quoc Thong Le Gia, *Evolution of time-fractional stochastic hyperbolic diffusion*

11:00-11:25 John Nolan, *Riesz capacity via hitting distribution for stable processes*

Thursday 11:30-12:30, Room 260-016

11:30-11:55 Beniamin Goldys, *Differentiability of transition semigroup of generalized Ornstein-Uhlenbeck process: a probabilistic approach*

12:00-12:25 Philipp Wacker, *(Biological) Evolution is similar to misspecified (stochastic) filtering*

Thursday 14:00-15:30, Room 260-016

14:00-14:25 Debopriya Mukherjee, *Optimal relaxed control of stochastic hereditary evolution equations with Levy noise*

14:30-14:55 Chi-Jen Wang, *Discontinuous non-equilibrium phase transition in Schloegl's second model for autocatalysis*

15:00-15:25 Akash Ashirbad Panda, *Large Deviation Principle for Stochastic Nematic Liquid Crystals Driven By Multiplicative Gaussian Noise*

Friday 11:30-12:30, Room 260-016

11:30-11:55 Ruyi Liu, *Optimal Information Disclosure of the Principal-Agent Problem in Infinite Horizon*

12:00-12:25 Joern Wichmann, *Reaching the equilibrium: Long-term stable numerical schemes for SPDEs*

42 Structural aspects of matroids and graphs

Tuesday 11:30-12:30, Room 303-B09

11:30-11:55 Nick Brettell, *Detachable pairs in 3-connected matroids and simple 3-connected graphs*

12:00-12:25 Sam Bastida, *Contracting a Single Element in a Transversal Matroid*

Tuesday 14:00-15:30, Room 303-B09

14:00-14:25 Ryo Nikkuni, *Conway-Gordon type theorems and its applications*

14:30-14:55 Hyoungjun Kim, *Obstructions to knotless embedding*

15:00-15:25 Hwa Jeong Lee, *Signed mosaic graphs and mosaic number of knots*

Tuesday 16:00-17:00, Room 303-B09

16:00-16:25 Zach Walsh, *The foundation of a generalized parallel connection*

16:30-16:55 Anastasia Chavez, *The valuation polytope on height two posets*

Wednesday 10:30-12:00, Room 303-B11

10:30-10:55 Mark Ellingham, *Orientable and bipartite twisted duals of graph embeddings*

11:00-11:25 Sang-il Oum, *Bounding the chromatic number of t-perfect graphs*

43 Topology, geometry and combinatorics of biopolymers

Wednesday 10:30-12:00, Room 260-221

10:30-10:55 Tetsuo Deguchi, *Phantom network theory with no fixed crosslinks and exact results derived by the lattice Green's functions*

11:00-11:25 Kai Ishihara, *On characterizations of unlinking pathways*

11:30-11:55 Chris Bradly, *Lattice polymers near a permeable interface*

Thursday 11:30-12:30, Room 260-221

11:30-11:55 Jin Yu, *Construction of plectonemic and stretched two-phase dynamics of DNA supercoiling*

12:00-12:25 Natasha Jonoska, *Engineering tertiary chirality in helical biopolymers*

Thursday 14:00-15:30, Room 260-221

14:00-14:25 Agnese Barbensi, *Topologically steered simulations and the role of geometric constraints in protein knotting*

14:30-14:55 Pengyu Liu, *Tree-polynomial representations of RNA secondary structures and their application in understanding R-loop formation*

Friday 11:30-12:30, Room 260-221

11:30-11:55 Koya Shimokawa, *Spatial graphs confined to tube regions in the simple cubic lattice*

12:00-12:25 Nathan Clisby, *Endless self-avoiding walks*

Friday 14:00-15:30, Room 260-221

14:00-14:25 Nicholas Beaton, *Lattice models of theta-shaped polymers and other branching structures*

14:30-14:55 Puttipong Pongtanapaisan, *Computing the Trunk of Links: Methods and Applications in Linking Probability*

Nets in the Projective Plane and Alexander Duality

Nancy Abdallah[1], *Hal Schenck*[2]

[1]University of Borås, [2]Auburn University

A net in the projective plane is a configuration of lines A and points X satisfying certain incidence properties. Nets appear in a variety of settings, ranging from quasigroups to combinatorial design to classification of Kac-Moody algebras to cohomology jump loci of hyperplane arrangements. For a matroid M and rank r, we associate a monomial ideal (a monomial variant of the Orlik Solomon ideal) to the set of flats of M of rank at most r. In the context of line arrangements in the projective plane, applying Alexander duality to the resulting ideal yields insight into the combinatorial structure of nets.
Algebraic Combinatorics and Matroids, Thursday 14:30-14:55 Room 303-B09

Solomon-Terao polynomial and Castelnouvo-Mumford regularity of hyperplane arrangements

Takuro Abe[1]

[1]Rikkyo University

A Solomon-Terao polynomial is defined by Solomon and Terao by using the higher order logarithmic derivation modules of hyperplane arrangements. It has two variables x and t, and if we specialize $x = 1$ then we have the characteristic polynomial of hyperplane arrangenents. However, what the Solomon-Terao polynomial itself is, is still unknown. On the other hand, the other specialization $x = 1$ has a meaning as a Poincaré polynomial of the regular nilpotent Hessenberg varieties when the corresponding arrangement is the ideal subarrangement of the Weyl arrangement. However, still almost nothing is known about this $x = 1$-specialization (reduced Solomon-Terao polynomial). For example. we do not know the degree of it and whether it is monic or not. In this talk, we investigate this reduced Solomon-Terao polynomial by using logarithmic derivation modules, and its Castelnouvo-Mumford regularity when the arrangement is tame.
Algebraic Combinatorics and Matroids, Wednesday 10:30-10:55 Room 303-B09

Operator Networks in Inverse Problems : Direct and Bayesian Inversion

Anuj Abhishek[1]

[1]Case Western Reserve University

Neural operators such as Deep Operator Networks (DeepONet) and Convolutional Neural Operators (CNO) have been shown to be fairly useful in approximating an operator between two function spaces. In this talk, we at first show that they can be used to approximate operators

that are maps between more general Banach spaces (not necessarily just function spaces) and which appear in various important medical imaging problems. Following recent developments in the field, we derive universal approximation theorem type results for two different network implementations that are used for learning the types of operators that turn up in imaging modalities such as EIT, DOT and QPAT. We then show how these operator learning frameworks may be used for direct inversion as well as may be used as surrogate models for the likelihood evaluation in Bayesian inversion. This is based on joint works with Thilo Strauss (Xi'an Jiaotong-Liverpool University) and Taufiquar Khan and Sudeb Majee (UNC Charlotte).
Microlocal analysis and inverse problems, Friday 14:00-14:25 Room 260-009

Persistent equivariant cohomology

Henry Adams[1]

[1]University of Florida

Persistent equivariant cohomology measures not only the shape of the filtration, but also attributes of a group action on the filtration, including in particular its fixed points. We give an explicit description of the persistent equivariant cohomology of the circle action on the Vietoris-Rips metric thickenings of the circle. Our computation relies on the Serre spectral sequence and the Gysin homomorphism. Joint with Evgeniya Lagoda, Michael Moy, Nikola Sadovek, and Aditya De Saha, available at https://arxiv.org/abs/2408.17331.
Applied and Computational Topology, Tuesday 14:30-14:55 Room 260-223

The coupled Temperley-Lieb algebra and planar parafermions in $\mathbb{Z}_N$ clock models.

Remy Adderton[1]

[1]Australian National University

We present a generalization of the Temperley-Lieb algebra (TLA) consisting of N coupled copies of TLA representations for general $N \geq 2$. A diagrammatic representation of the coupled algebra is achieved through a planar parafermion algebra involving planar tangles. Here parafermion operators acting on the Hilbert space of a quantum spin chain take the form of 1-boxes acting on planar tangles satisfying a so-called para-isotopy relation. The operation of a string Fourier transform on such tangles plays a key role in the diagrammatic description of the three-term cubic relations of the coupled algebra. We present the role of the planar parafermion algebra in certain quantum spin chain Hamiltonians with $\mathbb{Z}_N$ symmetry, including a new form of the N-state superintegrable chiral Potts (SICP) Model described in terms of $N-1$ types of generators of the coupled algebra. Here the Onsager algebra and resultant commuting charges are presented in terms of the coupled Temperley-Lieb algebra and planar parafermion language, where the Dolan-Grady relations are satisfied through the isotopy relations of the planar parafermion algebra. The existence of shift modes in the chiral Potts and free-parafermion $\mathbb{Z}_N$ spin chains is presented as well as the process of Baxterization of a braid representation in the planar

parafermion algebra. The application of the coupled Temperley-Lieb algebra in the study of the eigenspectrum of the superintegrable chiral Potts Hamiltonian is also presented.
Mathematical Physics, Tuesday 14:30-14:55 Room 260-221

Development of a block bethod for solving multiple order ODEs

Emmanuel Adeyefa[1]

[1]Federal University Oye-ekiti

In this work, a convergent hybrid block method (CHBM) with two off-grid points for direct integration of first, second, and third-order initial value problems (IVPs) is proposed. The development of a block method for the solution of IVPs has been considered overwhelmingly in the literature. However, using a block method to directly solve multi-order IVPs has not been so common. Thus, the formulation of a single numerical algorithm for the direct numerical integration of first, second and third-order IVPs is our focus. The method is formulated from a continuous scheme derived using collocation and interpolation techniques and implemented in a block-by-block manner as a numerical integrator for IVPs. To assess the method's applicability, efficiency, and accuracy, the convergence analysis has been investigated, and six test problems are considered
Computational Mathematics, Friday 12:00-12:25 Room 402-231

A uniform formula on the number of integer matrices with given determinant and height

Muhammad Afifurrahman

[1]University of New South Wales

We obtain an asymptotic formula for the number of integer 2×2 matrices with determinant Δ and whose absolute value of the entries are at most H. The formula holds uniformly for a large range of Δ with respect of H.
Arithmetic Geometry and Number Theory, Tuesday 16:00-16:10 Room 405-430

Unfolding isola and mushroom bifurcations of limit cycles

Pablo Aguirre[1], *Adrián López[1]*

[1]Universidad Técnica Federico Santa María

The so-called mushroom and isola bifurcations are phenomena observed in various contexts, including biological, chemical, and physical models. The terms "mushroom" and "isola" aptly describe the shapes of the associated bifurcation diagrams, resembling a mushroom cap or an isolated closed locus, respectively. While mushroom and isola phenomena have been observed mainly for equilibrium points, the emergence of similar bifurcations for limit cycles remains more elusive and has only recently garnered interest. In a recent work, one of these authors and his colleagues numerically found the first example in which both isola and mushroom dynamics of limit cycles appear in a population/ecological model. The emergence of these phenomena indicates novel mechanisms for the sustained oscillations and coexistence of both populations. On a fundamental level, the formation of these structures is closely related to the topological organization of branches of fixed points in return maps. Since these return maps are, in general, very hard to find explicitly, it is a non-trivial task to determine whether a specific mathematical model will exhibit isola or mushroom phenomena simply by examining the constituent terms of its equations. While numerical schemes are available to detect an isola of equilibrium points or periodic orbits and continue it in parameter space, to the best of our knowledge, the occurrence of isolas and mushrooms in a given model has yet to be explained in terms of its specific equations within a theoretical framework. Inspired by the computational findings in the aforementioned population model, we study conceptual return maps that account for the local dynamics near periodic orbits in suitable cross-sections. We propose a two-parameter map that serves as a universal unfolding for mushroom and isola phenomena. In this way, we aim to identify the underlying mathematical mechanisms leading to the formation of isolas and mushrooms in branches of limit cycles in model vector fields.

Computational Methods and Applications of Dynamical Systems, Monday 14:00-14:25 Room 303-G20

Free idempotent-generated regular *-semigroups

Azeef Muhammed Parayil Ajmal[1]

[1]Western Sydney University

Regular $*$-semigroups is a class of semigroups which occupies something of a 'sweet spot' between the important classes of inverse and regular semigroups, and contains many natural examples like diagram monoids. In a recent work "A groupoid approach to regular $*$-semigroups", *Advances in Mathematics, 437, 2024*, by focussing on the *projection algebra* structure of the semigroup, it was shown that the category **RSS** of regular $*$-semigroups is isomorphic to the category of so-called *chained projection groupoids*. This generalisation of the celebrated ESN (Ehresmann-Schein-Nambooripad) Theorem also leads to the construction of certain free (idempotent- and projection-generated) regular $*$-semigroups, which we shall call as *chain semigroups*. Free idempotent generated semigroups is a hot topic in the area of algebraic theory of semigroups. In this talk, we shall discuss the construction of chain semigroups and show how they form free objects in the category **RSS**. This construction involves the notion of *linked pairs*, which are the regular $*$-analogues of Nambooripad's singular squares in biordered sets. This is a recent joint work with James East, Robert Gray and Nik Ruškuc.

50 years of Communications in Algebra, Thursday 11:30-11:55 Room 303-G15

An aspherical almost complex four-manifold with negative signature

Michael Albanese[1]

[1]University of Adelaide

In previous work with Luca Di Cerbo and Luigi Lombardi, we studied the Singer conjecture and the Gromov-Lück inequality in the context of aspherical complex surfaces. A question which naturally arose from that work is whether there exists an aspherical complex surface with negative signature. In this talk, I will show that if one weakens complex to almost complex, such examples exist.

Differential geometry and geometric analysis, Friday 12:00-12:25 Room 260-005

Time Dependent Wave Propagation in Waveguides with Rectangular Scattering Regions

Afnan Aldosri[1]

[1]University of Newcastle

This talk explores the time-dependent behaviour of an incident wave pulse as it interacts with a rectangular scattering region within a symmetrically positioned waveguide. The time-domain solution is derived from the frequency-domain solutions obtained using the eigenfunction matching method. Based on these frequency-domain solutions, the time-dependent behaviour is then computed through matrix multiplication. The results provide a visual representation of the wave's motion, illustrating the scattering, reflection, and transmission of the wave over time.

Mathematical methods in continuum mechanics and wave theory, Wednesday 11:00-11:10 Room 401-307

Computational Uncertainty Quantification for Inverse problems in Python (CUQIpy)

Amal Alghamdi[1], *Nicolai A B Riis, Felipe Uribe, Silja L Christensen, Babak M Afkham, Per Christian Hansen, Jakob S Jørgensen*

[1]DTU

Inverse problems are prevalent in various scientific and engineering applications, and uncertainty quantification (UQ) of solutions to these problems is essential for informed decision-making. In this talk, we present CUQIpy (pronounced "cookie pie"), a Python software package for computational UQ in inverse problems using a Bayesian framework. CUQIpy offers concise syntax that closely matches mathematical expressions, streamlining the modeling process and enhancing the user experience. The versatility and applicability of CUQIpy to many Bayesian inverse problems are demonstrated in various test cases including, but not limited to, computed

tomography, electric impedance tomography, and characterization of ear aqueduct varying-in-space diffusivity. These examples showcase the software's efficiency, consistency, and intuitive interface. Our comprehensive approach to UQ in inverse problems provides accessibility for non-experts and advanced features for experts. CUQIpy is developed as part of the CUQI project at the Technical University of Denmark and is available at https://github.com/CUQI-DTU/CUQIpy.
Microlocal analysis and inverse problems, Wednesday 10:30-10:55 Room 260-009

Time-Dependent Modeling of a Circular Ice Shelf

Rehab Aljabri[1]

[1]The University of Newcastle

A mathematical model is presented to investigate the vibrations in the time domain of circular ice shelves under different boundary conditions. The system is modelled using the shallow-water equations, which reduces the problem to a sixth-order partial differential equation. It is shown that this equation is separable in cylindrical coordinates, and the solution is expanded in Bessel functions. Different boundary conditions are investigated, clamped and free circular and no-flux and no-pressure conditions. These are the standard simplified boundary conditions considered in ice shelf modelling. The modes of vibration are calculated and the time-dependent motion is simulated. Even for this idealised model, the ice shelf shows a very complex motion in the time domain.
Mathematical methods in continuum mechanics and wave theory, Wednesday 10:30-10:40 Room 401-307

Time Domain Vibration Analysis of a Cracked Ice Shelf

Alyah Alshammar[1]**i**

[1]University of Newcastle

Understanding the effect of cracks on ice shelf vibrations is crucial for assessing their structural integrity, predicting possible breakup events, and understanding their interactions with the surrounding environment. In this work, we propose a novel approach to model the simulation of cracked ice shelf vibrations using the thin beam approximation along with cracked beam boundary conditions. By representing the ice shelf as a thin elastic plate floating on a shallow layer of water, we develop a simplified mathematical framework that captures the essential dynamics of crack-induced vibrations. We will present a simulation for a cracked ice shelf under two conditions no-flux and no-pressure conditions which were discussed in details to investigate the effect of cracks on their vibrations.
Contributed Session A, Tuesday 16:30-16:55 Room 260-016

Modelling the effects of mechanical properties on mutant cells in an epithelial tissue

Faris Alsubaie[1]

[1]University of Queensland

A mutant cell and its proliferation within healthy tissue underline several biological problems such as cancerous mitosis, and tumour growth. Here we investigate the effects of the mechanical properties of the cells with various proliferation rates of the mutant cell and healthy cells within epithelial tissue. We develop a two-dimensional computational model for the survival probability of the mutant cell based on Cellular Potts Model, which predicts that the survival probability of a hard mutant cell, which has a high cortex contractility and a low cell-cell adhesion, emerges in compressed regime of hard healthy cells agree well with the Moran Process Model prediction. However, when the mutant cell emerges within a stretched regime, we find that the survival probability of the mutant cell is lower than the prediction that based on the Moran Process. A soft mutant cell, which has a low cortex contractility, that emerges within a layer of hard healthy cells has a higher survival probability compared to a hard mutant cell in a soft healthy cell and is different from the prediction of the Moran Process for the mutant survival probability. These results show that the mechanical properties of the mutant cells and mechanical stress in the surrounding tissues can play a role in the fixation probability of cancerous mutations.
Contributed Session A, Friday 11:30-11:55 Room 303-G15

Probabilistic approaches to rational points on algebraic surfaces

Anthony Várilly Alvarado[1], *Austen James*

[1]Rice University

The Brauer group of a del Pezzo over a number field is thought to govern the existence of rational points. A large piece of this group is determined by the Galois-module structure on the geometric Picard group of a surface. I will explain how to use simple ideas from Bayesian inference to determine, with a high and quantifiable degree of confidence, this Galois-module structure, and hence the Brauer group, of a cubic surface over the rational numbers. I will also indicate certificates for the probabilistic results. Technology permitting, I will show a live demo.
Arithmetic Geometry and Number Theory, Tuesday 11:30-11:55 Room 405-430

(Cancelled) Non-split sharply 2-transitive groups in positive odd characteristic and geometric small cancellation methods

Marco Amelio[1], *Simon André*[2], *Katrin Tent*[1]

[1]Universitaet Muenster, [2]Institut de mathématiques de Jussieu - Paris Rive Gauch

Until recently, the existence of non-split sharply 2-transitive groups (i.e., sharply 2-transitive groups without a non-trivial normal abelian subgroup) was an open problem. The first examples were produced by Rips, Segev and Tent in 2017 and by Rips and Tent in 2019. It is possible to associate to every sharply 2-transitive group a characteristic, which can be either 0 or a positive prime number. The examples constructed by Rips, Segev and Tent have characteristic 2, while the ones constructed by Rips and Tent have characteristic 0, leaving the problem open for odd characteristics. In order to produce such examples, it is necessary to understand how to take some 'complicated and controlled' quotients, a construction for which the framework of geometric small cancellation as developed by Gromov, Delzant, Dahmani, Guirardel, Osin and Coulon (among others) has proved to be very fruitful. The main bulk of our work consists in adapting these small cancellation methods to produce such examples of non-split sharply 2-transitive groups in odd characteristic. In this talk, I will give some background on sharply 2-transitive groups and a rough overview on how we adapted the construction used for characteristic to 0 to odd characteristic, with special emphasis on the modified geometric small cancellation methods that suit our setting.

Groups and Geometry, Thursday 15:00-15:25 Room 260-092

Weight subgroups of quasi-isolated blocks of finite exceptional groups

Jianbei An[1]

[1]University of Auckland

Let G be a finite group whose order is divisible by a prime p, B a p-block and $\mathrm{dz}(G)$ the set of defect zero ordinary irreducible characters of G. A pair (R, φ) is a B-weight if $R \leq G$ is a p-subgroup and $\varphi \in \mathrm{dz}(N_G(R)/R)$ such that $B(\varphi)^G = B$, where $B(\varphi)$ is the block of $N_G(R)$ containing the lift of φ and $B(\varphi)^G$ is the induced block. We call R a *B-weight subgroup*. The blockwise Alperin weight conjecture (1987) states that the number of G-conjugacy classes of B-weights is the number of irreducible Brauer characters of B. Späth (2013) introduced a collection of properties for non-abelian simple groups, called the inductive blockwise Alperin weight condition (for short, inductive BAW condition), and proved the reduction theorem: if the inductive BAW condition is satisfied for all non-abelian finite simple groups at the prime p, then the blockwise Alperin weight conjecture holds for all finite groups. The theorem is a refinement of a reduction theorem of Navarro and Tiep (2013). The inductive BAW condition has been verified for many simple groups. For example, the condition has been verified by An-Hiss-Lübeck (2022) for $F_4(q)$ in odd p, and by Feng-Li-Zhang for classical groups of type A. In 2022, Feng-Li-Zhang reduced the verification of the inductive condition for groups of Lie type in non-defining characteristic to quasi-isolated blocks. Thus it is important to classify all weight subgroups of quasi-isolated blocks. A weight subgroup R is a radical subgroup R, where R is radical if $R = O_p(N_G(R))$. Radical subgroups of classical groups are classified for sporadic,

symmetric, classical groups, and exceptional groups except for $E_6^{\pm}(q)$ $(p = 2)$, $E_7(q)$ and $E_8(q)$ in non-defining characteristics. In this talk, we explain how to classify B-weight subgroups, where B is a quasi-isolated block of exceptional groups.
Groups, actions and computations, Tuesday 14:00-14:25 Room 260-051

Two characterizations of the smallest non-solvable group

Chimere Anabanti, *Alireza Asboei*

[1]University of Pretoria, [2]Farhangian University

We introduce two invariants for finite groups, and use each to characterize A_5.
50 years of Communications in Algebra, Thursday 14:00-14:25 Room 303-G15

Tumbling stones and curvature flows

Ben Andrews[1]

[1]Australian National University

In addition to the well-known mean curvature flow, there is a large family of nonlinear geometric parabolic equations which can be used to deform hypersurfaces. In most cases very little is known about the long time behaviour under these flows. I will describe what we do know, and what seems reasonable to conjecture. I will also introduce an interesting new family of highly nonlocal geometric deformations which are inspired by a question of Marcel Berger, motivated by the observed behaviour of rock tumblers, which correspond to certain singular limits of curvature-driven flows.
Recent advances in geometric PDE, Monday 14:00-14:50 Room 260-057

Modelling and simulation to advance antiviral therapy for measles

Anet Jorim Norbert Anelone[1]

[1]Na

Measles continues to be a leading cause of disease, morbidity, and mortality worldwide . This situation is partly due to a lack of vaccine coverage and the absence of any licensed antiviral drugs. Recent therapeutic successes have been achieved in animal studies using small-molecule polymerase inhibitors (SMPI). However, therapeutic research has not yet benefited from mathematical investigations that could extract further insights from the rich data obtained from animal studies. It is important to advance our understanding of treatments for measles to address gaps in clinical management and public health interventions. Motivated by the need to enhance therapeutic achievements, this work represents the first mathematical modelling stud-

ies aimed at contributing to knowledge of measles treatment using SMPI. Treatment strategies with SMPI are evaluated using ordinary differential equations that model measles dynamics in the blood, and SMPI is analysed as a control mechanism to gain insights by applying control systems theory. The proposed mathematical modelling framework effectively simulates both successful and ineffective treatments. Applying control theory provides analytical conditions for determining the attractions of manifolds associated with the clearance of infectious viremia. These dynamical conditions also determine efficacy, therapeutic time window, and robustness to variations in biological rates, in the presence or absence of virus-specific immune responses. Before the peak viremia in untreated cases, antiviral effects of SMPI need to become sufficiently potent to enforce a decline in acute viremia, to exhibit robust therapeutic mitigation of immunosuppression and symptoms. After the peak viremia in untreated cases, therapeutic benefits are achieved when the antiviral effects of SMPI are not negligible compared to those mounted by potent measles-specific cellular immunity. Together, these results suggest time-varying in vivo requirements, which have implications for dosing and scheduling to achieve therapeutic benefits using small-molecule polymerase inhibitors during acute measles infection. Thus, integrating mathematical modelling of measles in vivo with experimental and clinical studies has strong potential to advance treatments for measles.
Contributed Session A, Wednesday 11:30-11:55 Room 260-040

Twisted groupoids that are not induced by 2-cocycles

Becky Armstrong[1]

[1]Victoria University of Wellington

Twisted groupoids are generalisations of group extensions that play an important role in C*-algebraic theory: every classifiable C*-algebra has an underlying twisted groupoid model. It is well known that group extensions are in one-to-one correspondence with group 2-cocycles. Analogously, every groupoid 2-cocycle gives rise to a twisted groupoid. However, an example due to Kumjian shows that the converse is not true. Kumjian's counterexample is a twisted groupoid consisting entirely of isotropy, but in this talk I will present a new example of a twisted groupoid that is not all isotropy, such that the twisted isotropy subgroupoid is not induced by a 2-cocycle. (This is joint work with Abraham C.S. Ng, Aidan Sims, and Yumiao Zhou.)
Functional Analysis and Operator Algebras, Monday 15:00-15:25 Room 260-055

Single-Index Batched Contextual Bandits

Sakshi Arya[1], *Hyebin Song*

[1]Case Western Reserve University

In order to handle the curse of dimensionality for nonparametric regressions in contextual bandit problem, we propose a novel semi-parametric bandit approach to handle sequential-decision making problems in the batched bandit setting. Here, we assume that for each arm, the relationship between the covariates and responses can be modeled in the reduced 1-dimensional subspace (effective dimension reduction subspace) based on the single-index regression framework. Consequently, we adopt an adaptive binning and successive elimination algorithm for the sequential decision-making along the estimated single-index direction. We provide optimal regret guarantees on our proposed algorithm and illustrate the performance on simulated datasets.

Recent developments in data science and machine learning, Wednesday 11:00-11:25 Room 402-220

Moments of characteristic polynomials of random matrices

Theo Assiotis[1]

[1]University of Edinburgh

I will discuss various results on certain moments of characteristic polynomials of random matrices and their connections to exchangeable arrays and integrable systems. This is based on joint work with Alper Gunes, Jon Keating and Fei Wei.

Special Functions, q-Series and Beyond, Thursday 14:30-14:55 Room 401-312

Uncertainty Quantification for Neurobiological Networks

Daniele Avitabile[1]

[1]VU Amsterdam

This talk presents a framework for forward uncertainty quantification problems in spatially-extended neurobiological networks. We will consider networks in which the cortex is represented as a continuum domain, and local neuronal activity evolves according to an integro-differential equation, collecting inputs nonlocally, from the whole cortex. These models are sometimes referred to as neural field equations. Large-scale brain simulations of such models are currently performed heuristically, and the numerical analysis of these problems is largely unexplored. In the first part of the talk I will summarise recent developments for the rigorous numerical analysis of projection schemes for deterministic neural fields, which sets the foundation for developing Finite-Element and Spectral schemes for large-scale problems. The second part of the talk will discuss the case of networks in the presence of uncertainties modelled with random data, in particular: random synaptic connections, external stimuli, neuronal firing rates, and initial conditions. Such problems give rise to random solutions, whose mean, variance, or other quantities of interest have to be estimated using numerical simulations. This so-called forward uncertainty quantification problem is challenging because it couples spatially nonlocal, nonlinear problems to large-dimensional random data. I will present a family of schemes that couple a spatial projector for the spatial discretisation, to stochastic collocation for the random data. We will analyse the time- dependent problem with random data and the schemes from a functional analytic viewpoint, and show that the proposed methods can achieve spectral accuracy, provided the random data is sufficiently regular. We will showcase the schemes using several examples. Acknowledgements This talk presents joint work with Francesca Cavallini (VU Amsterdam),

Svetlana Dubinkina (VU Amsterdam), and Gabriel Lord (Radboud University).
New directions in pattern formation, Friday 12:00-12:25 Room 303-B11

Covariations between persistent synoptic features and Antarctic sea ice via unsupervised regression learning

Andrew Axelsen[1], *Terence O'Kane*[2], *Courtney Quinn*[1], *Andrew Bassom*[1]

[1]University of Tasmania, [2]Commonwealth Scientific and Industrial Research Organisation

In this talk, we focus on analysing metastable states in the mid to high latitudes of the southern hemisphere, specifically focussing on covariations between synoptic weather systems and sea ice. Analysing high-dimensional multivariate coupled dynamics is achieved through extracting persistent structures associated with of coherent states from observations of the earth system. Lorenz famously first applied singular value decomposition to isolate time-invariant patterns (empirical orthogonal functions, or EOFs) of the major tropospheric modes and their associated time-series (principal components). We extend this approach to include sea ice concentration in the EOFs. By combining this with a nonparametric, temporally regularised, vector autoregressive approach to assign observed data instances (features) to a locally stationary state, we obtain an evolving spatio-temporal feature space within the context of an underlying reduced order model. We apply this approach using a single level (baroclinic) and multiple levels (barotropic) of the troposphere coupled to sea ice concentration. The results elucidate the effects of persistent atmospheric activity on sea ice variability in the seas surrounding in the Antarctic.
Contributed Session A, Thursday 14:00-14:25 Room 303-B11

Maximal Regularity for Stochastic Parabolic Volterra Integral Equations

Boris Baeumer[1], *Markus Antoni*[2], *Petru Cioica-Licht*[2], *Noa Bihlmaier*[3]

[1]University of Otago, [2]University of Kassel, [3]University of Tuebingen

We give conditions on the Lévy measure associated with the integral kernel of a Volterra integral equation to yield maximal regularity and hence provide existence and uniqueness results for solutions to (possibly stochastic) non-linear Volterra integral equations.
Functional analysis and partial differential operators, Monday 14:00-14:25 Room 260-020

Hybrid bounds for x in terms of $\omega(x^n - 1)$

Gustav Kjaerbye Bagger[1]

[1]UNSW Canberra

Let ω_n denote the number of distinct prime factors of $x^n - 1$ for positive integers x and n. Consider the following problem: Given a fixed ω_n, what lower bound can one give for x? Trivially, x is bounded below by the product over the smallest ω_n primes, but can we do better? I will present some improvements to this type of bound via cyclotomic polynomials and discuss applications.

Computational Number Theory and Applications, Tuesday 14:30-14:40 Room 405-422

A hybrid method for solving constrained DC optimization problems

Adil Bagirov[1]

[1]Federation University Australia

In this talk, we present a hybrid method for solving the constrained difference of convex (DC) programming problems. This method is the combination of two methods: a method for finding a feasible point and a method for finding stationary points of DC programming problems. The first method is designed using ϵ-subdifferentials of DC components. The second method uses the improvement function and feasible points as a starting point. We apply the augmented subgradient method as a local method. The convergence of the hybrid method is studied. We evaluate this method using a collection of academic test problems and compare it with several constrained nonsmooth optimization solvers.

Optimisation, Friday 11:30-11:55 Room 402-221

Mixed finite element methods for the coupling of Biot and Poisson-Nernst-Planck equations

Gabriel N Gatica[2], *Cristian Inzunza*[2], **Ricardo Ruiz Baier**[1]

[1]Monash University, [2]CI2MA and Universidad de Concepcion

We introduce and analyze conservative primal-mixed finite element methods for numerically solving the coupled Biot poroelasticity and Poisson–Nernst–Planck equations (modeling ion transport in deformable porous media). For the poroelasticity, we consider a primal-mixed, four-field formulation in terms of the solid displacement, the fluid pressure, the Darcy flux, and the total pressure. In turn, the Poisson–Nernst–Planck equations are formulated in terms of the electrostatic potential, the electric field, the ionized particle concentrations, their gradients, and the total ionic fluxes. The weak formulation is posed in suitable Banach spaces, and it exhibits the structure of a perturbed block-diagonal operator consisting in turn of perturbed

and generalized saddle-point problems for the Biot equations, a generalized saddle-point problem for the Poisson equations, and a perturbed twofold saddle-point problem for the Nernst–Planck equations. The well-posedness analysis hinges on the Banach fixed-point theorem along with small data assumptions, the Babuška–Brezzi theory in Banach spaces, and a slight variant of recent abstract results for perturbed saddle-point problems, again in Banach spaces. The associated Galerkin scheme is addressed similarly, employing the Brouwer and Banach theorems to yield existence and uniqueness of discrete solution. A priori error estimates are derived, and rates of convergence for specific finite element subspaces satisfying the required discrete inf-sup conditions are established. Finally, several numerical examples validating the theoretical error bounds, and illustrating the performance of the proposed family of finite element methods, are presented.
Computational Mathematics, Friday 14:30-14:55 Room 402-231

Transitions of resonance tongues in periodically forced systems

John Bailie[1], *Priya Subramanian*[1], *Bernd Krauskopf*[1]

[1]University of Auckland

Resonance is a phenomenon encountered in many fields of science when a system is subjected to external forcing or coupling. Generally, these systems have dynamics on a stable invariant torus that may be characterized by the rotation number ρ, given by the ratio of the involved frequencies. For rational values of ρ, the system is said to be in resonance, and the flow on the torus converges to a stable periodic solution. We investigate the overall resonance structure of an invariant torus that exists in a bounded region of a parameter plane. As a case study, we examine a periodically forced planar model for vertical mixing in the North Atlantic with three bifurcation parameters: a threshold η above which mixing is convective, a virtual salinity flux μ, and amplitude c of the seasonal variation of this flux. For positive forcing $c > 0$, there exits a region of the (μ, c)-plane, bounded by a curve of torus bifurcation, with a two-dimensional stable invariant torus. We adopt an approach grounded in Morse theory to determine the overall resonance structure in the (μ, c)-plane as a function of η. To this end, we develop an algorithm for computing the rotation number with $\rho = p/q$, and do so for q up to 10^4. More specifically, we present a classification of the resonance structure in terms of the extrema of the rotation number ρ on the boundary.
Computational Methods and Applications of Dynamical Systems, Monday 15:00-15:30 Room 303-G20

Mathing a better world: Expanding cultural capital in mathematics

Rowena Ball

[1]Australian National University

In 1959 ‘the unreasonable effectiveness of mathematics’ was contemplated by Wigner as ‘a wonderful gift which we neither understand nor deserve”. Well, sixty-five years later, is mathematics

still so wondrously, unreasonably, effective? Until end 2019 mathematics publications proliferated like never before, yet the world now is beset by even worse problems that are unprecedented in kind or in scale and global reach: Global heating, the despairing, seemingly endless, cycles of regional wars over the control of land that humanity seems locked into, the rise of the far right, the intractable biases of AI and consequent enshittification of the internet, microplastics pollution in oceans... As the 21st century streams on we might begin to suspect that mathematics could benefit from a bit of new shot in order to update and maintain its celebrated unreasonable effectiveness in the contemporary and near-future settings. Where might that new shot, that new mathematics, come from? Through a story of Indigenous mathematics, I shall outline an initiative for mathematics to diversify culturally, draw on cultural and intellectual capital that was there all along - a rich global landscape of Indigenous and non-Western mathematical knowledge that is coming to light -, embrace different epistemologies, and use this knowledge to tackle humanity's immediate problems.
Contributed Session A, Monday 16:00-16:25 Room 405-430

A Comparative Study of Probability and Statistics High School Curricula between Australia and South Asia

Dush Bandarawickrama[1]

[1]University of Southern Queensland

Mathematical proficiency, particularly in statistics, is crucial for success across various scientific disciplines and for data-driven decision-making in both academic and professional settings (Büchele & Feudel, 2023; Ikegawa, 2021). However, research indicates that South Asian students often encounter challenges in acquiring statistical skills, which are essential for their academic progression (Tavakol & O'Brien, 2022). This presentation is part of a primary study that investigates the mathematical preparedness of South Asian international students pursuing degrees that require strong quantitative reasoning skills. Specifically, this segment of the study compares the probability and statistics content of the Queensland General Mathematics curriculum with that of South Asian high school curricula using the Vertical Analysis approach as outlined by (Charalambous et al., 2010). The analysis reveals that South Asian textbooks tend to emphasise mathematical theory, whereas Australian textbooks place greater emphasis on the application and modelling of mathematical concepts in real-life scenarios. Based on these findings, the researcher will propose recommendations to assist South Asian students in bridging the educational gap between their prior learning experiences and the expectations of Australian universities. Keywords: South Asian mathematics textbooks, mathematics curriculum gap, statistical skills of South Asian students in Australia
Mathematics Education, Monday 16:45-16:55 Room 260-115

Acyclic matchings on Bruhat intervals and totally nonnegative Springer fibres

Huanchen Bao[1], *Xuhua He*

[1]National University of Singapore, [2]The University of Hong Kong

Discrete Morse theory, developed by Forman, is an efficient tool to determine the homotopy type of a regular CW complex. The theory has been reformulated by Chari in purely combinatorial terms of acyclic matchings on the face poset. In this talk, I will discuss explicit constructions of such acyclic matchings on Bruhat intervals using reflection orders. As an application, we show the totally nonnegative Springer fibres are contractible, verifying a conjecture of Lusztig. This is based on joint work with Xuhua He.
Algebraic Combinatorics and Matroids, Thursday 12:00-12:25 Room 303-B09

Topological Optimal Transport for Geometric Cycle Matching

Agnese Barbensi[1], *Stephen Y Zhang, Michael PH Stumpf, Tom Needham*

[1]School of Maths and Physics, University of Queensland

Topological data analysis is a powerful tool for describing topological signatures in real world data. An important challenge in topological data analysis is matching significant topological signals across distinct systems. In geometry and probability theory, optimal transport formalises notions of distance and matchings between distributions and structured objects. We propose to combine these approaches, constructing a mathematical framework for optimal transport-based matchings of topological features. Building upon recent advances in the domains of persistent homology and optimal transport for hypergraphs, we develop a transport-based methodology for topological data processing. We define measure topological networks, which integrate both geometric and topological information about a system, introduce a distance on the space of these objects, and study its metric properties, showing that it induces a geodesic metric space of non-negative curvature. The resulting Topological Optimal Transport (TpOT) framework provides a transport model on point clouds that minimises topological distortion while simultaneously yielding a geometrically informed matching between persistent homology cycles.
Applied and Computational Topology, Thursday 12:00-12:25 Room 260-223

Topologically steered simulations and the role of geometric constraints in protein knotting

Agnese Barbensi[1], *Alexander R. Klotz, Dimos Gkountaroulis*

[1]School of Maths and Physics, University of Queensland

We introduce a method to determine the optimal pathway by which a polymer may knot or unknot, while subject to a given set of physics, and we investigate the effect of imposing

geometric constraints. We show that with protein-like geometric constraints, the frequency of twist knots increases, similar to the observed abundance of twist knots in protein structures.
Topology, geometry and combinatorics of biopolymers, Thursday 14:00-14:25 Room 260-221

Just don't say "maths" - the Puzzle Café and other innovative mathematics engagement

Kate Barnard[1]

[1]Astronomy Australia Ltd

Most of us love mathematics, and we are frustrated that the general public does not share our passion. In fact it's worse than that; "I'm terrible at math(s)" invites trauma-bonding arising from the deep dark days of school mathematics classes. Mathematics has a PR problem. We know that mathematics is beautiful and creative and expansive and mind-blowing. How do we fold people into the joy of mathematics the way we craft a satisfying origami artwork? How do we share this beauty and creativity? How do we inspire appreciation for mathematics, whatever our audiences' level of schooling or emotional experience with mathematics? In this interactive presentation I will share examples, insights and questions from two decades engaging diverse audiences such as inner-city museum-goers, festival hippies, 4 year-olds with their flustered parents, and more. We will explore various engagement modalities including festival activations, physical theatre shows, large-scale participatory rule-based artwork, interactive online shows and other creative outreach activities. As an in-depth case study, I will present The Puzzle Café - a public activation designed for festivals where attendees choose from a menu of puzzles, brain teasers, craft activities and rule-based artwork creation. In targeting audiences that consider themselves "not mathy", the Puzzle Café deliberately avoids using the word "mathematics"; it can scare people off and make them think it's not for them. At this welcoming space, folks can wander in and make a quick tangram artwork, or get caught up in joyful, mathematical thinking for hours, scribbling away by themselves to figure out a coin flip puzzle or talking animatedly with friends about the Monty Hall Problem. Some of us do mathematics engagement because it's a requirement of a grant, or part of our job, because we love it, or all of the above and more. Whatever your reason, this presentation will provide you with tools and ideas for your existing mathematics outreach and engagement, or inspire you to get involved with sharing mathematics with public audiences.
Engagement with mathematics through communication and outreach, Tuesday 14:30-14:55 Room 260-040

Extremal problems for semilinear graphs

Abdul Basit[1]

[1]Monash University

A very general phenomenon in combinatorial geometry is that geometric graphs exhibit tamer extremal behaviour as compared to arbitrary graphs. This can be formalised via the notion of semilinear graphs, which are graphs defined using systems of linear equations and inequalities. We will see some recent extremal results for semilinear graphs. We will also talk about connections of these results to combinatorial geometry and model theory. No background is assumed, and the talk will be accessible to non-experts.

Joint work with Artem Chernikov, Daniel Horsley, Sergei Starchenko, Terence Tao, and Chieu-Minh Tran.
Contributed Session B, Wednesday 11:00-11:25 Room 260-215

Contracting a Single Element in a Transversal Matroid

Sam Bastida[1]

[1]Victoria University of Wellington

It is well known that the class of transversal matroids is not closed under contraction or duality. The complexity of deciding whether a minor or dual of a transversal matroid remains transversal is in Σ_2 and thus far there has been no improvement on this bound. We explore this issue, providing a polynomial-time algorithm for determining whether a single element contraction of a transversal matroid remains transversal. If so, our algorithm also provides a transversal representation. We then develop the techniques used in search of a polynomial time algorithm for determining whether the dual of a transversal matroid remains transversal.
Structural aspects of matroids and graphs, Tuesday 12:00-12:25 Room 303-B09

Extended Weyl groups

Barbara Baumeister

[1]Bielefeld University

We will recall the definition of an extended Weyl group and present some of their properties.
Groups and Geometry, Thursday 14:00-14:50 Room 260-092

Imprimitive permutation groups of rank 3

Anton Baykalov[1]

[1]University of Western Australia

The classification of finite primitive permutation groups of rank 3 was completed in the 1980s. This significant milestone has led to a variety of applications. By a classical result of Higman,

an imprimitive transitive finite permutation group G has a unique non-trivial block system Σ, and both induced group G^{Σ} and G_{σ}^{σ} for $\sigma \in \Sigma$ are 2-transitive (so either affine or almost simple). This offers a natural way to split the analysis of such groups. In this talk, I will discuss the most recent developments in classifying imprimitive rank 3 groups, as well as some applications in combinatorics.
Groups, actions and computations, Monday 16:00-16:25 Room 260-051

Lattice models of theta-shaped polymers and other branching structures

Nicholas Beaton[1], *Aleksander Owczarek, James Gleeson*[1], *Andrew Rechnitzer*[2]

[1]University of Melbourne, [2]University of British Columbia

We implement a new version of the BFACF algorithm combined with the Wang-Landau method to sample lattice polymers with a theta shape. The initial goal is to understand how the three "arms" scale in length, and if this resembles the scaling of a large knotted polygon in dilute solution. Other shapes like "tadpoles" are also studied. These branching structures can potentially be used to model R-loops and other complex polymer molecules.
Topology, geometry and combinatorics of biopolymers, Friday 14:00-14:25 Room 260-221

Global Ricci Curvature Behaviour for the Kahler-Ricci Flow with Finite Time Singularities

Alexander Bednarek[1]

[1]The University of Sydney

We consider the Ricci flow in the setting of Kahler manifolds. The Ricci flow is a tool for deforming smooth manifolds with respect to their Ricci curvature in hopes of extracting a nice metric, whereas Kahler manifolds are smooth manifolds equipped with compatible Riemannian, complex and symplectic structures. These properties enable the study of the Kahler-Ricci flow to be reduced to that of a complex Monge-Ampere type PDE. In the case that the existence time is necessarily finite, we show that under the existence of a map into complex projective space and a cohomology condition, we can find an L^4-like estimate on the Ricci curvature and that the Riemannian curvature is Type I in the L^2-sense. This enables us to better understand the flow as it approaches its time of singularity.
Recent advances in geometric PDE, Monday 16:00-16:10 Room 260-057

Ensemble Kalman Methods for Large-Scale Geophysical Inverse and Optimal Experimental Design Problems

Alex De Beer[1, 2], *Elvar Bjarkason*[3], *Michael Gravatt*[2], *Ruanui Nicholson*[2], *John O'Sullivan*[2], *Michael O'Sullivan*[2], *Oliver Maclaren*[2]

[1]School of Mathematics and Statistics, The University of Sydney, [2]Department of Engineering Science and Biomedical Engineering, University of Auckland, [3]Graduate School of International Resource Sciences, Akita University

Ensemble Kalman methods form a set of derivative-free algorithms which are widely used to appropriate the solutions to Bayesian inverse problems with complex forward models and high-dimensional parameter spaces. In this talk, we give a brief introduction to ensemble Kalman methods, providing an illustrative example using a large-scale, real-world geothermal reservoir model. We then turn our attention to the incorporation of these methods within the optimal experimental design (OED) framework, where our aim is to identify a measurement plan which minimises the expectation of a given function of the resulting posterior distribution. Through several geophysical examples, we illustrate how ensemble Kalman methods can be used for OED with non-differentiable forward problems, and with design criteria other than those based on local covariance information, which are the focus of most conventional algorithms for OED.
Stochastic and Deterministic Inverse Problems, Monday 16:00-16:25 Room 260-223

Coupled Delayed Feedback Loops in Biological Systems: Stability and Oscillations

Jacques Belair[1]

[1]Université De Montréal

Biological regulatory systems are often appropriately modeled as coupled systems of nonlinear delay differential equations. For example, the production of mammalian blood cells involves an intertwined network of physiological processes, with nonlinear, delayed feedback control mechanisms: erythrocytes (red blood cells) and thrombocytes (platelets) while each having their own main regulatory hormone, erythropoietin and thrombopoietin respectively, are also interacting, specially in pathological conditions. We consider the (highly) simplified model

$$\begin{cases} x'(t) & = -\alpha x(t) + f(x(t-\tau_1), y(t-\tau_2)) \\ y'(t) & = -\beta y(t) + g(x(t-\tau_1), y(t-\tau_2)) \end{cases}$$

with f and g appropriate Hill functions for the coupled regulation of these two cell lines to study how the interaction of the control mechanisms may influence the dynamics. Equilibrium solutions are determined, their stability established and the nature of the oscillations when instability occurs are investigated. The linear analysis revolves around a transcendental characteristic equation of second order with two delays; a Centre manifold analysis at the change of stability of equilibria provides insight into possible dynamics.
Differential delay equations and their applications, Tuesday 11:30-11:55 Room 303-B05

An explicit log-free zero-density estimate for the Riemann zeta-function

Chiara Bellotti[1]

[1]UNSW Canberra

In this talk we present an explicit log-free zero-density estimate for the Riemann zeta-function of the form $N(\sigma, T) \leq AT^{B(1-\sigma)}$ when σ is close to 1. This estimate will improve on the existing explicit zero-density results for the Riemann zeta-function when σ is sufficiently close to 1 and for a finite range of T above the verification height of the Riemann Hypothesis.
Computational Number Theory and Applications, Tuesday 14:45-14:55 Room 405-422

Discrete Level Set Persistence for Finite Discrete Functions

Robin Belton[1], *Georg Essl*

[1]Vassar College

Finite discrete functions are the fundamental data representation in numerous application areas. Level sets of functions provide a way to describe topological invariants of functions via the homological changes in level sets. The recognition that under suitable assumptions, homological changes are consequences of extrema in the level set is core to classical Morse theory. However, these assumptions are often not satisfied for finite discrete functions. We study an intuitive technique for level set persistence on finite discrete functions. We discuss the Morse-like behavior in this setting, as well as the dualities and symmetries that occur on bounded and circular finite domains. Additionally, we present an interactive JavaScript implementation for level set persistent homology on finite discrete functions.
Applied and Computational Topology, Tuesday 14:00-14:25 Room 260-223

Mathematical modelling of pressure dynamics within the skull and its influence on arterial blood pressure control

Alona Ben-Tal[1, 2], *Joshua Duley*[1, 2], *Tonja Emans*[2], *Alexander Gourine*[3], *Fiona McBryde*[2], *Julian Paton*[2]

[1]Insightful Modelling, [2]University of Auckland, [3]University College London

High blood pressure (hypertension) affects nearly 25% of the population in New Zealand and is the highest risk factor for cardiovascular complications such as stroke and heart attack. Up to 50% of patients on medication to lower blood pressure remain hypertensive and many of those whose blood pressure is under control with medication remain at high risk of a cardiovascular event. This suggests that there are other mechanisms affecting the regulation of blood pressure that are not targeted by current medication. We hypothesize that blood pressure sensors within the skull, which were recently discovered, play an important role in blood pressure control. To test this hypothesis, we aim to develop a new mathematical model of blood pressure regulation that includes the newly discovered blood pressure sensors. This is part of a three-year Health Research Council of New Zealand (HRC) project that also involves studies in rats. To date, we have further developed models of the circulation (Noreen at al. 2022, https://doi.org/10.1016/j.mbs.2021.108766) to include representation of pressures and blood flows within parts of the abdomen and the skull. Earlier versions of the blood circulation model were also coupled to a model of heart rate control (Ben-Tal et al. 2014, 10.1016/j.mbs.2014.06.015). The circulation model consists of 12 compartments, including the four chambers of the heart, and can simulate the dynamic change of pressures and volumes in these compartments. Model parameters were adjusted to represent rats and sensitivity analysis to changes in parameters was carried out. The model can mimic several experimental observations and potential pathways for disease progression.

INDUSTRIAL MATHEMATICS, TUESDAY 14:00-14:25 ROOM 402-211

Motion and Transport in Curve Dynamics

Michal Benes[1]

[1]Czech Technical University In Prague, Faculty of Nuclear Sciences And Physical Engineering

We investigate the motion of closed non-intersecting curves with velocity given by curvature and force. This motion is considered in plane, along surfaces, or in space. It is treated by the parametric method with the velocity decomposed into the normal and tangent directions, in space also into the bi-normal direction. We admit scalar quantities to be transported along the curves by diffusion and influenced by mutual interaction with the curve. This forms a system of degenerate parabolic equations for which the local existence and uniqueness of solution can be obtained. A numerical discretization can be constructed using the method of flowing finite volumes. Long-term stability is supported by a redistribution scheme providing uniformity of discretization nodes of the curve. We demonstrate behavior of the solution on computational studies related to the dislocation dynamics in the crystalline structure of materials, dynamics of vortex rings in space, and electric signal spreading in excitable media. We also indicate future challenges related to the forced curvature motion of space curves. Key words: Curvature driven flow; transport on curves; parametric method; flowing finite volume method. References [1] M. Kolář, M. Beneš and D. Ševčovič: Area Preserving Geodesic Curvature Driven Flow of Closed Curves on a Surface. Discrete Continuous Dynamical Systems B, Vol. 22, Iss. 10 (2017), 3671–3689. [2] M. Beneš and M. Kolář and D. Ševčovič: Curvature driven flow of a family of interacting curves with applications, Math. Meth. Appl. Sci., Vol. 43 (2020), 4177–4190. [3] M. Beneš, M. Kolář and D. Ševčovič: Qualitative and Numerical Aspects of a Motion of a Family of Interacting Curves in Space, SIAM Journal on Applied Mathematics, Vol. 82, Iss. 2 (2022).

MATHEMATICS OF NONLINEAR DIFFUSION PROCESSES, FRIDAY 11:30-12:20 ROOM 260-018

Dynamic strains on ice shelves resulting from flexural and extensional motions forced by ocean wave packets

Luke Bennetts[1]

[1]University of Adelaide

Retreat and weakening of the Antarctic sea ice barrier is allowing powerful ocean swell to reach ice shelf fronts and flex them until the point of failure. This process has been heavily implicated in several major calving events. Model predictions of strains on ice shelves due to incoming swell are typically based on flexural motions only. However, observations and numerical model outputs have identified that ice shelves experience extensional motions in addition to flexural motions in response to ocean waves. This has motivated a theoretical, frequency-domain (time harmonic) model that predicts extensional motions cause strains of larger or comparable magnitude to those caused by flexural motions. Therefore, previous model predictions may be substantially underestimating ice shelf strains. However, the time-domain (transient) picture is less clear, as extensional and flexural motions travel at different speeds, such that they only sum in localised regions of space and time. We extend the theoretical model to the time domain to investigate this phenomenon in the context of incident wave packets, over a broad parameter space, and compare our results to frequency-domain predictions and models that consider flexural motions only.

Mathematical methods in continuum mechanics and wave theory, Thursday 15:00-15:25 Room 401-307

Linear waves on the expanding region of Schwarzschild de Sitter spacetimes: forward asymptotics and scattering from infinity

Louie Bernhardt[1]

[1]University of Melbourne

In this talk I will discuss several new results relating to the linear wave equation on Schwarzschild-de Sitter spacetime. Focusing on the expanding region, I establish a finite-order asymptotic expansion satisfied by finite-energy solutions. This is accomplished by introducing new higher-order weighted energy estimates that capture the higher-order asymptotics of solutions. I also prove the existence and uniqueness of scattering solutions from data at infinity which possess asymptotics consistent with the forward problem. I will explain how this is achieved via the construction of approximate solutions that capture the desired asymptotics, as well as a new weighted energy estimate suitable for the backward problem. Time permitting, I will also discuss how these results generalise to a class of expanding spacetimes which do not necessarily converge back to Schwarzschild-de Sitter at infinity.

Recent advances in geometric PDE, Wednesday 10:30-10:40 Room 260-057

Nonlinear stability of Einstein-matter models near the big bang singularity

Florian Beyer[1], *Todd Oliynyk*[2]

[1]University of Otago, [2]Monash University

This talk is about our recent progress in understanding the complex mathematical landscape of the big bang singularity in general relativity. Utilizing Fuchsian partial differential equation techniques, we have established rigorous nonlinear stability results for certain Friedmann cosmological models, particularly focusing on solutions to the fully coupled Einstein-matter equations. While these results reinforce some of the assumptions of the standard cosmological model, it also brings to light new critical phenomena that have yet to be fully understood. This research was conducted in collaboration with Todd Oliynyk from Monash University.
Differential geometry and geometric analysis, Thursday 14:00-14:25 Room 260-005

Expansion formulas for elliptic hypergeometric series

Gaurav Bhatnagar[1]

[1]Ashoka University

We provide an alternate approach to obtaining expansion formulas on the lines of the well-poised Bailey lemma. We recover results due to Spiridonov and Warnaar and one new formula of this type. These formulas contain an arbitrary sequence as an argument, and are thus flexible in the number of parameters they contain. As a result, we are able to derive new transformation formulas for elliptic hypergeometric series. These transformation formulas appear to be new even in the basic hypergeometric case, when $p = 0$. This is joint work with Archna Kumari.
Special Functions, q-Series and Beyond, Tuesday 16:00-16:25 Room 401-312

Supersolvable posets and fiber-type arrangements

Christin Bibby[1], *Emanuele Delucchi*[2]

[1]Louisiana State University, [2]University of applied arts and sciences of Southern Switzerland

We present a combinatorial analysis of fiber bundles of generalized configuration spaces on connected abelian Lie groups. These bundles are akin to those of Fadell–Neuwirth for configuration spaces, and their existence is detected by a combinatorial property of an associated finite partially ordered set. We obtain a combinatorially determined class of $K(\pi, 1)$ spaces, and under a stronger combinatorial condition prove a factorization of the Poincaré polynomial when the Lie group is noncompact. In the case of toric arrangements, this provides an analogue of Falk–Randell's formula relating the Poincaré polynomial to the lower central series of the fundamental group.
Singularities, Tuesday 15:00-15:25 Room 260-024

A Serre spectral sequence for the moduli space of tropical curves

Christin Bibby[1], *Melody Chan[2]*, *Nir Gadish[3]*, *Claudia Yun[4]*

[1]Louisiana State University, [2]Brown University, [3]University of Pennsylvania, [4]University of Michigan

The map $M_{g,n} \to M_g$ on moduli spaces of genus g algebraic curves, given by forgetting marked points, is a fibration whose fiber is a configuration space of a surface. One can then "in principle" compute the cohomology of $M_{g,n}$ using the Serre spectral sequence. We present a tropical analogue of this spectral sequence, manifesting as a graph complex and featuring the cohomology of compactified configuration spaces on graphs. We use this to obtain new calculations in the top weight cohomology of the moduli spaces $M_{2,n}$ and $M_{3,n}$.

Computations and applications of algebraic geometry and commutative algebra, Thursday 14:00-14:25 Room 303-B05

(Cancelled) General rogue waves of infinite order: exact properties, asymptotic behavior, and effective numerical computation

Deniz Bilman[1]

[1]University of Cincinnati

In this talk we will present results from a comprehensive analysis of a family of solutions of the focusing nonlinear Schrödinger equation called general rogue waves of infinite order. These solutions have recently been shown to describe various limit processes involving large-amplitude waves, and they have also appeared in some physical models not directly connected with nonlinear Schrödinger equations. We establish the following key property of these solutions: they are all in $L^2(\mathbb{R})$ with respect to the spatial variable but they exhibit anomalously slow temporal decay. In this talk, we will define these solutions, establish their basic exact and asymptotic properties, and describe computational tools for calculating them accurately. This is joint work with Peter D. Miller.

Discrete and continuous integrable systems: geometry analysis and applications, Monday 16:00-16:25 Room 260-036

Spectral theory, semiclassical limits and soliton gases for the focusing nonlinear Schrodinger equation with periodic boundary conditions

Gino Biondini[1]

[1]State University of New York at Buffalo

I will present some recent results on the focusing nonlinear Schrödinger (fNLS) equation with periodic boundary conditions. I will begin by presenting a two-parameter family of exact, periodic finite-band elliptic potentials whose spectral theory admits analytical treatment. I will also show that the semi-classical limit of these potentials exhibits a thermodynamic band/gap scaling compatible with that of soliton and breather gases. I will then demonstrate that, upon augmenting these potentials by a small random noise (inevitably present in real physical systems), the solution of the fNLS equation evolves into a fully randomized, spatially homogeneous breather gas, a phenomenon termed breather gas fission. Finally, I will show that the statistical properties of the breather gas at large times are determined by the spectral density of states generated by the unperturbed initial potential. The theoretical predictions are verified by comparison with direct numerical simulations of the fNLS equation.
Harmonic analysis and Hamiltonian PDE, Wednesday 10:30-11:20 Room 260-028

Exploring Fuzzy Ideals and Filters in Almost Distributive Fuzzy Lattices

Bekalu Tarekegn Bitew[1]

[1]Bahir Dar University

This study investigates the fuzzy extensions of ideals and filters within Almost Distributive Fuzzy Lattices (ADFLs). By utilizing a fuzzy partial order framework, we establish that a fuzzy set qualifies as a fuzzy ideal or filter if its support corresponds to a classical ideal or filter. We analyze the resulting fuzzy substructures, uncovering properties that parallel those of traditional structures. This research contributes to the theory of fuzzy partial orders and highlights potential applications in fuzzy logic and algebraic systems represented as ADFLs.
Contributed Session B, Monday 16:00-16:25 Room 303-B11

Spontaneous symmetry breaking in a coupled photonic crystal dimer with two interacting light fields

Rodrigues Bitha[1, 2, 3], *Bernd Krauskopf*[1, 3], *Neil G. R. Broderick*[2, 3]

[1]Department of Mathematics, The University of Auckland, [2]Department of Physics, The University of Auckland, [3]Dodd Walls Centre for Photonic and Quantum Technologies

Spontaneous symmetry breaking in optical cavities refers to the process in which two initially symmetric optical modes spontaneously evolve into distinct, non-identical modes. This phe-

nomenon has been observed in various configurations of optical resonators where two interacting modes are coupled either linearly or nonlinearly. Here, we investigate the underlying mathematical model that describes the interactions of two optical modes in a photonic crystal dimer, where the configuration of the system supports both linear and nonlinear coupling, as well as a four-wave mixing-induced nonlinearity. We employ a dynamical system approach to perform a comprehensive theoretical study that allows us to identify, delimit, and explain the parameter regions where different behaviors emerge. Our results show that the system can exhibit additional regions of spontaneous symmetry breaking, leading to a wide range of complex dynamics. To guide experimentalists in observing these dynamics, we present our findings in the form of one- and two-parameter bifurcation diagrams.
New directions in pattern formation, Tuesday 14:00-14:25 Room 303-B11

Geometric and algebraic reduction of multisymplectic manifolds

Casey Blacker[1]

[1]George Mason University

A symplectic Hamiltonian manifold consists of a Lie group action on a symplectic manifold, together with the additional structure of a moment map, which encodes the group action in terms of the assignment of Hamiltonian vector fields. In special cases, the moment map determines a smooth submanifold to which the Lie group action restricts and the resulting quotient inherits the structure of symplectic manifold. In every case, it is possible to construct a reduced Poisson algebra that plays the role of the space of smooth functions on the reduced symplectic manifold. In this talk, we will discuss an adaptation of these ideas to the multisymplectic setting. Specifically, we will exhibit a geometric reduction procedure for multisymplectic manifolds in the presence of a Hamiltonian action, an algebraic reduction procedure for the associated L-infinity algebras of classical observables, and a comparison of these two construction. This is joint work with Antonio Miti and Leonid Ryvkin.
Recent advances in geometric PDE, Thursday 14:00-14:25 Room 260-057

Analyticity of Solutions to Fractional Partial Differential Equations

Simon Blatt[1]

[1]Paris Lodron University Salzburg

We will explore a classic topic in the realm of partial differential equations within a contemporary context: the analyticity of solutions to elliptic equations. While initial results for classical elliptic PDEs were established by Bernstein in 1904, the landscape for fractional and nonlocal equations remains less fully charted, with only partial results or findings pertaining to very specific cases, such as the Hartree-Fock and Boltzmann equations, available to date. In this presentation, we will review some of the established results before delving into our recent discoveries. These include advances in understanding knot energies, general semi-linear integro-differential equations, and two classes of non-linear integro-differential equations. Notably, we

will examine the non-local minimal surfaces introduced by Caffarelli, Roquejoffre, and Savin, and discuss how our findings contribute to this evolving field.
Mathematics of nonlinear diffusion processes, Thursday 11:30-12:20 Room 260-018

Feedback with implicit state-dependent delay:

Samuel Bolduc-st-aubin[1]

[1]University of Auckland

The El Niño-Southern Oscillation, or ENSO, manifests itself as periodic fluctuations in sea surface temperature and atmospheric conditions across the equatorial Pacific Ocean, which are notoriously hard to predict even with sophisticated global climate models. This motivates simpler representations of ENSO that consider the underlying feedback mechanisms. We are interested in delay differential equation (DDE) models for ENSO, that portray the interaction between delayed feedback and seasonal forcing. More specifically, we account for the delays introduced due to the finite velocities of the oceanic waves that transport warmer and cooler water across the Pacific Ocean, while a non-autonomous periodic forcing represents the seasonal variation. In conceptual climate models, delayed processes are generally assumed to be constant. However, it is important to note that the use of constant delays is a modelling assumption. Delays in climate models are inherently non-constant and depend on the state of the system, and this makes state-dependence an appealing improvement from a modelling perspective. Building upon prior research, we extend our investigation of an established ENSO DDE model by incorporating implicitly defined state-dependent delays. We study here an idealised model where the delayed negative feedback is modelled by a step function. This enables us to construct solutions analytically and we prove that, for a large range of parameters, implicit state-dependent delay does not give different dynamics compared to the constant-delay case. These findings provide insight into why the introduction of implicit time delays may not significantly affect the dynamics, as when observed in a prior investigation.
Differential delay equations and their applications, Tuesday 16:00-16:25 Room 303-B05

Iwasawa theory of Frobenius-torsion class group schemes

Jeremy Booher[1], *Bryden Cais*[2], *Joe Kramer-Miller*[3], *James Upton*[4]

[1]University of Florida, [2]University of Arizona, [3]Lehigh University, [4]University of California Santa Cruz

We establish a new Iwasawa theory for the kernel of Frobenius on Jacobians of curves in geometric $\mathbf{Z}_p$-towers over the projective line in characteristic p, thereby proving several conjectures of Booher and Cais.
Arithmetic Geometry and Number Theory, Tuesday 14:00-14:25 Room 405-430

Doubly isogenous curves of genus two with a rational action of D_6

Jeremy Booher[1], *Everett Howe, Andrew Sutherland*[2], *Felipe Voloch*[3]

[1]University of Florida, [2]MIT, [3]University of Canterbury

Say that two curves are doubly isogenous if they are isogenous and if the double covers constructed using the multiplication by two map on their Jacobians are also isogenous. We investigate the number of pairs of doubly isogenous curves over a finite field in the family of genus two curves with automorphism group containing D_6. We find many more doubly isogenous pairs than one would expect from reasonable heuristics, which we explain by finding such a pair over a number field. We show that the Zilber–Pink conjecture implies that there can only be finitely many such examples. We discuss how our family of curves can potentially give a deterministic polynomial-time algorithm to factor univariate polynomials over finite fields via an argument of Kayal and Poonen.

Computational Number Theory and Applications, Thursday 15:00-15:25 Room 405-422

The Einstein-Maxwell-Scalar Field Problem in T2 and Gowdy symmetry.

Mia Boothroyd[1]

[1]Otago University

We consider the asymptotic behaviour of solutions to the Einstein-Maxwell-Scalar Field problem in the cosmological setting under the assumption of T2 and Gowdy symmetry. Whilst it is a well-known result that in the vacuum case, the class of T2 symmetric spacetimes have constant twist, we show that this is not necessarily so in the case with matter. We first provide a general criterion under which the twists can be made constant by enforcing certain restrictive assumptions on the matter fields and consider the asymptotic behaviour of solutions to the Einstein-Maxwell-Scalar Field problem in Gowdy symmetry with a constant twist. We then consider the more general case of an evolving twist in the T2 symmetric setting. Using the Fuchsian theorem, we are able to prove that a unique solution exists to the backwards in time problem and derive an asymptotic expansion for the solution. Our results are parameterised in terms of the Kasner exponent p1 and the parameter k, known in the literature as the asymptotic velocity. Whilst it is a well known result that in the vacuum case, one has stable solutions to the Einstein equations in Gowdy and T2 symmetry for 0 ¡ k ¡ 1, our results show that the presence of matter (specifically, of electromagnetic fields) places a further restriction on the range of allowed k values.

Recent advances in geometric PDE, Wednesday 10:45-10:55 Room 260-057

A Divergence-Preserving Unfitted Finite Element Method for the Darcy Problem

Anne Boschman[1], *Alberto Martin*[2], *Ricardo Ruiz Baier*[1], *Santiago Badia*[1]

[1]Monash University, [2]Australian National University

Geometrically unfitted finite element methods are powerful discretization tools for the numerical approximation of partial differential equations on complex or evolving geometries. These methods, such as CutFEM, XFEM, or AgFEM, allow the computational mesh to remain independent of the domain's geometry, thereby providing greater flexibility and efficiency. However, without appropriate stabilization techniques, unfitted methods can lead to unstable and severely ill-conditioned discrete problems, typically due to the presence of small cut cells. To address this, stabilization techniques, such as ghost penalty stabilization and cell aggregation methods, are employed to ensure stability regardless of the cut configuration [1, 2]. In this contribution, we present a stable unfitted finite element method for the Darcy problem on a complex geometry. In the context of body-fitted methods, div-conforming finite element pairs, such as Raviart–Thomas elements and discontinuous piecewise polynomials, are typically used for the Darcy problem to preserve its underlying structure (i.e. achieve mass conservation) at the discrete level. Here, we propose stabilization terms specifically designed for the ill-posed cut cells, ensuring the stability of the mixed Darcy problem while maintaining its div-conforming properties. We will discuss the stability and convergence properties of the proposed unfitted method, and demonstrate these in numerical experiments.

[1] de Prenter, F., Verhoosel, C.V., van Brummelen, E.H., Larson, M.G., & Badia, S. (2023) Stability and Conditioning of Immersed Finite Element Methods: Analysis and Remedies. Arch Computat Methods Eng.

[2] Badia, S., Neiva, E., & Verdugo, F. (2022) Linking ghost penalty and aggregated unfitted methods. Computer Methods in Applied Mechanics and Engineering.

Computational Mathematics, Thursday 12:00-12:25 Room 402-231

Garside shadows in some rank 3 affine Coxeter groups

Jordan Bounds, *Yeeka Yau, Devin Bryant, Sam Housand, Sam Dayton, Menna Ellaqany*

[1]Furman University

Coxeter groups are robust family of structures with a plethora of applications to various scientific fields. A relatively recent tool in this area of study that has gained a lot of attention is the notion of a Garside shadow. Roughly speaking, a Garside shadow in a Coxeter group W is a subset which contains the generating set for W and is closed under taking joins (in a fixed weak ordering) and taking suffixes of elements. It is known that Garside shadows exist in all Coxeter groups and an explicit description of the minimal Garside shadows has been obtained for numerous classes of infinite Coxeter groups. However, there is still much left to uncover regarding these interesting structures. For instance, while it has been known that the minimal elements of the Shi-m arrangement correspond to a Garside shadow in particular Coxeter groups, it was previously unknown if any Garside shadows existed between the arrangements. Our

current work, completed with the assistance of undergraduate researchers and collaborators at the University of Syndey, involves an in-depth examination of the Garside shadows of rank 3 affine Coxeter groups. In this talk, we provide a summary of our preliminary results, including a complete description of the Garside shadows between the Shi-0 and Shi-1 arrangements in some rank 3 affine Coxeter groups.
Groups and Geometry, Friday 11:30-11:55 Room 260-092

Lattice polymers near a permeable interface

Chris Bradly[1]

[1]University of Melbourne

We study the localisation of lattice polymer models near a permeable interface in two dimensions. Localisation can arise due to an interaction between the polymer and the interface, and can be altered by a preference for the bulk solvent on one side or by the application of a force to manipulate the polymer. Different combinations of these three effects give slightly different statistical mechanical behaviours. The canonical lattice model of polymers is the self-avoiding walk which we mainly study with Monte Carlo simulations to calculate the phase diagram and critical phenomena. For comparison, a solvable directed walk version is also defined and the phase diagrams are compared for each case. We find broad agreement between the two models, and most minor differences can be understood as due to the different entropic contributions. In the limit where the bulk solvent on one side is overwhelmingly preferred we see how the localisation transition transforms to the adsorption transition; the permeable interface becomes effectively an impermeable surface.
Topology, geometry and combinatorics of biopolymers, Wednesday 11:30-11:55 Room 260-221

Detachable pairs in 3-connected matroids and simple 3-connected graphs

Nick Brettell[1], *Charles Semple*[2], *Gerry Toft*[2]

[1]Victoria University of Wellington, [2]University of Canterbury

To prove results like Kuratowski's Theorem, which characterises planar graphs, or excluded-minor characterisations of matroids representable over a finite field, one usually requires a lemma guaranteeing the existence of element(s) that can be deleted or contracted while preserving some connectivity condition. For example, a typical modern proof of Kuratowski's Theorem uses that a 3-connected graph has an element that can be contracted to produce another 3-connected graph. For proving excluded-minor characterisations of matroids representable over a field (or fields), we strive for a pair of elements to delete or contract and keep 3-connectivity, known as a detachable pair. In this talk, I will present a characterisation of when a matroid (or simple 3-connected graph) has a detachable pair, and discuss applications of this result.
Structural aspects of matroids and graphs, Tuesday 11:30-11:55 Room 303-B09

Exact solutions to multidimensional nonlinear reaction-diffusion. Part 1: Conditionally integrable nonlinear reaction-diffusion-convection applied to irrigation

Phil Broadbridge[1]

[1]La Trobe University

For a long time, the only known exact solutions were travelling waves or similarity solutions from power-law or exponential reaction terms. Now there is a class of conditionally integrable reaction-diffusion models including a general nonlinear reaction function. Transient reaction-diffusion solutions may be constructed from any steady solution to a linear Helmholtz-type equation $Lu + k^2u = 0$, where L can be any linear elliptic operator, even the 4th-order Cahn-Hilliard operator. Applications are shown for phase field separation and for irrigation of a cropped field with transpiration.

Mathematics of nonlinear diffusion processes, Monday 15:00-15:25 Room 260-018

Exact solutions to multidimensional nonlinear reaction diffusion. Part 2: Nonlinear reaction-diffusion applied to fisheries and Cahn-Hilliard phase fields

Phil Broadbridge[1]

[1]La Trobe University

For a long time, the only known exact solutions were travelling waves or similarity solutions from power-law or exponential reaction terms. Now there is a class of conditionally integrable reaction-diffusion models including a general nonlinear reaction function. Transient reaction-diffusion solutions may be constructed from any steady solution to a linear Helmholtz-type equation $Lu + k^2u = 0$, where L can be any linear elliptic operator, even the 4th-order Cahn-Hilliard operator. Applications are shown for phase field separation and for irrigation of a cropped field with transpiration.

Mathematics of nonlinear diffusion processes, Tuesday 15:00-15:25 Room 260-018

Absolute continuity of stationary measures

Aaron Brown[1]

[1]Northwestern University

In the setting of dissipative random dynamics, an important question is the dimension and regularity of stationary measures. We establish absolute continuity of the natural (physical or SRB) stationary measures for certain open families of random dynamics on the torus.

Ergodic Theory and Dynamical Systems, Tuesday 11:30-11:55 Room 303-G23

The growth of Fourier coefficients of restricted eigenfunctions

Madelyne Brown[1]

[1]University of Auckland

Many physical phenomena, such as heat diffusion, wave propagation, and the behaviour of quantum particles, can be described in terms of Laplace eigenfunctions ϕ_λ, which satisfy $-\Delta\phi_\lambda = \lambda^2\phi_\lambda$, where Δ is the Laplace-Beltrami operator. In this talk, we will discuss the growth of high frequency (large λ) eigenfunctions on a compact, Riemannian manifold M when restricted to a submanifold H. We analyse the restricted eigenfunctions $\phi_\lambda|_H$ by studying the behaviour of their Fourier coefficients with respect to an arbitrary orthonormal basis on the submanifold. We obtain an explicit bound on these Fourier coefficients depending on how the semiclassical defect measures associated with the two collections of functions, the eigenfunctions and basis on H, relate. Lastly, we obtain a little-o improvement under an additional assumption on the dynamics of the underlying geodesic flow on M.

Microlocal analysis and inverse problems, Monday 16:30-16:55 Room 260-009

Computing sheaf cohomology over noncommutative projective schemes

Michael Brown[1], *Daniel Erman*[2], *Gregory G. Smith*[3]

[1]Auburn University, [2]University of Hawai'i, [3]Queen's University

Given a commutative graded algebra $A = \bigoplus_{i\geq 0} A_i$ over a field k such that $A_0 = k$, one has an associated projective scheme $X = \mathrm{Proj}(A)$. When A is not commutative, no such scheme X exists, but one may nevertheless define a category associated to A that has many of the same homological properties as the category of coherent sheaves on a projective scheme. In particular, there is a noncommutative analogue of sheaf cohomology for objects in this category. Our goal is to develop a method for computing noncommutative sheaf cohomology in the case where A is Koszul and Gorenstein. As an application, we prove a noncommutative generalization of the Horrocks splitting criterion, which is a necessary and sufficient condition for a vector bundle on projective space to split as a sum of line bundles.

Computations and applications of algebraic geometry and commutative algebra, Friday 11:30-11:55 Room 303-B05

Self-similar quantum groups

Nathan Brownlowe[1]

[1]The University of Sydney

Dave Robertson (UNE) and I recently introduced the notion of self-similarity for compact quantum groups. Together with Christian Voigt (Glasgow) and Mike Whittaker (Glasgow) we

have extended this idea to the setting of discrete quantum groups, and have been studying examples, including a "quantum Grigorchuk group". I will report on our latest progress.
Functional Analysis and Operator Algebras, Tuesday 12:00-12:25 Room 260-055

A Geometric Introduction to Diversity Theory

David Bryant[1], *Paul F. Tupper* [2]

[1]University of Otago, [2]Simon Fraser University

A *diversity* is a pair (X, δ) where X is a set and δ is a real-valued function on finite subsets of X such that

(D1) $\delta(A) \geq 0$ and $\delta(A) = 0 \Leftrightarrow |A| \leq 1$

(D2) i$\delta(A \cup C) \leq \delta(A \cup B) + \delta(B \cup C)$ whenever B is non-empty,

for finite $A, B, C \subseteq X$ [1]. A diversity is a set-based analogue of a metric space. Examples of diversities include the diameter of a set; the length of a Steiner tree; phylogenetic diversity; the circumradius; the length of a minimal TSP tour; mean width; minimal connected hypergraph; the length of an enclosing zonotope. We have been discovering that the theory of diversities sometimes runs in parallel with that of metrics [1,2] and sometimes veers off in completely new directions.

In this talk I briefly introduce diversity theory before describing recent work on classes of 'geometric' diversities with origins in convex analysis [2]. We are particularly interested in characterizations of diversity embeddings, motivated by potential applications in hypergraph algorithms, machine learning and topological data analysis. [3,4].

[1] Bryant, D., & Tupper, P. F. (2012). Hyperconvexity and tight-span theory for diversities. Advances in Mathematics, 231(6), 3172-3198.

[2] Bryant, D., Nies, A., & Tupper, P.F. (2017). A universal separable diversity. Analysis and Geometry in Metric Spaces, 5(1), 138-151.

[3] Bryant, D., Huber, K. T., Moulton, V., & Tupper, P. F. (2023). Diversities and the generalized circumradius. Discrete & Computational Geometry, 70(4), 1862-1883.

[4] Bryant, D., & Tupper, P. (2014). Diversities and the geometry of hypergraphs. Discrete Mathematics & Theoretical Computer Science, 16(PRIMA 2013).

[5] Jozefiak, A. D., & Shepherd, F. B. (2023). Diversity Embeddings and the Hypergraph Sparsest Cut. arXiv preprint arXiv:2303.04199.

Contributed Session B, Tuesday 12:00-12:25 Room 303-G14

Relative Optimal Transport for Topological Data Analysis

Peter Bubenik[1], *Alex Elchesen*[2]

[1]University of Florida, [2]Colorado State University

The main tool of topological data analysis, persistent homology, produces a formal sum of intervals called a persistence diagram. If we choose a metric for points in the plane, then we have a formal sum in a metric space. To measure distances between persistence diagrams, we use ideas from optimal transport. However, unlike the classical theory of optimal transport, we have a distinguished subset, the diagonal, corresponding to intervals of zero length, which acts as a reservoir for gaining or losing mass. We develop a theory of optimal transport for metric spaces relative to a distinguished subset. The resulting theory provides a framework for the functional analysis of persistence diagrams.
Applied and Computational Topology, Thursday 11:30-11:55 Room 260-223

Asymptotic Behavior of Rational Painlevé-V Functions

Robert Buckingham[1]

[1]University of Cincinnati

The Painlevé-V equation has two families of rational solutions, one built from generalized Umemura polynomials and one built from generalized Laguerre polynomials. The zeros and poles of both families exhibit remarkable geometric structures. In joint work with Matthew Satter of the University of Michigan, we derive a novel Riemann–Hilbert representation for the rational solutions built from Umemura polynomials and use it to obtain large-degree asymptotic behavior. We also discuss ongoing work with Trevor Johnson of the University of Cincinnati giving related results for the generalized Laguerre solutions.
Discrete and continuous integrable systems: geometry analysis and applications, Tuesday 16:00-16:25 Room 260-036

Seven years of Peter's Party Planning Problems

Yudhistira Bunjamin[1], *Diana Combe*[1]

[1]UNSW Sydney

Peter's Party Planning Problems is a mathematics outreach workshop that was first delivered in 2018. The primary learning outcome of the workshop is to convey the notion of non-existence in mathematics. This learning outcome is achieved using a series of tasks where participants plan a series of parties for Peter's seven friends. Over the past seven years, the design of the workshop has evolved over repeated runs of the workshop. This talk will recount the journey that the workshop has gone through over the years and aims to present a case study of the

long-term development required to design a workshop that is equitable and versatile. We begin by demonstrating the tasks in the workshop. We will then discuss some of the key developments over the years after the workshop was initially run.
Engagement with mathematics through communication and outreach, Monday 15:00-15:25 Room 260-040

Coalescence for Feller diffusions

Conrad Burden[1], *Robert Griffiths*[2]

[1]Australian National University, [2]Monash University

Consider the diffusion process defined by the forward equation $u_t(t,x) = \frac{1}{2}\{xu(t,x)\}_{xx} - \alpha\{xu(t,x)\}_x$ for $t, x \geq 0$ and $-\infty < \alpha < \infty$, with an initial condition $u(0,x) = \delta(x - x_0)$. This equation was introduced and solved by Feller to model the growth of a population of independently reproducing individuals. We explore important coalescent processes related to Feller's solution. For any α and $x_0 > 0$ we calculate the distribution of the random variable $A_n(s;t)$, defined as the finite number of ancestors at a time s in the past of a sample of size n taken from the infinite population of a Feller diffusion at a time t since since its initiation. For the case of a supercritical diffusion we construct a coalescent tree which has a single founder as a time-inhomogeneous pure death process and derive the distribution of coalescent times.
Probability and Mathematical Statistics, Tuesday 15:00-15:25 Room 260-098

Optimal shape domain for the torsion problem

Krzysztof Burdzy[1]

[1]University of Washington

Consider a bounded convex planar domain. Let $u(x)$ be the expected lifetime of Brownian motion starting from x and killed upon exiting the domain. The norm of the gradient of $u(x)$ has a universal bound among all domains with area 1. There exists an optimizer, i.e., a domain where the supremum of the norm of the gradient of $u(x)$ is attained. It is not known whether the optimizer is unique. The main result is that every optimizer has a line segment in its boundary. Also, the boundary does not have corners.
Probability and Mathematical Statistics, Thursday 12:00-12:25 Room 260-098

Observations on the Structure of Small 4-Manifold Triangulations

Rhuaidi Burke[1]

[1]University of Queensland

We consider two fundamental problems in PL topology. First, given a manifold M, what is the minimum number of simplices needed to triangulate M? Second, given a triangulated manifold, can we develop a decomposition theory that breaks the triangulation into simple, yet meaningful, building blocks? These blocks should be large enough to simplify the representation and analysis of the triangulation but small enough to appear frequently across various triangulations. In this talk, we present recent progress on constructing such a decomposition theory for triangulations of 4-manifolds. We describe key examples of some building blocks and the types of triangulations that contain them. Finally, we introduce several decompositions for 4-manifolds based on these pieces, from which we obtain lower bounds on the complexity of certain triangulations in terms of their topology.

Early Career Showcase in Low-Dimensional Topology, Monday 16:00-16:25 Room 260-073

Equation learning of ODE systems from Stochastic agent based models using a library of chemical reactions

Kevin Burrage[1]

[1]Queensland University of Technology

In this talk I introduce our work developing a new method [1] based on a library of chemical reactions for constructing a system of ordinary differential equations from stochastic simulations arising from an agent-based model. The advantage of this approach is that this library respects any coupling between systems components, whereas the SINDy algorithm (introduced by Brunton, Proctor and Kutz) treats the individual components as decoupled from one another. Another advantage of our approach is that we can use a non-negative least squares algorithm to find the non-negative rate constants in a very robust, stable and simple manner. We illustrate our ideas on an agent-based model of tumour growth on a 2D lattice. In the second part of the talk I address the issue that as the number of species increases the size of the library can become very large. This is addressed by subsampling the library as part of an evolutionary optimisation scheme, which enables the generation of parsimonious models. I illustrate this idea in practice.

Computational Mathematics, Tuesday 14:00-14:25 Room 402-231

Lines in geometries associated with finite buildings

Sira Busch[1], *Hendrik Van Maldeghem* [2]

[1]Münster University, [2]Ghent University,

Suppose Δ is an irreducible, thick, finite, spherical building of rank greater one. We call a panel s-thick, if it is contained in precisely s+1 chambers. Suppose the panels of cotype i in Δ are s-thick. Every set of s vertices of type i admits a common opposite vertex. This is not true for s+1 vertices of type i. Hence the question: When is it the case that we can find a common opposite vertex in Δ to s+1 given vertices of type i? Answering this question is an ongoing project of Hendrik Van Maldeghem and myself that we already solved for the classical case. This question arose while working on constructions in finite Lie incidence geometries that yielded in us, together with Jeroen Schillewaert, determining all Levi subgroups of parabolic subgroups of groups of Lie type related to thick, irreducible, spherical buildings of simply laced type. Viewed in another way, answering this question lays a basis for investigating the analogues of blocking sets in Lie incidence geometries. In my talk I would like to explain our project and how it connects group theory, incidence geometry and combinatorics.
Groups and Geometry, Friday 14:00-14:25 Room 260-092

Trees and B-series

John Butcher[1], *Helmut Podhaisky*[2]

[1]University of Auckland, [2]Martin-Luther University Halle-Wittenberg

B-series are used for the analysis of Runge–Kutta and other methods for the numerical solution of an initial value problem $y'(x) = f(y(x)), y(x_0) = y_0$, on the interval $[x_0, x_0 + h]$ Let T be the set of rooted trees, $\varnothing$ the empty tree and $T^{\#} = T \cup \{\varnothing\}$. For a given mapping a from $T^{\#}$ to the reals, The corresponding B-series is

$$B_h(a)y_0 = a(\varnothing)y_0 + \sum_{t \in T} \frac{h^{|t|}}{\sigma(t)} a(t)F(t)y_0,$$

where $|t|$ is the order (number of vertices) of t and $\sigma(t)$ is the symmetry (order of the symmetry group) of t. If $a(\varnothing) = 1, a(t) = 1/t!$, then $B_h(a)y_0$ is the Taylor series for the flow on $[0, h]$ and if $b(\varnothing) = 1, b(t) = \Phi(t)$, then $B_h(b)y_0$ is the Taylor series for a Runge–Kutta method approximation. This leads to the conditions $\Phi(t) = 1/t!, |t| \leq p$ for a method to have order p. This paper introduces the elementary theories of trees and B-series and shows how the Hopf algebra of rooted trees is used to give an algebraic counterpart to manipulations of numerical approximations. Although B-series software is available, this is necessarily based on symbolic programming. In contrast to these approaches, it is shown in this paper how cheap B-series calculations can be carried out.
Computational Mathematics, Wednesday 10:30-10:55 Room 402-231

Rigorous machine-learning-assisted existence of O(3)xO(10)-invariant Einstein metrics on S^{12}

Timothy Buttsworth[1], *Liam Hodgkinson*[2]

[1]The University of New South Wales, [2]The University of Melbourne

Finding new Einstein metrics continues to be a popular problem in Riemannian geometry. In this talk, I will discuss the problem of finding Einstein metrics on spheres by imposing various symmetries. I will then discuss recent progress in the use of computational and machine learning methods to rigorously prove existence of a new cohomogeneity one Einstein metric on S^{12}
Recent advances in geometric PDE, Friday 15:00-15:25 Room 260-057

The Boone–Higman conjecture for groups acting on locally finite trees

Kai-Uwe Bux[1], *Claudio Llosa Isenrich*[2], *Xiaolei Wu*[3]

[1]Bielefeld University, [2]Karlsruhe Institute of Technology, [3]Fudan

We develop a method for proving the Boone-Higman Conjecture for groups acting on locally finite trees. As a consequence, the Boone-Higman Conjecture holds for all Baumslag-Solitar groups and for all free(finite rank)-by-cyclic groups. This resolves two cases that have been raised explicitly by Belk, Bleak, Matucci and Zaremsky. (Joint with Xiaolei Wu and Claudio I. Llosa)
Groups and Geometry, Wednesday 11:30-11:55 Room 260-092

Tool for identifying the geometric properties of the emergence of blenders in a three-dimensional Hénon-like map

Dana C'Julio[1], *Hinke M Osinga*[1], *Bernd Krauskopf*[1]

[1]University of Auckland

A dynamical system given by a diffeomorphism with a three-dimensional space may have a *blender*, which is a hyperbolic set Λ with, say, a one-dimensional stable invariant manifold that behaves like a surface. This means that the stable manifold of any fixed or periodic point in Λ weaves back and forth as a curve in phase space such that it is dense in some planar projection; we refer to this as the *carpet property*. Moreover, this property persists for small arbitrary perturbations. The presence of a blender can be used to prove the robust existence of a non-transverse heterodimensional cycle, which implies the so-called wild chaos.
We present an algorithm for computing very long pieces of such a one-dimensional manifold that we implemented in Matlab to identify efficiently, accurately and reliably a very large number of intersection points with a specified section. With this method, we investigate the geometric properties of the emergence of blenders in a three-dimensional Hénon-like map $\mathcal{H}$ by computing the one-dimensional manifold of its fixed and periodic points. Specifically, we discover that the organisation of the projection of the intersection points follows a consistent pattern as a parameter is varied. Consequently, we can study in detail the specific parameter values and order of events that occur as the blender arises.
Computational Methods and Applications of Dynamical Systems, Friday 14:30-14:55 Room 303-G20

Existence and classification of solutions for nonlinear elliptic equations with singular potentials

Florica Cîrstea[1], *Frédéric Robert*[2], *Hosea Wondo*[1]

[1]The University of Sydney, [2]University of Lorraine

In this talk, we present new results on the existence and classification of the behaviour near zero of the positive $C^2(B_R(0) \setminus \{0\})$ solutions of

$$-\Delta u = \frac{u^{2^\star(s)-1}}{|x|^s} - \mu \frac{u^q}{|x|^\tau} \quad \text{in } B_R(0) \setminus \{0\},$$

where $B_R(0)$ is the open ball in $\mathbb{R}^n$ centered at 0 and of radius $R > 0$. Here, $n \geq 3$, $q > 1$, $\mu > 0$, $\tau \in \mathbb{R}$, $s \in (0,2)$ and $2^*(s) = 2(n-s)/(n-2)$. The classification of singularities is intimately connected with the position of τ with respect to 2, as well as s. We will focus on the case of removable singularities to emphasize the changes between $\tau < 2$ and $\tau \geq 2$. We will also examine certain singular asymptotic profiles using Pohozaev type arguments. We obtain the existence of solutions with the desired profile via a dynamical systems approach.

Functional analysis and partial differential operators, Tuesday 16:00-16:50 Room 260-020

The Douglas–Rachford algorithm for inconsistent problems

Bethany Caldwell[1], *Regina Burachik*[1], *Yalçın Kaya*[1], *Walaa Moursi*[2]

[1]University of South Australia, [2]University of Waterloo

The Douglas–Rachford algorithm has been successfully employed to solve convex optimization problems, or more generally find zeros of monotone inclusions. Recently, the behaviour of these methods in the inconsistent case, i.e., in the absence of solutions, has been a topic of interest as these problems appear regularly but can be difficult to analyse. We give a result for the strong convergence of the shadow sequence of the Douglas–Rachford algorithm in the possibly inconsistent case when one of the operators is uniformly monotone and 3* monotone but not necessarily a subdifferential. We also provide numerical experiments comparing the performance of the Douglas–Rachford algorithm for inconsistent finite- and infinite-dimensional linear-quadratic problems with the Peaceman–Rachford algorithm and Dykstra's projection algorithm.

Optimisation, Wednesday 11:00-11:25 Room 402-221

Developing and Refining a Framework to Identify the Language Demands and Resources for Multilingual Students in Inquiry-Based Undergraduate Mathematics Courses

Ernesto Calleros[1]

[1]California State University Fresno

Inquiry-based mathematics education (IBME) includes features such as: (a) Using tasks with authentic problem contexts, (b) building on students' everyday resources, (c) relying on small-group and whole-class discussions, and (d) establishing certain norms of participation for the inquiry classroom community (Laursen & Rasmussen, 2019). Prior research on active learning (which includes IBME) suggests inquiry approaches are more effective than lectures in undergraduate mathematics education (Freeman et al., 2014). However, inquiry-based approaches might not yield equal benefits for students from certain marginalized groups (e.g., women in Johnson et al., 2020). One important group to consider is multilingual students whose primary language differs from the language of instruction. In this dissertation, I conducted a multi-case study analysis to explore an overarching question related to equity for multilingual students: What language demands and resources do multilingual students experience in one inquiry-oriented linear algebra (IOLA) course? Grounded in a situated sociocultural theory of learning, I constructed a framework that captures language demands and resources along three interrelated dimensions: lexico-grammatical, situational, and normative. The data collected were classroom observations of one IOLA course taught by an expert instructor, as well as semi-structured interviews with 4 multilingual students from the course. The 4 students spanned a diverse range of linguistic and cultural backgrounds (Korean, Vietnamese, Malaysian, and Latino) and comfort levels with English. The interview data was analyzed using inductive and deductive coding (Miles et al., 2019). The initial data analysis led to a refinement of the conceptual framework. The study's findings showed that (a) authentic problem contexts use complex language, especially for multilingual students; (b) "everyday" language resources for students from the dominant community might not function as such for multilingual students; (c) an emphasis on verbal participation can obscure multilingual students' communication resources; and (d) inquiry classrooms can induce norm tensions about communication for multilingual students when the norms of their communities outside the inquiry classroom are not explicitly considered. This study underscores the opportunity to continue improving IBME to address the language demands induced for multilingual students by incorporating instructional language resources and leveraging the students' language resources.
Mathematics Education, Friday 14:00-14:50 Room 260-115

Computational techniques for recovering singularities, with application to X-ray tomography

Daniela Calvetti[1]

[1]Case Western Reserve University

A common task in imaging applications is the recovery of the singularities of the image from noisy indirect observations. These problems are often ill-posed, either because of the poor con-

ditioning of the forward operator, or for incompleteness of the data, the limited angle X-ray tomography being an example of the latter type of ill-posedness. In computational approaches, often the ill-posedness is compensated by using regularization techniques, or by resorting to the Bayesian statistical framework, where the prior distribution plays the role of regularization. In this talk, we consider a Tikhonov-type regularization approach arising from a Bayesian hierarchical prior model, in which the regularizing functional is parametrized by a distributed hyperparameter. By writing the iterative process of estimating the unknown distribution constituting the image in an adjoint form, we show that it is possible to design a computational algorithm suitable for large scale problems that effectively reconstruct the singularities of the image.
Microlocal analysis and inverse problems, Wednesday 11:00-11:25 Room 260-009

The Physical interpretation of the Newman-Penrose constants and Newman's H-space

Breanna Camden[1], *Chris Stevens*[1]

[1]University of Canterbury

The *Newman Penrose (NP) constants* are five complex absolutely-conserved quantities defined on future null infinity $\mathscr{I}^+$ for asymptotically flat space-times. Owing to a recent construction of an initial boundary value problem for the generalised conformal field equations, $\mathscr{I}^+$ has been made accessible by numerical methods allowing the NP constants to be numerically determined for the first time. However, the NP constants have only been explicitly calculated for limiting cases such as stationary, time-symmetric or small deviations from axi-symmetric space-times which have limited relevance to physically-meaningful space-times. We generalise this framework to include a wider selection of initial asymptotically flat space-times. By varying the initial physically-motivated parameters of these numerical evolutions, we determine how the NP constants depend on such parameters, and thus motivate an explicit physical interpretation of the NP constants. We also explore potential relationships between the NP constants, $\mathscr{H}-$space and twistor theory as recently hinted at by Penrose.
Recent advances in geometric PDE, Wednesday 11:45-11:55 Room 260-057

Numerically extending the Generalised Conformal Field Equations to include energy and momentum.

Lachlan Campion[1], *Chris Stevens*[1]

[1]University of Canterbury

The best model we currently have to describe gravity is that of Einstein's field theory of general relativity (GR) which allows us to relate geometry to mass and energy. A novel prediction that was made using Einstein's theory was that of gravitational waves, which were first measured in 2015. Gravitational waves and phenomena such as energy and momentum are not well defined locally. but do have a well defined description at 'infinity', One method that is particularly well suited to study these phenomena, is that of conformal compactification, which allows "infinity" to be described by local differential geometry. In the 1990's, Helmut Friedrich developed an extension of Einstein's field equations to include infinity, now known as the Generalised Conformal Field Equations (GCFE). The GCFE comprise a system of PDEs that can be reduced to a system of ODES in all components except the curvature components by a judicious choice of gauge (Conformal Gauss Gauge). The GCFE in this gauge has been used for numerical simulations, as undertaken by Frauendiener, Stevens et al., to calculate the propagation of gravitational waves in vacuum, namely with vanishing energy momentum tensor. By using theoretical work undertaken by Juan Kroon, we generalize the existing framework to include energy momentum. This unlocks the ability to study phenomena, fully coupled to gravity, such as electromagnetic waves, charged black holes and various scalar fields. This talk showcases how this has been done.

Recent advances in geometric PDE, Monday 16:45-16:55 Room 260-057

The non-relativistic limit for the cubic Dirac equation

Timothy Candy[1], *Sebastian Herr*[2]

[1]University of Otago, [2]University of Bielefeld

The Dirac equation is the relativistic version of the Schrödinger equation, and hence unsurprisingly it plays a central role in relativistic (where the speed of light is finite) quantum mechanics. It is known that for certain nonlinear models, as the speed of light tends to infinity, the Dirac equation converges on finite time scales to the Schrödinger equation. Here I will explain how recent uniform (in the speed of light) estimates for small data solutions to the cubic Dirac equation can be used to prove that the non-relativistic limit in fact holds on global time scales in dimensions d¿1. In particular we have convergence of scattering states and wave operators from the Dirac equation to the corresponding Schrödinger equation. This is joint work with Sebastian Herr.

Harmonic analysis and Hamiltonian PDE, Tuesday 14:00-14:50 Room 260-028

Mathematical design of a bioartificial pancreas

Suncica Canic[1], *Yifan Wang, Jerffrey Kuan, Justin Webster, Boris Muha, Martina Bukac, Lorena Bociu, Shuvo Roy*

[1]UC Berkeley

The future of bioartificial organ design is poised with tremendous promise. Achieving success in this field necessitates collaborative efforts among experts spanning diverse domains such as biology, medicine, engineering, materials science, and mathematics. This presentation aims to illuminate the pivotal role played by recent advancements in mathematical analysis and numerical method development in studying the interplay between fluids and poroelastic media (fluid-poroelastic structure interaction), and how these innovations have significantly contributed to

the design of a bioartificial pancreas for the treatment of Type 1 and Type 2 diabetes.
Industrial Mathematics, Monday 14:30-14:55 Room 402-211

Blenders and robust transitivity for a family of derived from Anosov maps on T3

Marisa Cantarino[1], *Andy Hammerlindl*[1], *Warwick Tucker*[1]

[1]Monash University

Blenders originally emerged as objects in dynamical systems as an example given by C. Bonatti and L. Díaz of a system which is not uniformly hyperbolic but it is robustly transitive. Roughly speaking, on an n-manifold, a blender is a hyperbolic invariant subset of the system that allows for robust intersections of s-dimensional stable manifolds and u-dimensional unstable manifolds, with s + u ¡ n. The way to make this intersection robust without “the right dimensions” is to make the stable set of the blender to “fill the space as if it is higher dimensional”. This intersection allows the existence of robust heterodimensional cycles, giving conditions for robust transitivity. We present a family of D.A. (derived-from-Anosov) systems on the 3-torus for which we are exploring robust transitivity using the presence of blenders. The existence of a blender and robust transitivity are proved using computer assisted strategies. This is ongoing work made with the collaboration of Andy Hammerlindl and Warwick Tucker.
Ergodic Theory and Dynamical Systems, Wednesday 10:30-10:55 Room 303-G23

Noncommutative law of large numbers

Junming Cao[1], *Yong Jiao*[1], *Sijie Luo*[1], *Dejian Zhou*[1]

[1]Central South University

The convergence rate of the law of large numbers plays an essential role in probability theory, which is closely related to the large deviation theory, concentration of measure, Markov chains and related areas. One of the most fundamental results in such investigations is the Baum-Katz theorem. In this talk, we focus on studying the Baum-Katz type theorem in the noncommutative setting. Firstly, we establish a Baum-Katz theorem for noncommutative successively independent random variables, resolving an open problem posed by Stoica. Our approach differs from the classical setting but relies on the theory of asymmetric maximal inequality for noncommutative martingales. Additionally, we derive a moderate deviation inequality and extend this result as well as the Baum-Katz theorem to the noncommutative martingales case. As an application of our results, we obtain the noncommutative Marcinkiewicz-Zygmund type strong laws of large numbers.
Contributed Session A, Thursday 14:30-14:55 Room 303-B11

Arnold Diffusion in the Three Body Problem

Maciej Capinski[1], *Marian Gidea*

[1]AGH University of Krakow

An arbitrarily small perturbation of an integrable Hamiltonian system can lead to macroscopic changes of its constant of motion. Such behaviour is referred to as Arnold diffusion. We will present a geometric mechanism which leads to such phenomenon. As an application of our method we will consider the Neptune-Triton-asteroid system, with the mass of the asteroid playing the role of the perturbation parameter. The proof is computer assisted.
Computational Methods and Applications of Dynamical Systems, Tuesday 11:30-11:55 Room 303-G20

Isothermic Surfaces

Fran Burstall[2], **Emma Carberry**[1], *Udo Hertrich-Jeromin*[3], *Franz Pedit*[4]

[1]The University of Sydney, [2]The University of Bath, [3]The University of Vienna, [4]The University of Massachusetts at Amherst

I shall describe a puzzling relationship between two cohomology classes associated to a constant mean curvature (cmc) surface Σ in a 3-dimensional space form M. Korevaar and Kusner introduced the *moment class* $\mu \in H^1(\Sigma, \mathbb{R}) \otimes \mathfrak{g}_M^*$, where $\mathfrak{g}_M$ denotes the Killing fields of M. This was, for example, used by Kapouleas to show the necessity of the balancing conditions used in his gluing construction of cmc surfaces. On the other hand, cmc surfaces are globally isothermic and key to the modern integrable systems approach to such surfaces is the *retraction form* η, for which $[\eta] \in H^1(\Sigma, \mathbb{R}) \otimes \mathfrak{c}_M$, where $\mathfrak{c}_M \supset \mathfrak{g}_M$ are the conformal vector fields. Using an observation of Meeks–Pérez–Tinaglia, in the Euclidean case it is not difficult to see that the translational part of the moment class may be represented by (the dual of) the rotational part of the retraction form. This demands further explanation, and in fact there is a natural isomorphism $\mathfrak{g}_M \cong \mathfrak{g}_M^*$ which identifies the full retraction and moment classes for any space form. However a geometric explanation as to *why* this relationship exists is at present elusive.
Differential geometry and geometric analysis, Tuesday 11:30-12:20 Room 260-005

Adaptive Computation of Fourth-Order Problems

Carsten Carstensen[1]

[1]Humboldt-Universität zu Berlin

The popular (piecewise) quadratic schemes for the fourth-order plate bending problems based on triangles are the nonconforming Morley finite element, two discontinuous Galerkin, the C0 interior penalty, and the WOPSIP schemes. The first part of the presentation discusses recent applications to the linear bi-Laplacian and to semi-linear fourth-order problems like the stream function vorticity formulation of incompressible 2D Navier-Stokes problem and the von K´arm´an plate bending problem. The role of a smoother is emphasised and reliable and efficient a posteriori error estimators give rise to adaptive mesh-refining strategies that recover optimal rates in numerical experiments. The last part addresses recent developments on adaptive multilevel Argyris finite element methods. The presentation is based on joint work with B. Gräßle (U Zurich) and N. Nataraj (IITB, Mumbai) partly reflected in the references below.

Computational Mathematics, Thursday 11:30-11:55 Room 402-231

Recent progress in the representation theory of totally disconnected locally compact groups

Max Carter[1]

[1]Université Catholique de Louvain

Let G be a locally compact group and $C^*(G)$ the enveloping C^*-algebra of $L^1(G)$. The group G is called GCR (resp. CCR) if, for every irreducible unitary representation (π, H) of G, $\pi(C^*(G))$ contains $K(H)$ (resp. $\pi(C^*(G)) = K(H)$) where $K(H)$ denotes the algebra of compact operators on the Hilbert space H. Of course, by definition, every CCR group is GCR. GCR groups, also commonly referred to as 'type I" groups, are known to be, in some sense, those groups in which it is possible to classify all of their unitary representations. Consequently, it is an important question in the representation theory of locally compact groups to determine which groups are GCR and CCR. This question has been studied a considerable amount over the past century and is relatively well understood, for instance, in the case when G is either a connected group, a Lie/algebraic group over a local field, or a discrete group. The question of which (non-linear) non-discrete totally disconnected locally compact groups are GCR/CCR is not as well understood in comparison to the prior mentioned classes of groups. There has, however, been considerable progress on this topic in recent years, especially in the context of groups acting on locally-finite trees. The purpose of this talk will be to give a brief introduction to this topic, recent progress in the area, and ongoing work. A focus will be given towards projects that I am actively working on. Depending on how various projects progress in the lead up to the meeting, I may choose to focus the talk more-so in one of the following directions: (i) amenable groups acting on locally-finite trees; (ii) groups acting on non-affine non-spherical buildings.

Groups and Geometry, Monday 14:30-14:55 Room 260-092

Unstable vortices and non-uniqueness for 2D Euler and gSQG

Angel Castro[1]

[1]ICMAT-CSIC

In the sixties Yudovich proved global existence and uniqueness of solutions for the 2D Euler incompressible equation in $L^1 \cap L^\infty$. This result extends to the case with a force in $L^1_t(L^1 \cap L^\infty)$.

Although global existence in $L^1 \cap L^p$, $1 < p < \infty$, was obtained by Diperna and Majda in 1987, the problem of uniqueness, in this range of p, has remained completely open until the Vishik's work in 2018 . Indeed, Vishik proved that there are forces in $L^1_t(L^1 \cap \text{Ł}^p)$, $1 < p < \infty$, such that at least two different solutions exist for 2D Euler starting in the same initial data. In this talk we will present an alternative approach to prove this theorem. More precisely, we will show a different way to construct unstable radial vortices with compact support which also give rise to non-uniqueness. This strategy also work for $\alpha-$gSQG, $0 \leq \alpha \leq 1$. This family of transport equations, with velocity $\mathbf{u} = -\nabla^{\perp}(-\Delta)^{-1+\frac{\alpha}{2}}\theta$, for the scalar θ, interpolates from 2D Euler ($\alpha = 0$) to the Surface Quasi-Geostrophic equation ($\alpha = 1$). This is a joint work with D. Faraco, M. Mengual and M. Solera.

Recent advances in mathematical fluid dynamics, Wednesday 11:00-11:25 Room 401-311

A Number Theoretic Algorithm Leading to the Proof of the GGR Conjecture on Generalized Differentiation

Stefan Catoiu[1]

[1]Depaul University

We provide an algorithm on $n+1$-sets of non-negative integers that starts with the first $n-1$ forward shifts of the arithmetic progression $0, 1, 2, ..., n$ and ends with the "geometric" progression $0, 1, 2, 2^2, ..., 2^{n-1}$, using two rules of deduction: dilation by 2 and elimination of a common element between two sets with maximal overlap. An application of this to the classical real analysis led to the solution of the GGR Conjecture from 1998 on the equivalence between Peano and Riemann derivatives. Time permitting, I will go over a second, purely algebraic proof of the conjecture. This talk is based on joint work with J. Marshall Ash and Hajrudin Fejzić.

REFERENCES

[1] J. M. Ash and S. Catoiu. Characterizing Peano and symmetric derivatives and the GGR Conjecture's solution. Int. Math. Res. Not. IMRN 2022, no. 10, 7893–7921.

[2] J. M. Ash, S. Catoiu, and H. Fejzić. A new proof of the GGR conjecture, C. R. Math. Acad. Sci. Paris 361 (2023), 349–353.

[3] S. Catoiu and H. Fejzić. A generalization of the GGR conjecture, Proc. Amer. Math. Soc. 151 (2023), 5205–5221.

[4] J. M. Ash, S. Catoiu, and H. Fejzić. Two pointwise characterizations of the Peano derivative, Results Math. 79 (2024), Article No. 251, 17 pp.

Computational Number Theory and Applications, Wednesday 11:45-11:55 Room 405-422

Rigidity of spin fill-ins with non-negative scalar curvature

Simone Cecchini[1], *Rudolf Zeidler, Sven Hirsch*

[1]Texas A&M University

I will present new mean curvature rigidity theorems of spin fill-ins with non-negative scalar curvature using two different spinorial techniques. The first technique is based on extending boundary spinors satisfying a generalized eigenvalue equation via the Fredholm alternative for an APS boundary value problem, while the second is a comparison result in the spirit of Llarull and Lott using index theory. Our results address two questions by Miao and Gromov, respectively. This is joint work with Sven Hirsch and Rudi Zeidler.
INDEX THEORY IN GEOMETRY AND MATHEMATICAL PHYSICS, TUESDAY 15:00-15:25 ROOM 260-022

The cohomology of knotted semimetals

Joshua Celeste[1]

[1]The University of Adelaide

The study of modern quantum materials offers a space for a rich interaction between physics and mathematics. One such case of interest is that of topological semimetals. These phases of matter have interesting electrical conduction properties, and most importantly, such properties arise and are preserved under perturbations by underlying topology and geometry. Semimetals, just like their insulator and conductor cousins, are characterised by their band structure. The key defining property being an intersection between conduction and valence bands in momentum space. When this intersection set is 0-dimensional, one obtains a Weyl semimetal, known experimentally for providing a realisation of Weyl fermions. I shall consider a natural generalisation to so-called nodal semimetals, where the intersection set is 1-dimensional, generally being some kind of knot or link in momentum space. I shall give a brief introduction into how to describe and distinguish such systems via topological invariants. Then I shall discuss some results involving an extension to the topological classification scheme of Weyl semimetals via cohomology to consider the case of nodal semimetals, and a rigorous proof of a charge cancellation condition for '$\mathbb{Z}_2$-monopole charges' in nodal semimetals.
MATHEMATICAL PHYSICS, MONDAY 16:00-16:25 ROOM 260-221

Fun with simplicial homology

Daniele Celoria[1]

[1]UQ

Simplicial homology groups are an old and well-understood tool in combinatorial algebraic topology. We'll show that some simple tweaks to the definition yield some new homology

theories related to the Mayer-Vietoris spectral sequence. We will give some combinatorial and topological properties of these homology theories.
Early Career Showcase in Low-Dimensional Topology, Friday 14:00-14:25 Room 260-073

On the Geometry of Symmetric Products of Curves

Luca Fabrizio Di Cerbo[1]

[1]University of Florida

We discuss several aspects of the Riemannian and symplectic geometry of symmetric products of curves. In particular, we study the scalar curvature and symplectic asphericity of such spaces.
Singularities, Tuesday 16:00-16:50 Room 260-024

Ramanujan's theory of elliptic functions to the cubic base

Heng Huat Chan[1]

[1]Shandong University

In this talk, I will present a new approach to the study of Ramanujan's theory of elliptic functions to the cubic base using Jacobi's theta functions. This new approach does not involve the cubic theta series discovered by J.M. Borwein and P.B. Borwein.
Special Functions, q-Series and Beyond, Monday 16:00-16:25 Room 401-312

The integral closure of an affine ring

Gyu Whan Chang[1]

[1]Incheon National University

A finitely generated algebra over a field K is called an affine (K-)algebra, or, simply, an affine ring. Hence, R is an affine ring if and only if R is isomorphic to the quotient ring $K[X_1, \ldots, X_n]/I$ of a polynomial ring $K[X_1, \ldots, X_n]$ modulo an ideal $I \subseteq K[X_1, \ldots, X_n]$. Let R' be the integral closure of an affine ring R. In this talk, we show that R' is an r-Noetherian ring, i.e., each regular ideal of R' is finitely generated, and we study when R' is a Noetherian ring. We also give a couple of r-Noetherian rings with some interesting ring-theoretic properties.
50 years of Communications in Algebra, Thursday 14:30-14:55 Room 303-G15

Fifty years of Communications in Algebra

Scott Chapman[1]

[1]Sam Houston State University

In 1974, Earl Taft founded Communications in Algebra at Rutgers University. Volume 1, which consisted of 10 papers, was edited by an initial Editorial Board of 36 members representing 10 different countries. The journal began production with authors publishing their own camera ready copy. Now in our 50th year, Communications in Algebra publishes more than 5000 pages annually with the support of a 30-member Editorial Board representing 11 countries. The purpose of this talk is twofold.

1. To review the history of Communications in Algebra, highlighted by the announcement of the first two winners of the Earl Taft Memorial Award for outstanding mathematical writing and achievement for papers appearing in Communications in Algebra.
2. To review the current operation of the journal with an eye toward the future.

50 years of Communications in Algebra, Monday 14:00-14:25 Room 303-G15

The valuation polytope on height two posets

Anastasia Chavez[1], *Federico Ardila*[2], *Jessica De Silva*[3], *José Luis Herrera Bravo*[4], *Andrés Vindas Meléndez*[5]

[1]Saint Marys College of California, [2]San Francisco State University, [3]California State University, Stanislaus, [4]Universidad del Cauca, [5]Harvey Mudd College

Geissinger defined the valuation polytope as the set of all [0, 1]-valuations on a finite distributive lattice. Dobbertin showed the valuation polytope is equivalently defined as the convex hull of vertices characterized by all the chains of a given poset. In this project, we study the valuation polytope, VAL(P), arising from a poset P of height two on n elements. We consider height two posets, generally, and the zig-zag poset and complete bipartite poset, specifically. We will present results on their: normalized volume, the existence of a unimodular triangulation, and their f-vector. An important ingredient is an associated graphical matroid which we highlight throughout the talk. This is joint work with Federico Ardila, Jessica De Silva, José Luis Herrera Bravo, and Andrés R. Vindas-Meléndez.
Structural aspects of matroids and graphs, Tuesday 16:30-16:55 Room 303-B09

Equilibrium states for non-uniformly hyperbolic geodesic flows

Dong Chen[1]

[1]Indiana University Indianapolis

The geodesic flow over a closed negatively curved manifold is Anosov, thus any Hölder potentials have unique equilibrium states. However, it is much less known for non-uniformly hyperbolic geodesic flows. Knieper proved the uniqueness of the measure of maximal entropy for the geodesic flow on compact rank 1 non-positively curved manifolds, and it was extended by Burns, Climenhaga, Fisher, and Thompson to the uniqueness of the equilibrium states for a large class of non-zero potentials with pressure gap. In this talk, I will discuss related results for geodesic flows without focal points, and some recent results regarding potentials with pressure gap and others. This work is joint with N. Kao and K. Park.
Ergodic Theory and Dynamical Systems, Tuesday 16:00-16:25 Room 303-G23

Asymptotic stability of the sine-Gordon kink outside symmetry

Gong Chen[1]

[1]Georgia Tech

We consider scalar field theories on the line with Ginzburg-Landau (double-well) self-interaction potentials. Prime examples include the ϕ^4 model and the sine-Gordon model. These models feature simple examples of topological solitons called kinks. The study of their asymptotic stability leads to a rich class of problems owing to the combination of weak dispersion in one space dimension, low power nonlinearities, and intriguing spectral features of the linearized operators such as threshold resonances or internal modes. We present a perturbative proof of the full asymptotic stability of the sine-Gordon kink outside symmetry under small perturbations in weighted Sobolev norms. The strategy of our proof combines a space-time resonances approach based on the distorted Fourier transform to capture modified scattering effects with modulation techniques to take into account the invariance under Lorentz transformations and under spatial translations. A major difficulty is the slow local decay of the radiation term caused by the threshold resonances of the non-selfadjoint linearized matrix operator around the modulated kink. Our analysis hinges on two remarkable null structures that we uncover in the quadratic nonlinearities of the evolution equation for the radiation term as well as of the modulation equations. The entire framework of our proof, including the systematic development of the distorted Fourier theory, is general and not specific to the sine-Gordon model. This is forthcoming joint work with Jonas Lührmann (Texas A&M)
Harmonic analysis and Hamiltonian PDE, Monday 15:00-15:25 Room 260-028

Robust Optimization with Moment-Dispersion Ambiguity

Li Chen[1]

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No abstract
Optimisation, Monday 15:00-15:25 Room 402-221

Computing the endomorphism ring of supersingular elliptic curve from a full rank suborder

Mingjie Chen[1], *Christophe Petit*[2]

[1]KU Leuven, [2]Université Libre de Bruxelles

In this talk, we present a polynomial-time quantum algorithm for computing the endomorphism ring of a supersingular elliptic curve, given a full-rank subring of the endomorphism ring. We begin by connecting the Endomorphism Ring Problem to the Isogeny to Endomorphism Ring Problem introduced by Chen et al. (Asiacrypt '23). Building on their work, we then generalize their results to fully resolve both problems. Finally, we discuss the implications of our algorithm for isogeny-based cryptography. This is joint work with Christophe Petit.

Computational Number Theory and Applications, Friday 14:30-14:55 Room 405-422

Hybrid Model Using Realized Conditional Autoregressive Expectile Models and

Niya Chen[1], *Jennifer Chan*[1], *Linh Nghiem*[1]

[1]The University of Sydney

This paper proposes a novel approach that combines Feedforward Neural Networks (FNN) with Realized Conditional Autoregressive Expectile (CARE) statistical models to enhance quantile/expectile volatility forecasting on financial markets. Our proposed method leverages the strength of both FNN and CARE models. On one hand, the CARE model provides appropriate distributions for modelling volatility measures, including asymmetric Laplace and asymmetric Gaussian; the corresponding negative log-likelihood are used as a metric for training and validation loss. On the other hand, the flexibility of FNN allows us to capture complex patterns in the location of these distributions over time. We optimize neural network architecture and parameters of statistical models, and select the optimal weight for the contribution the two components at each quantile/expectile level. The proposed approach is applied to analyzing Bitcoin and Gold data between January 2018-March 2023, where our final models demonstrate superior performance regarding both accuracy and coverage levels of predictions, compared to competing approaches that only use FNN or statistical models alone.

Recent developments in data science and machine learning, Tuesday 12:00-12:25 Room 402-220

Counterexample to the second eigenfunction having one zero for a non-local Schrödinger operator

Sophie Chen, *Ben Andrews*

[1]ANU, [2]ANU

We construct a counterexample to the second eigenfunction having only one zero of a perturbed fractional Laplace operator on a bounded interval with Dirichlet 'boundary' data off the interval. At the time of writing, this appears to be one of the first analytical results on the qualitative behaviour of eigenfunctions of perturbed non-local Schrödinger operators. The key step in our construction is solving a related infinite potential well eigenvalue problem using the Kato-Rellich (degenerate) regular perturbation theory. We then employ an energy minimisation argument to produce the final counterexample. While our result focuses on the case $s = 1/2$, it appears to hold more generally for rational values of s in $(0, 1)$.
Recent advances in geometric PDE, Tuesday 16:45-16:55 Room 260-057

Investigating Party Structure Shifts in Parliamentary Networks

Eve Cheng[1]

[1]Australian National University

This talk explores shifts in the party structure within Australian parliamentary networks from 1947 to 2019 using graph theory, focusing on the career backgrounds of Members of Parliament (MPs). We analyze two sets of graphs: one representing MPs and the other capturing their career backgrounds. For the MP graphs, we compute key metrics such as average maximal flow and transitivity and generate three sets of random graphs for statistical comparison. In the career background graphs, we utilize betweenness centrality to identify influential nodes and detect bouquet structures. Additionally, we employ topological data analysis (TDA) to reduce the complexity of these graphs, allowing for a clearer visual inspection of potential clusters within the career networks. Altogether, the analysis reveals structural changes in political networks over time, providing insights into the evolving dynamics of party structures.
Applied and Computational Topology, Tuesday 12:00-12:25 Room 260-223

Topological analysis of the complex SSH model

Eve Cheng[1]

[1]Australian National University

The Su-Schrieffer-Heeger (SSH) model is a seminal example of a topological insulator, describing spinless, non-interacting fermions on a one-dimensional lattice with staggered hopping amplitudes. Since its introduction, the SSH model has been extended to a broader family of models,

including non-Hermitian variants, whose topological properties remain an open research frontier. In this talk, I will present the key challenges in the topological classification of non-Hermitian SSH models and outline our approach using Topological Data Analysis (TDA). As a first step, we have investigated the complex SSH model, which, while Hermitian, features complex hopping parameters. Our results demonstrate that TDA is effective in constructing the phase diagram for this model, offering new insights into its topological behavior and setting the stage for further exploration of non-Hermitian systems.
Mathematical Physics, Tuesday 16:30-16:55 Room 260-221

Homomorphic Encryption and Private AI

Jung Hee Cheon[1]

[1]Seoul National University / Cryptolab Inc.

In this talk, we will introduce recent progress on homomophic encryptions technology. It includes fast bootstrapping, linear operations, and nonlinear operations on encrypted data. Further, we show how it can be used to accelerate the machine learning and LLM on encrypted data. We also introduce implementation results on encrypted LLM and its practical applications.
Computational Number Theory and Applications, Friday 14:00-14:25 Room 405-422

Non-uniqueness for fluid equations

Alexey Cheskidov[1]

[1]Institute For Theoretical Sciences, Westlake University

In this talk I will review recent progress on non-uniqueness of solution to the Navier-Stokes and Euler equations and present a new intermittent convex integration scheme.
Recent advances in mathematical fluid dynamics, Friday 11:30-11:55 Room 401-311

Geodesic X-ray transform and streaking artifacts on

Hiroyuki Chihara[1]

[1]University of the Ryukyus

The X-ray transform on the plane or on the three-dimensional Euclidean space can be considered as the measurements of CT scanners for normal human tissue. If the human body contains metal regions such as dental implants in an oral cavity, stents in blood vessels, metal bones, etc., the beam-hardening effect for the energy level of the X-ray causes streaking arti- facts in its CT image. This talk discusses this phenomenon for the geodesic X-ray transform on non-

trapping simple compact Riemannian manifolds with strictly convex boundary. We show that the streaking artifacts result from the propagation of conormal singularities on the boundary of metal regions along the common tangent geodesics under the strong and seemingly strange assumption that the manifolds are two dimensional or spaces of constant curvature. This condition ensures that every Jacobi field takes the form of the product of a scalar function and parallel transport along the geodesic. Our results clarify the geometric meaning of the theory, which was imperceptible in the known results on the Euclidean space.
Microlocal analysis and inverse problems, Tuesday 11:30-11:55 Room 260-009

The Scale Function Values of (P)-closed Groups Acting On Trees

Marcus Chijoff[1]

[1]The University of Newcastle

The scale function is an important function in the study of totally disconnected locally compact groups. Groups acting on trees are a key example of totally disconnected locally compact groups. Reid-Smith recently introduced local action diagrams: combinatorial structures which parameterise groups acting on trees with Tits' independence property (P). We show how you can determine the values the scale function takes on such a group using its corresponding local action diagram.
Groups and Geometry, Monday 14:00-14:25 Room 260-092

Computing elasticity of certain integral domains

Hyun Seung Choi[1]

[1]Incheon National University

We compute the elasticity and ω-values of certain integral domains that are orders of a global field. To find the exact values, we restricted our domains of concern to numerical semigroup (power series) rings over a finite field, and orders of an imaginary quadratic field. This presentation is based on the paper [H. Choi, Class group and factorization in orders of a PID, J. Number theory, Vol. 265, 226-269 (2024)]
50 years of Communications in Algebra, Thursday 15:00-15:25 Room 303-G15

On the explicit version of Ingham's zero density estimate

Shashi Chourasiya[1], *Aleksander Simonic*[1]

[1]University of New South Wales Canberra

In 1940, Ingham provided a zero density estimate $N(\sigma, T) \ll T^{\frac{3(1-\sigma)}{2-\sigma}} \log^5 T$, for the Riemann zeta function. In this talk, I will discuss its explicit version.
Computational Number Theory and Applications, Tuesday 15:15-15:25 Room 405-422

Limits of perfect complexes

Lars Christensen[1], *Henrik Holm*

[1]Texas Tech University

Let R be a ring. In the category of R-modules, every homomorphism from a finitely presented module to a flat module factors through a finitely generated free module, and that property characterizes flat modules. This was proved independently by Govorov and Lazard in the 1960s and paved the way for their theorem that flat modules are filtered colimits of finitely presented free R-modules. I will discuss the equivalent result about complexes of modules in the context of the derived category of R.
50 years of Communications in Algebra, Tuesday 14:30-14:55 Room 303-G15

Mathematical modelling to understand the effect of mask design on non-invasive ventilation

Alys Clark[1], *Lomani O'Hagan*[1], *Jessica Fogarin*[2], *James Gordon*[2], *James Miller*[2], *Ashani Perera*[2], *S. Ali Mirjalili*[1]

[1]University of Auckland, [2]Fisher and Paykel Healthcare

Non-invasive ventilation (NIV) is a primary treatment for patients with acute hypercapnic respiratory failure, and choice of mask is important for its success. In some conditions reducing the effect of anatomical deadspace - air that does not contribute to gas exchange - may improve patient response to NIV therapy. The aim of this investigation was to use computational fluid mechanics to model upper airway washout with different NIV mask designs. Two mask designs were considered that differ only in seal and venting design. A 3D printed head which represents the face and upper airways was used to construct computational meshes reflecting the airspaces when an individual is using each mask design. To provide model boundary conditions, test the performance of models, the 3D printed head was mounted on a desktop lung simulator. The lung simulator has breathing patterns that are reflective of the compliance and resistance of the lungs in chronic obstructive pulmonary disease, a condition that may require NIV therapy. Air flow and pressure were measured at the mask and at the tracheal level under non-invasive therapies. Computational fluid dynamics was used to simulate air flow and carbon dioxide distribution within the airway geometry, and used to predict the impact of mask design on carbon dioxide distribution within the upper airways. The models show that a novel mask design can facilitate the washout of expired gas in the naval cavity, and thus improve carbon dioxide concentrations at end of expiration compared to conventional NIV. In simulations where the mouth and nasopharynx were both open, a 44% decrease in CO_2 in the nasal cavities, and a 28% decrease in CO_2 over the entire upper airway geometry was predicted to result from this

washout. Simulations were also conducted with the mouth or nasopharynx closed to determine the impact of airway closure on the efficacy of carbon dioxide washout. The model shows. That mask design can influence carbon dioxide clearance in the upper airways which may facilitate improved alveolar ventilation and subsequent gas exchange.
INDUSTRIAL MATHEMATICS, TUESDAY 14:30-14:55 ROOM 402-211

Semi-Cartan Subalgebras and Twisted Groupoid C*-Algebras

Lisa Orloff Clark[1]

[1]Victoria University of Wellington

In this talk, we introduce semi-Cartan C*-subalgebras, which are commutative subalgebras of a C*-algebra that are not necessarily MASAs. We will demonstrate how all twisted groupoid C*-algebras can be characterized by these semi-Cartan C*-subalgebras. This framework extends the classical Kumjian-Renault theory to include general twisted étale groupoid C*-algebras, including non-reduced C*-algebras of non-effective groupoids. This is joint work with Tristan Bice, Ying-Fen Lin, and Kathryn McCormick.
FUNCTIONAL ANALYSIS AND OPERATOR ALGEBRAS, MONDAY 14:00-14:25 ROOM 260-055

Endless self-avoiding walks

Nathan Clisby[1], *Neal Madras*

[1]Swinburne University of Technology

One can create an endless walk model from any random walk model by considering walks which still satisfy their defining rule when we concatenate the walk with itself ad infinitum. In some sense we can consider endless walks as models of walks or polymers with no ends, and thus they are potentially very useful if one wishes to partial out end effects. When this construction is applied to the famous self-avoiding walk model we obtain endless self-avoiding walks, which have some fascinating properties: they have a universal amplitude (not amplitude ratio), and their numbers grow purely exponentially with no modifying power law. I will describe recent progress in characterising endless self-avoiding walks, developing Monte Carlo algorithms for their study, and the results of computer experiments to estimate model parameters and associated critical exponents, including the universal amplitude.
TOPOLOGY, GEOMETRY AND COMBINATORICS OF BIOPOLYMERS, FRIDAY 12:00-12:25 ROOM 260-221

Transformations and summations for basic bilateral hypergeometric series

Howard S. Cohl[1], *Michael J. Schlosser*[2]

[1]National Institute of Standards and Technology, [2]Universität Wien

We derive transformation and summation formulas for basic bilateral hypergeometric series. As a starting point, we use two transformations of basic bilateral very-well-poised ${}_8\psi_8$. The first transformation is given as a sum of two nonterminating ${}_8W_7$'s and the second is given in terms of a sum of a ${}_4\psi_4$ and two balanced ${}_4\phi_3$'s. From these transformations we derive limiting transformations with vanishing denominator elements which shed light on the transformation properties of these basic bilateral hypergeometric series. We also study tuple product identities, namely triple, quintuple, sextuple, septuple, octuple, nonuple and undecuple, which are given in terms of sums of basic bilateral hypergeometric series. This is joint work with Michael Schlosser (Universität Wien).

Special Functions, q-Series and Beyond, Friday 15:00-15:25 Room 401-312

Ricci flow and the Anosov property

Solly Coles[1]

[1]Northwestern University

In a 2004 paper, Manning asked whether the Anosov property for a geodesic flow is preserved when the defining metric evolves under Ricci flow. A closely related question is whether a metric with no conjugate points can develop them under Ricci flow. In joint work (in progress) with Keith Burns and Dong Chen, we construct a metric on a surface that acquires conjugate points when it evolves under Ricci flow. We use this to give a negative answer to Manning's original question. In this talk, I will describe the connection between conjugate points and the Anosov property, before outlining our construction.

Ergodic Theory and Dynamical Systems, Thursday 11:30-11:55 Room 303-G23

The sound of symmetry: collaboration between mathematics and musicology for new creative works and community outreach

Denis Collins[1]

[1]The University of Queensland

This presentation will discuss the contexts informing collaboration between mathematics and music that lead to new musical compositions informed by mathematical theories. The presentation will outline the close connections between music theory and mathematics in Western culture since antiquity, with particular reference to ways in which music contributed to and was inspired by mathematical and general scientific developments. This rich and ongoing relationship is manifest in a recent creative work whose genesis involved a collaborative team from musicology, composition, and mathematics. The presentation will describe how this work generates considerable appreciation in lecture-performance events to specialist and general community audiences.

ENGAGEMENT WITH MATHEMATICS THROUGH COMMUNICATION AND OUTREACH, THURSDAY 14:30-14:55 ROOM 260-009

Recent discoveries about finite quotients of triangle groups

Marston Conder[1], *Darius Young*

[1]University of Auckland

For integers $k, l, m > 1$, the ordinary *triangle group* $\Delta^+(k,l,m)$ is the group with presentation $\langle\, x, y \mid x^k = y^l = (xy)^m = 1\,\rangle$, or equivalently $\langle\, x, y, z \mid x^k = y^l = z^m = xyz = 1\,\rangle$. Such groups play an important role in the study of large automorphism groups of algebraic curves and compact Riemann surfaces, and of regular maps on orientable and non-orientable surfaces. Much of the early part of this study (dating back over 100 years) considered only small quotients of triangle groups, and subsequent work concentrated on finite simple quotients. But surprisingly, the recent determination of all orientably-regular maps of genus up to 1501) has shown that finite simple groups and finite insoluble groups account respectively for less than 0.1% and less than 7% of the associated quotients of ordinary triangle groups, while finite soluble quotients account for over 93%. Very little attention has been paid to soluble quotients, and in this talk I will describe some recent research (with my PhD student Darius Young) that helps to correct this relative lack of attention. In particular, I will explain how every non-perfect hyperbolic ordinary triangle group has a smooth finite soluble quotient of derived length c for some $c \leq 3$, and has infinitely many such quotients of derived length d for every $d > c$. Also I will report on some work by Darius in the last few months in which he proved that the natural density (in the positive integers) of the set of orders of finite quotients of a triangle group $\Delta^+(k,l,m)$ is **zero** for every triple (k,l,m). This work completes and considerably extends an initial investigation by Larsen (2001), but avoids resorting to the classification of finite simple groups. It also led to the following (proved by MC & Gabriel Verret): the natural density of the orders of finite quotients of the free product $C_p * C_q = \langle\, x, y \mid x^p = y^q = 1\,\rangle$ is zero whenever p or q is odd, but is positive (even for smooth quotients) whenever p and q are even. Furthermore, this had unexpected consequences for the densities of orders of finite arc-transitive graphs of given valency, and also led to a much more general theorem about possibilities for the density of orders of finite quotients of a given finitely-generated infinite group.

GROUPS AND GEOMETRY, TUESDAY 11:30-12:20 ROOM 260-092

Grouping Calculus Students by Video Watching Behavior and the Effect of Group Membership on Learning

Doug Corey[1], *Aaron Weinberg*[2], *Joseph Corey*[3, 4], *Jason Martin*[5], *Michael Tallman*[6]

[1]Brigham Young University, [2]Ithaca College, [3]Georgia Tech University, [4]Family Search , [5]University of Central Arkansas, [6]Oklahoma State University

Since the Covid-19 pandemic, universities are doing more to teach math online. One of the most popular modes of online instruction is instructional videos. Unfortunately, the continuous stream of information of videos creates a high cognitive demand making learning difficult (Sweller, van Merrienboer, & Paas, 1998). Enabling learner control of the video to help students manage their learning experience, can help lower cognitive demand and improve learning (Spanjers, van Gog, & van Merriënboer, 2010). However, students interact with videos in different ways, and it is important for us to understand how these interactions impact what they learn. We use data from a large international study that used videos to help students learn first semester calculus. For each topic, students took a short pre-test before watching one to three instructional videos (usually about eight minutes per video), then took a post-test that was similar in length and content to the pre-test. We collected clickstream data for all videos as a record of student interactions with the video. Clickstream data included (among other things) timestamps when students started and stopped watching a video; when they paused; when they skipped portions (forward or backward) and where they skipped to; and what video segments they rewatched or didn't watch at all. Our data set includes 1512 students from 16 institutions (15 US, 1 Indonesian) studying up to 28 topics. Our research questions: Can students be meaningfully grouped by watching behavior? Does group behavior predict the learning as measured from pre- to post-test? We clustered student average watching behavior by K-means clustering and found students tend toward one of four video watching patterns, which we name and describe below: Watchers tend to watch the entire video with little pausing or skipping. Skimmers tend to watch a small portion of the video, but skip forward over sections and skip backward infrequently Skippers tend to not watch the videos initially, but after looking over the post-test, go back to the videos and then behave similar to skimmers. Studiers pause and skip backwards a lot and watch some sections multiple times Our statistical models show Watchers and Studiers have a higher probability of improving from pre- to post-test, than Skimmer and Skippers, with Studiers doing slightly better than Watchers. We will discuss implications of our findings for math courses using instructional videos and how to support students from different groups to increase their learning, especially Skimmers and Skippers.
Mathematics Education, Tuesday 11:30-11:55 Room 260-115

A large sieve inequality for moduli generated by a quadratic

Chandler (Chip) Corrigan[1]

[1]UNSW

In this talk, we present a large sieve inequality pertaining to moduli in the range of appropriate integer polynomials of degree two.
Arithmetic Geometry and Number Theory, Monday 15:00-15:10 Room 405-430

17T7 as a Galois group over Q through Hilbert modular forms

Edgar Costa[1], *Raymond van Bommel, Noam Elkies, Timo Keller, Sam Schiavone, John Voight*

[1]MIT

The inverse Galois problem asks whether every finite group can be realised as the Galois group of a finite Galois extension of Q. For a long time, the so-called group 17T7, acting transitively on a set of 17 elements, was the smallest group in the transitive group ordering for which no such extension of Q was known. In this talk, I will describe joint work with Raymond van Bommel, Noam Elkies, Timo Keller, Sam Schiavone, and John Voight, in which we use certain Hilbert modular forms to find such an extension.
Computational Number Theory and Applications, Monday 16:00-16:50 Room 405-422

Factorization in Monoids and Domains: History and Recent Results

Jim Coykendall[1]

[1]Clemson University

This talk will explore the history of modern factorization theory in integral domains and monoids. We will begin our clock with the seminal, pioneering paper of Carlitz in 1960 that provided an algebraic characterization of the half-factorial property in rings of algebraic integers and follow the path from there. We will highlight the development of modern factorization theory in the arenas of both integral domains and monoids, comparing and contrasting the results in both theatres. The aim of this talk is to be of interest to the specialist in factorization theory as well as the more peripheral enthusiast, and the history will culminate in some very recent advances in the theory of factorization.
50 years of Communications in Algebra, Tuesday 11:30-11:55 Room 303-G15

Quartic del Pezzo surfaces without quadratic points

Brendan Creutz[1]

[1]University of Canterbury

A quartic del Pezzo surface is an intersection of two quadrics in P^4 over a field k. I will discuss the possibilities for the minimal degree of a closed point on such surfaces. In earlier joint work with Bianca Viray we showed that quadratic points always exist over local fields and that over number fields there are always points whose degrees have GCD 2. I will present recent examples

of quartic del Pezzo surfaces over Q which have no quadratic points. These were found with the help of a large computer search carried out using magma. I will describe some of the computations involved. This is joint work with Bianca Viray.
Computational Number Theory and Applications, Monday 15:00-15:25 Room 405-422

The topology of G_2-moduli spaces

Diarmuid Crowley[1]

[1]University of Melbourne

Riemannian manifolds with holonomy group equal to the exceptional Lie group G_2 occur only in dimension 7. A remarkable result of Joyce states that the Teichmüller space of such metrics is a manifold of dimension equal to the third betti number of the underlying manifold 7-manifold. Beyond Joyce's result, little is known about the topology of moduli spaces of G_2 metrics. In this talk I recall joint work with Goette and Nordström, where we show that G_2 moduli spaces can be disconnected. I will also make some remarks about defining invariants which might detect higher homotopy in G_2 moduli spaces.
Index Theory in Geometry and Mathematical Physics, Tuesday 14:00-14:25 Room 260-022

Hodge theory of abelian covers of algebraic varieties

Moisés Herradón Cueto[1], *Eva Elduque[1]*

[1]Autonomous University of Madrid

Let $f\colon U \to \mathbb{C}^*$ be an algebraic map from a smooth complex connected algebraic variety U to the punctured complex line $\mathbb{C}^*$. Using f to pull back the exponential map $\mathbb{C} \to \mathbb{C}^*$, one obtains an infinite cyclic cover U^f of the variety U, together with a $\mathbb{Z}$-action coming from adding $2\pi i$ in $\mathbb{C}$. The homology groups of this infinite cyclic cover, with their $\mathbb{Z}$-actions, are the family of Alexander modules associated to f. In previous work jointly with Eva Elduque, Christian Geske, Laurențiu Maxim and Botong Wang, we constructed a mixed Hodge structure on the torsion part of these Alexander modules. In this talk, we will talk about generalizing this theory to abelian covering spaces of algebraic varieties which arise in an algebraic way, i.e. from maps $f\colon U \to G$, where G is a semiabelian variety. This is joint work with Eva Elduque.
Singularities, Friday 14:00-14:50 Room 260-024

Tensor-Train Methods for Sequential State and Parameter Estimation in State-Space Models

Tiangang Cui[1]

[1]The University of Sydney

Numerous real-world applications require the estimation, forecasting, and control of dynamic systems using incomplete and indirect observations. These problems can be formulated as state-space models, where the challenge lies in learning the model states and parameters from observed data. We present new tensor-based sequential Bayesian learning methods that jointly estimate parameters and states. Our methods provide manageable error analysis and potentially mitigate the particle degeneracy encountered in many particle-based approaches. Besides offering new insights into algorithmic design, our methods naturally incorporate conditional transports, enabling filtering, smoothing, and parameter estimation within a unified framework.
Computational Mathematics, Tuesday 16:30-16:55 Room 402-231

Intrinsic Subspaces of High-Dimensional Inverse Problems and Where to Find Them

Tiangang Cui[1]

[1]The University of Sydney

The high dimensionality is a central challenge faced by many numerical methods for solving large-scale Bayesian inverse problems. In this talk, we will present some recent developments in the identification of low-dimensional subspaces that offer a viable path to alleviating this dimensionality barrier. Utilising concentration inequalities, we are able to identify the intrinsic subspaces from the solutions of certain eigenvalue problems and derive corresponding dimension-truncation error bounds. The resulting low-dimensional subspace enables the design of inference algorithms that can scale sub-linearly with the apparent dimensionality of the problem.
Stochastic and Deterministic Inverse Problems, Thursday 14:30-14:55 Room 260-040

Kruglov's operator in semifinite von Neumann algebras equipped with free independence

Daniel Czapski[1], *Dmitriy Zanin*[1]

[1]School of Mathematics and Statistics, University of New South Wales

The Kruglov operator on integrable random variables functions like a stochastic integral with respect to a Poisson process which "converts disjointness into independence". Introduced in the 1990's by F. Sukochev and S. Astashkin in their study of norm bounds on sums of independent random variables, within two decades it had played a central role in showing that Johnson-

Schechtman-like inequalities exist in a large class of symmetric Banach function spaces precisely when the Kruglov operator on such spaces acts boundedly on the space. In the non-commutative realm, we replace L^∞ with a semifinite von Neumann algebra $\mathcal{M}$, the expectation with a faithful, normal, tracial state τ, and classical independence with the free independence of D. Voiculescu. While a form of the free Kruglov operator has been constructed by Sukochev and D. Zanin in proving a free analogue of the Johnson-Schechtman inequalities in non-commutative symmetric spaces, it remains limited to the probabilistic case. We seek a simpler and more general construction of a free Kruglov operator on semifinite von Neumann algebras equipped with faithful, normal, semifinite traces which is a direct analogue of its classical cousin. In this talk, I will outline some of the relevant background and the progress that has been made so far.
Functional Analysis and Operator Algebras, Tuesday 16:00-16:25 Room 260-055

On multiple zeta values in positive characteristic

Tuan Ngo Dac[1]

[1]CNRS And University of Caen Normandy

Numerous real-world applications require the estimation, forecasting, and control of dynamic systems using incomplete and indirect observations. These problems can be formulated as state-space models, where the challenge lies in learning the model stat
Arithmetic Geometry and Number Theory, Monday 14:30-14:40 Room 405-430

On special functions and twisted L-series

Tuan Ngo Dac[1]

[1]CNRS And University of Caen Normandy

In the function field arithmetic, Anderson and Thakur introduced a special function related to Drinfeld modules in 1990, which has led to many important results in this theory. In 2012, Pellarin developed another class of special functions related to Tate algebras and proved a remarkable rationality identity. We will briefly review these works. Then, we will introduce a generalization of the Anderson-Thakur and Pellarin special functions and prove a rationality result for several variable twisted L-series associated with shtuka functions.
Special Functions, q-Series and Beyond, Friday 14:00-14:25 Room 401-312

Singular Weyl's law with Ricci curvature bounded below

Xianzhe Dai[1]

[1]Ucsb

The classical Weyl's law describes the asymptotic behavior of eigenvalues of the Laplace Beltrami operator in terms of the geometry of the underlying space. Namely, the growth order is given by (half of) the dimension and the limit by the volume. The study has a long history and is important in mathematics and physics. In a recent joint work with S. Honda, J. Pan and G. Wei, we find two surprising types of Weyl's laws for some compact Ricci limit spaces. The first type could have power growth of any order (bigger than one). The other one has an order corrected by logarithm as some fractals even though the space is 2-dimensional. Moreover the limits in both types can be written in terms of the singular sets of null capacities, instead of the regular sets. These are the first examples with such features for Ricci limit spaces. Our results depend crucially on analyzing and developing important properties of the examples constructed by J. Pan and G. Wei.
Differential geometry and geometric analysis, Monday 15:00-15:25 Room 260-005

The logistic equation on rough domains

Daniel Daners[1]

[1]The University of Sydney

We consider the existence and uniqueness of positive solutions to an abstract logistic equation using functional analytic tools. The aim of the theory is to allow applications to logistic equations with diffusion on arbitrary bounded domains, in particular removing the need to apply boundary maximum principles to compare sub- and super-solutions. The main tool is the spectral theory of generators of positive irreducible semi-groups. This is based on joint work with Wolfgang Arendt.
Functional analysis and partial differential operators, Tuesday 14:00-14:25 Room 260-020

Parameter Continuation and Uncertainty Quantification Near Stochastically Perturbed Limit Cycles and Tori

Harry Dankowicz[1], *Zaid Ahsan, Christian Kuehn*

[1]University of Maryland

This talk shows the use of parameter continuation techniques to characterize intermediate-term dynamics due to the presence of small Brownian noise near normally-hyperbolic, transversally-stable periodic orbits and quasiperiodic invariant tori found in the deterministic limit. The proposed formulation relies on adjoint boundary-value problems for constructing continuous families of transversal hyperplanes that are invariant under the linearized deterministic flow, and covariance boundary-value problems for describing Gaussian distributions of intersections of stochastic trajectories with these hyperplanes. Analytical and numerical results, including validation with the help of the continuation package COCO, show excellent agreement with stochastic time integration for problems with either autonomous or time-periodic drift terms.
Computational Methods and Applications of Dynamical Systems, Tuesday 12:00-12:25

Room 303-G20

Doubly relaxed forward-Douglas–Rachford splitting for the sum of two nonconvex and a DC function

Minh N. Dao[1]

[1]RMIT University

We consider a class of structured nonconvex nonsmooth optimization problems whose objective function is the sum of three nonconvex functions, one of which is expressed in a difference-of-convex (DC) form. This problem class covers several important structures in the literature including the sum of three functions and the general DC program. We propose a splitting algorithm and prove the subsequential convergence to a stationary point of the problem. The full sequential convergence, along with convergence rates for both the iterates and objective function values, is then established without requiring differentiability of the concave part. Our analysis not only extends but also unifies and improves recent convergence analyses in nonconvex settings. We benchmark our proposed algorithm with notable algorithms in the literature to show its competitiveness on both synthetic data and real power system load data.

Optimisation, Friday 12:00-12:25 Room 402-221

Gettn' Freqky with Spatial Point Patterns

Tilman Davies[1]

[1]University of Otago

Modelling a spatial point process typically demands a sample-driven estimate of its intensity function, the function on $\mathbb{R}^2$ (usually $W \subset \mathbb{R}^2$) that governs both the rate and the structure of event occurrence in space. In many applications, both deterministic and stochastic components are considered to simultaneously drive observation intensity. In general, uniquely identifying these two components is impossible given a single point pattern – a realisation of the point process. Estimation in the face of this unidentifiability is therefore contingent on other assumptions (for example, those related to scale-of-effect) and subjective choices. In this talk, which doubles as an open request for collaboration, I shall risk exposing my utter lack of insight by considering how, if at all, the frequency domain might be exploited to aid in disentangling these two sources of variation.

Probability and Mathematical Statistics, Tuesday 16:30-16:55 Room 260-098

Integrable systems, Painlevé VI and explicit solutions to the anti-self dual Einstein equation via radicals

Owen Dearricott[1]

[1]La Trobe University

Though Einstein's equation is well studied, relatively few Einstein metrics have been written in terms of explicit formulae via radicals. In this talk we discuss many such examples that occur as anti-self dual Einstein metrics and describe their singularities. The construction heavily relies upon the theory of isomonodromic deformation and related algebraic geometry developed by N.J. Hitchin in the 1990s and the equivalence of the anti-self dual Einstein equation to a certain Painlevé VI equation under some symmetry assumptions discovered by K.P. Tod. The solution to Painlevé VI is achieved through a relation of its solution to pairs of conics obeying the Poncelet's porism by exploiting Cayley's criterion. In this talk we discuss some important cases that are not well fleshed out in the literature, such as the solution of Painlevé VI associated with the Poncelet porism where the inscribing-circumscribing polygons have an even number of sides. Moreover, we provide some explicit metrics with unusual cone angle singularities along a singular real projective plane that were speculated about by Atiyah and LeBrun and discuss their sectional curvature.

Differential geometry and geometric analysis, Thursday 15:00-15:25 Room 260-005

Analysis of Coherent Structures in Shear Flows

Kengo Deguchi[1]

[1]Monash University

There is a long history of studying coherent vortex structures that appear in turbulent shear flows—such as those seen around airplane wings. Understanding these vortex structures is crucial for many practical applications, and therefore numerous analyses have been conducted. However, balancing analytical rigor with practically useful results within the theoretical framework of this field remains extremely challenging. Complex phenomena like turbulence are difficult to analyse without modelling, yet the effectiveness of these models often cannot be logically justified. One potential strategy to address this issue is to use dynamical systems theory to find invariant solutions and then apply high Reynolds number asymptotic analysis. This approach has been growing within the theoretical fluid mechanics community, but it remains in a sort of limbo—caught between the gaps in both mathematics and physics/engineering. Will we ever be able to bridge these gaps?

Recent advances in mathematical fluid dynamics, Thursday 14:30-14:55 Room 401-311

Phantom network theory with no fixed crosslinks and exact results derived by the lattice Green's functions

Jason Cantarella[1], **Tetsuo Deguchi**[2], *Clayton Shonkwiler*[3], *Erica Uehara*[4]

[1]University of Georgia, [2]Ochanomizu University, [3]Colorado State University, [4]Kyoto University

The phantom network theory plays a fundamental role in the understanding of the elasticity and scattering behavior of polymer networks such as rubbers and gels. Here we remark that a large number of gels are made from biological polymers. However, it is nontrivial to evaluate the elastic modulus of a given phantom network, since it is not practically straightforward to clarify the effects of fixed crosslinks. In fact, the value of shear modulus may depend on the number and positions of fixed crosslinks. However, no systematic study has been performed to estimate possible changes in it due to a different choice of fixed crosslinks. In this talk we show that by making use of homology in topology we reformulate the phantom network theory so that networks have no fixed crosslinks: One can investigate the elastic properties of a given phantom network with fixed crosslinks by mapping it to another phantom network with no fixed crosslinks but under external fields associated with given positions of fixed crosslinks. We also show that the shear modulus of the corresponding network with no fixed crosslinks is explicitly expressed in terms of the pseudo-inverse of the graph Laplacian (i.e., the Kirchhoff matrix) of the network's graph. Thus, we can straightforwardly evaluate it numerically and analytically, and explicitly estimate the finite-size effects in the shear modulus due to fixed crosslinks. Moreover, for a lattice-type network the pseudo-inverse of the graph Laplacian is given by the lattice Green's function, and hence several quantities such as the position fluctuations are explicitly evaluated. The present talk is based on research results of the JST CREST project (2019 JPMJCR19T4) with the title: "Construction of homological topology theory on the elasticity of polymer networks and creation of devices through mixing ring polymers in polymeric materials".
Topology, geometry and combinatorics of biopolymers, Wednesday 10:30-10:55 Room 260-221

Replenishing Euler systems at their bad primes

Daniel Delbourgo[1]

[1]University of Auckland

In contrast to the situation 20 years ago, a significant number of Euler systems are readily available for number theorists to use: cyclotomic units, Heegner points, Kato's zeta-elements, Beilinson-Flach elements, Asai classes, etc... An in-built design feature is that these objects have been stripped of their Euler factors at primes dividing the conductor of the representation. In joint work with Raiza Corpuz, we outline a simple trick that allows one to replenish these missing Euler factors (for modular forms and their tensor products), leading to a sharper divisibility in the Iwasawa Main Conjecture. The construction exploits a new factorisation for the p-adic L-function (deduced from the functional equation) in the case where the underlying representation is self-dual.
Arithmetic Geometry and Number Theory, Tuesday 14:30-14:55 Room 405-430

Cohomology jump loci for Schubert arrangements

Graham Denham[1], *Prajwal Udanshive*

[1]University of Western Ontario

Much is known about the cohomology of rank-1 local systems on the complements of hyperplane arrangements, at least in cohomological degree 1. The general picture remains elusive, however. The Schubert arrangements provide a nontrivial family of examples for which a complete and explicit description of the jump loci, in all degrees, is possible.
Singularities, Tuesday 14:00-14:50 Room 260-024

How twisty is that orbit?

Anand Deopurkar[1]

[1]Australian National University

Fix a polynomial P. How complicated is the set of all polynomials obtained from P by changes of coordinates? This question, and many others, generalise as follows: given a representation an algebraic group, how complicated is the orbit of a given element? I will describe some answers, featuring toric varieties, Newton polyhedra, and stacks.
Computations and applications of algebraic geometry and commutative algebra, Friday 15:00-15:25 Room 303-B05

Pedagogical Practices: PISA 2022 data analysis of inquiry-based and teacher-directed approaches

Marcel Derkum[1], *Tanya Evans[1]*

[1]University of Auckland

In recent decades, the implementation of inquiry-based learning in mathematics classrooms has garnered attention for its potential to enhance students' understanding and critical thinking. However, its effectiveness compared to traditional teacher-directed methods remains debated (Evans & Dietrich, 2022; Kirschner et al., 2006). This study examines New Zealand's education data from PISA 2022, focusing on 15-year-old students' mathematical literacy. Through statistical analysis, it investigates the impact of two pedagogical approaches—Inquiry-based and Teacher-directed—on students' mathematics scores while controlling for socio-economic factors. Based on the student questionnaire, two variables, IBMETHOD and TDMETHOD were created. IBMETHOD represents an Inquiry-based approach, wherein students are encouraged to explore new-to-them mathematics without explanations given by a teacher beforehand. The teacher acts as a facilitator, providing resources and encouragement while refraining from direct explanations. Emphasis is placed on engaging students in everyday life problem-solving scenarios and prompting students to discover new ways to solve problems. TDMETHOD represents the contrasting Teacher-directed approach, characterised by teachers providing explicit explanations of new concepts, demonstrating algorithms and worked problems, and guiding students through activities to replicate and practice demonstrated procedures. Hierarchical multiple regression analysis revealed that both IBMETHOD and TDMETHOD significantly contribute to predicting mathematical literacy scores, even after controlling for socio-economic status. Notably, the addition of each IBMETHOD and TDMETHOD to the model leads to significant improvements in predictive accuracy. The main finding is that students exposed to Teacher-directed instruction demonstrate significantly higher mathematical literacy scores compared to those in Inquiry-based classrooms, even after accounting for socio-economic differences. However, the methodological limitations of this analytical approach will be discussed.

References:
Evans, T., & Dietrich, H. (2022). Inquiry-based mathematics education: a call for reform in tertiary education seems unjustified. STEM Education, 2(3), 221-244. https://doi.org/10.3934/steme.2022014
Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching. Educational Psychologist, 41(2), 75-86. https://doi.org/10.1207/s15326985ep4102_1
Mathematics Education, Wednesday 11:00-11:25 Room 260-115

An Innovative Approach to Cost Optimization: Prioritizing Key Systems and Subunit Ranking to Enhance Overall Performance of coffee machine

Pooja Dhiman[1]

[1]Cluey Learning

Coffee is cherished worldwide as a beloved beverage, renowned for its ability to boost energy and revitalize its drinkers. To achieve the perfect cup, coffee beans must undergo a meticulous process—gathering, roasting, and brewing—each step shaping the final flavor. Equally essential is the coffee machine itself, whose flawless performance enhances the taste and ensures consistency. This crucial system, often operating behind the scenes, plays a vital role in delivering a reliable, high-quality brew. However, many brewing techniques still struggle to unlock the full potential of the beans. For cafés, a coffee machine represents a significant investment, requiring consistent use over long periods. Ensuring the machine's reliability is essential to make it a worthwhile economic asset. The focus of this study is to improve machine reliability through enhanced maintenance strategies. By estimating the complex structure of coffee machines using fuzzy logic, we aim to optimize performance and reduce costs. Our research proposes a novel approach to improving machine dependability by applying advanced techniques to trapezoidal fuzzy numbers. This method prioritizes maintaining key systems and ranks subunits to boost overall performance. By incorporating fuzzy arithmetic, we estimate reliability indices like failure rates and repair times for each system component. The study's findings will enable more efficient maintenance schedules, ultimately reducing operating costs while enhancing system

reliability.
Industrial Mathematics, Thursday 14:00-14:25 Room 402-211

Computational Polya Theory revisited

Persi Diaconis[1]

[1]Stanford University

Classical Polya theory is about enumeration under symmetry. Consider a finite group G acting on a finite set X. This splits X into disjoint orbits say. One may ask: How many orbits are there? What are their sizes? Do they have 'nice names'? How can one choose an orbit uniformly at random? For example, if $X = G$ acting on itself by conjugation, the orbits are conjugacy classes. When $G = S_n$ the conjugacy classes are indexed by partitions and the last question becomes 'how can one choose a random partition of n?' Say when $n = 10^6$ and you need a few thousand of them. These can be intractable problems; when $G = U(n, q)$ is the group of uni-upper triangular $n \times n$ matrices with entries in $\mathbb{F}_q$, we cannot describe the conjugacy classes and one can prove, in a reasonable sense, we will never be able to. Computer scientists Goldberg and Jerrum have introduced randomized algorithms (the Burnside process) to approach these problems. This gives provable (and actually useful) algorithms for counting and random generation in some of the problems above. I have used these algorithms to study the problems for conjugacy classes, double cosets and as a way of generating random unlabeled trees and other graphs. It seems to work and sometimes we can prove that. There are many simple-to-state open problems.
Groups, actions and computations, Friday 14:30-15:20 Room 260-051

Analysing dynamics near heteroclinic networks with a projected map

David Groothuizen Dijkema[1], *Claire Postlethwaite*[1], *Vivien Kirk*[1]

[1]University of Auckland

A heteroclinic cycle is a particular solution structure found in dynamical systems, typically composed of a collection of saddle equilibria and heteroclinic orbits connecting them in a cyclic manner. Trajectories near an attracting heteroclinic cycle visit all saddles in order, spending increasingly long periods of time near each saddle before making a rapid switch to the next one. Systems with heteroclinic cycles can be used to model intransitive interactions and intermittent phenomena. A heteroclinic network is a connected union of heteroclinic cycles. Trajectories near a heteroclinic network can exhibit complex dynamics. They may be attracted to one cycle within the network, possibly visiting a finite number of other cycles first, or they may be attracted to a larger subset of cycles of the network, visiting them in regular or irregular sequences. Regions of parameter space associated with the different asymptotic behaviour can form highly intricate patterns, including Farey-like concatenation. This talk will discuss how a particular piecewise-smooth map can be used to investigate the complex dynamics near

heteroclinic networks.
Ergodic Theory and Dynamical Systems, Tuesday 12:00-12:25 Room 303-G23

Wasserstein Distributionally Robust Optimization with Piecewise SOS-Convexity

Neil Dizon[1], *Queenie Huang*[1], *Vaithilingam Jeyakumar*[1], *Guoyin Li*[1]

[1]University of New South Wales

In this talk, we present tractable reformulations of certain classes of distributionally robust optimization (DRO) problems over Wasserstein balls, involving non-convex piecewise sum-of-squares (SOS)-convex functions. We demonstrate that these problems can be reformulated as tractable conic linear optimization problems. We illustrate our theoretical results through numerical experiments with data-driven mean-CVaR portfolios.
Optimisation, Friday 14:00-14:25 Room 402-221

Invariant Manifolds and the Emergence of Wild Chaos

Sam Doak[1], *Hinke M Osinga*[1], *Bernd Krauskopf*[1]

[1]University of Auckland

Wild chaos is a type of higher-dimensional chaotic dynamics that is robust. One of its defining characteristics is the presence of robust, non-transverse intersections between stable and unstable manifolds. The persistence of non-transverse intersections is counter-intuitive: for example, such behaviour in three dimensions necessitates robust intersections between two one-dimensional manifolds. Consequently, such curves must 'behave' as if they were a surface, facilitating robust intersections with other one-dimensional manifolds. We focus on a promising potential candidate for a discrete-time dynamical system exhibiting wild chaos, of which there are very few explicit examples. The defining diffeomorphism has dimension three, is volume preserving, and is quadratic with quadratic inverse. We illustrate the emergence of wild chaos in this system by first considering the one-dimensional manifolds of its two fixed points. Indeed, these curves appear to have 'surface-like' properties. We show that each fixed point lies in a different hyperbolic set, which are distinguished by the dimensions of their unstable manifolds. Moreover, the one-dimensional manifolds of these hyperbolic sets give rise to robust, non-transverse intersections. We also discuss how these manifolds disentangle from each other as a parameter is varied, thereby highlighting specific changes in the manifold geometry that could represent a mechanism to produce wild chaos.
Computational Methods and Applications of Dynamical Systems, Tuesday 16:00-16:25 Room 303-G20

Scattering for the conformal wave equation

Benjamin Dodson[1]

[1]Johns Hopkins University

In this talk we prove scattering for radially symmetric conformal nonlinear wave equations with sharp initial data.

Harmonic analysis and Hamiltonian PDE, Thursday 14:30-15:20 Room 260-028

Bayesian Statistics for Undergraduate Students and Their Instructors

Mine Dogucu[1]

[1]University of California Irvine

One popular probabilistic term that researchers use is the p-value. This term is often misinterpreted and does not usually correspond to what researchers are often looking for – the probability of a hypothesis being true. In more recent years, adoption of Bayesian methods has been one of the recommendations to battle issues rising from the mis- and over-use of the p-value. The mathematical foundations of Bayesian methods have been around for centuries. However, the wider use of these methods in scientific research have been possible with the recent advances in computing. The statistical training of researchers, instructors, and students has not yet kept up at the same pace as the advances in computing. During this talk, we will discuss how to move towards closing this gap with Bayesian training at the undergraduate level and examine training models for students and their instructors. We will share examples and findings from a curricular study as well as a training program funded by the National Science Foundation of the United States.

Contributed Session A, Monday 14:00-14:25 Room 303-B11

Superpositions of continuous autoregressive random fields

Illia Donhauzer[1]

[1]La Trobe

The talk will introduce the supCAR random fields constructed as superpositions of CAR (continuous autoregressive) random fields. The supCAR random fields form a class of models for which marginal distributions and dependence structures are modeled independently from each other. The marginal distributions of the supCAR fields belong to the class of infinitely divisible distributions, and the dependence structures are defined by a wide class of covariance functions. The talk will also present new limit theorems for the supCAR fields as well as properties of the limit processes.

Probability and Mathematical Statistics, Monday 16:45-16:55 Room 260-098

On Presenting Linear Orderings and Boolean Algebras

Rodney Downey[1]

[1]Victoria University

Linear orderings and boolean algebras occupy an interesting place in the theory ofcomputable structures. In spite of being unclassifiable, they seem "easy to understand". In this talk I will look at when orderings and boolean algebras have a "simple" presentation.One example will be a very simple proof of the fact that there is a low linear ordering not isomorphic to a computable ordering. This Frolov and Zubkov's suggestion of an oracle construction, and involves essentially no injury.

Computability Theory and Applications, Monday 14:00-14:25 Room 303-B07

Ellipsoidal Billiards, Combinatorics, and Polynomial Pell's Equations

Vladimir Dragovic[1]

[1]The University of Texas At Dallas

We discuss interrelations between billiards within ellipsoids in the d-dimensional Euclidean space, theory of approximations, theory of partitions, and polynomial Pell's equations over d real intervals. We classify periodic trajectories by employing their relationship with extremal polynomials. We answer positively all three Ramirez-Ros conjectures. We also study resonant trajectories by relating them to extremal rational functions and generalized Pell's equations. The talk is based on joint work with Milena Radnović and the following papers:

1. V. Dragović, M. Radnović, Periodic ellipsoidal billiard trajectories and extremal polynomials, Communications. Mathematical Physics, 2019, Vol. 372, p. 183-211.
2. G. Andrews, V. Dragović, M. Radnović, Combinatorics of the periodic billiards within quadrics, The Ramanujan Journal, Vol. 61, No. 1, p. 135-147, 2023.
3. V. Dragović, M. Radnović, Resonance of ellipsoidal billiards trajectories and extremal rational functions, Advances in Mathematics, Article 109044, Vol. 424, 2023.

Discrete and continuous integrable systems: geometry analysis and applications, Monday 15:00-15:25 Room 260-036

Exotic families of higher intersection embedded spheres

Joshua Drouin[1]

[1]Florida Polytechnic University

We study the difference between the homotopy groups of spaces of smooth embeddings and spaces topological embeddings of a sphere into four-manifolds. In particular, we show that the kernel of the map on homotopy groups of spaces of smooth embeddings to spaces of topological embeddings may have an arbitrarily high-rank summands for a some 4-manifolds. This behavior is found for spheres of arbitrary self-intersection. We also establish an analogous result for homology groups.

Early Career Showcase in Low-Dimensional Topology, Tuesday 14:00-14:25 Room 260-073

Simulation-based Inference and Model Misspecification

Chris Drovandi[1]

[1]Queensland University of Technology

Simulation-based Inference (SBI) methods are very useful for fitting complex statistical models to data, as they only rely on the ability to simulate from the model, rather than evaluating its likelihood function, which is often intractable. However, many SBI methods are known not to be robust to model misspecification, that is, when the model is unable to recover all the key features of the data. This talk will discuss some recent methods we have developed for considerably improving the robustness of SBI methods to model misspecification. This is joint work with various collaborators.

Probability and Mathematical Statistics, Thursday 14:30-14:55 Room 260-098

The q-Schur algebra of type D

Jie Du[1]

[1]University of New South Wales

When I. Schur used representations of the symmetric group S_r to determine polynomial representations of the complex general linear group $GL_n(\mathbb{C})$, certain finite-dimensional algebras, known as Schur algebras, played a bridging role between the two. The well-known Schur duality summarizes the relation between the representations of $GL_n(\mathbb{C})$ and S_r. Over almost a hundred years, this duality has profoundly influenced representation theory and has evolved in various forms such as the Schur-Weyl duality and Schur-Weyl-Brauer duality. In this talk, I will discuss a latest development, which I call the Schur-Weyl-Hecke duality, initiated by Huanchen Bao and Weiqiang Wang in their study of quantum symmetric pairs and canonical basis theory. This duality connects the i-quantum groups $U^j(n)$ and $U^i(n)$ to the Hecke algebras of types B and C, respectively, and has many applications. However, in the type D case, such a duality, first attempted by Fan and Li, is still missing. In this talk, I will introduce the algebraic and geometric constructions of the q-Schur algebras of type D. This includes the finite geometry of some partial isotropic flag varieties, the associated convolution algebras and their natural bases, and some fundamental multiplication formulas. If time permits, more applications such as the

associated duality will be discussed.
Groups, actions and computations, Tuesday 14:30-14:55 Room 260-051

Extending Beyond Fickian Diffusion with Continuum Thermodynamics as a Guide

Fernando Pereira Duda[1], *Eliot Fried* [2]

[1]Programa de Engenharia Mecanica, Universidade Federal do Rio de Janeiro, [2]Mechanics and Materials Unit, Okinawa Institute of Science and Technology

Mathematics of nonlinear diffusion processes, Monday 16:00-16:50 Room 260-018

Regularized maximum likelihood for density estimation in structural models

Fabian Dunker[1], *Christoph Breunig, Emil Mendoza, Marco Reale*

[1]University of Canterbury

We want to nonparametrically estimate a density f but we only observe a sample from a distribution g where f and g are related by an ill-posed operator equation g = Tf. A simple example is deconvolution. More interesting examples are several random coefficient models in econometrics which will be introduced in the talk. We propose a regularized maximum likelihood method to estimate f with general convex penalty term. In this talk we will discuss connections to elastic nets and show convergence rate results based on variational regularization theory. Small sample performance is illustrated in simulations and with a data application.
Recent developments in data science and machine learning, Friday 11:30-11:55 Room 402-220

Discrete Painlevé equations from geometric deautonomization of QRT maps.

Anton Dzhamay[1]

[1]Bimsa

In this talk we consider some examples of discrete Painlevé equations that can be obtained from a given QRT map using the technique of geometric deautonomization. One common interesting feature of such equations is that they often correspond to quasi-translations, or the elements of infinite order in the corresponding affine Weyl group whose certain power is a translation. Such elements often become translations if one considers a smaller affine Weyl subgroup, the phenomena that is known as the projective reduction. We explain how one can obtain such subgroups.
Discrete and continuous integrable systems: geometry analysis and applications, Thurs-

day 14:00-14:25 Room 260-036

Transformation representations of diagram monoids

James East[1]

[1]Western Sydney University

Cayley's Theorem states that any finite monoid can be faithfully represented as a semigroup of transformations (self-maps) of a finite set. The minimum size of such a set is the *(minimum transformation) degree* of the monoid. We obtain formulae for the degrees of the most well-studied families of finite diagram monoids, including the partition, Brauer, Temperley–Lieb and Motzkin monoids. For example, the partition monoid $\mathcal{P}_n$ has degree $1 + \frac{B(n+2)-B(n+1)+B(n)}{2}$ for $n \geq 2$, where these are Bell numbers. The proofs involve constructing explicit faithful representations of the minimum degree, many of which can be realised as (partial) actions on projections. This is joint work with Reinis Cirpons and James Mitchell, both at Univ St Andrews.
50 years of Communications in Algebra, Tuesday 16:00-16:25 Room 303-G15

A very special sextic

Michael Eastwood[1]

[1]University of Adelaide

What is so special about $184x^6 - 192x^5 - 300x^4 - 320x^3 - 150x^2 - 48x + 23$ and what does this have to do with the moduli space of genus 2 Riemann surfaces and its singularities?
Singularities, Wednesday 11:30-11:55 Room 260-024

Expanding on Banks' Results: New Approaches to the Spacing of Zeros of the Riemann Zeta Function

Ali Ebadi[1]

[1]UNSW Canberra

In his recent work, William Banks has demonstrated that under the Riemann Hypothesis, there exists an interval corresponding to given constants $y \neq 0$ and $C > 0$ where both a zero of the zeta function exists and its shifted value by y is non-zero. This talk discusses the collaborative efforts of my supervisor, Bryce Kerr, and myself to extend Banks' results from a single-variable context to a multidimensional framework.
Arithmetic Geometry and Number Theory, Tuesday 16:15-16:25 Room 405-430

Factor Analysis of Infrastructure Output on Economic Growth of Kenya

Emmanuel Ekitela[1,2]

[1]African German Network for Excellence in Science, [2]European Scientific Journal

The purpose of this study is to investigate the factor analysis of infrastructure output on economic growth of Kenya. Infrastructure output can contribute to economic growth of Kenya through channels like: reduction in transportation costs, increased access to goods and services, increased demand and supply diversification, increased durability of goods, increased foreign direct investments and achieving economies of scale and scope. Financing infrastructure in Kenya consists of a massive gap that requires strong inclusiveness in achieving 2030 vision. A research survey method was adopted to examine determinants influencing infrastructure output and economic growth of Kenya. The data collected was both primary and secondary data. A questionnaire was prepared to be filled by the respondents equally.
Contributed Session A, Tuesday 11:30-11:55 Room 260-036

On the complexity of the epimorphism problem for finitely presented groups

Murray Elder[1], *Jerry Shen*[1], *Armin Weiß*[2]

[1]University of Technology Sydney, [2]University of Stuttgart

Friedl and Löh recently showed that deciding whether or not there is an epimorphism from an arbitrary finitely presented group to either a virtually cyclic group or to the direct product of a finite group with an abelian group is decidable. In this talk I will report on recent work on pinpointing the complexity of deciding epimorphism to these and other classes of groups. Joint work with Jerry Shen and Armin Weiß.
Groups, actions and computations, Friday 11:30-11:55 Room 260-051

A few exceptional algebras

Alberto Elduque[1]

[1]University of Zaragoza

In 1977, V. Kac (Commun. Algebra 5, 1977) obtained the classification of the simple finite-dimensional Jordan superalgebras over an algebraically closed field of characteristic 0, from his previous classification of the simple Lie superalgebras. One of the surprises was the appearance of a 10-dimensional Jordan superalgebra, known as Kac's superalgebra K_{10}. In a different setting, the author and S. Okubo (Commun. Algebra 30, 2002) classified the com-

position superalgebras, and here only two new superalgebras appeared, of dimension 3 and 6, and only in characteristic 3. These objects were discovered by I.P. Shestakov. It turns out that these exceptional objects are closely related to the finite-dimensional simple modular Lie superalgebras, with an indecomposable Cartan matrix, with not counterpart in characteristic zero. Moreover, it will be shown that these exceptional objects can be obtained either from the algebra of octonions, or from the Albert algebra, via tensor categories.
50 years of Communications in Algebra, Monday 14:30-14:55 Room 303-G15

On plane curve complements with certain fundamental groups

Eva Elduque[1, 3], *José Ignacio Cogolludo-Agustín*[2, 4]

[1]Universidad Autónoma De Madrid, [2]Universidad de Zaragoza, [3]ICMAT, [4]IUMA

Given a smooth complex quasi-projective curve with an extra orbifold structure (which we interpret as a finite set of points with multiplicities), we can define its orbifold fundamental group, and refer to the groups defined in this way as "curve orbifold groups". In this talk, we will study geometric conditions for a smooth complex connected quasi-projective variety U to have its fundamental group be of this form: an extension of a curve orbifold group by a finite group. These groups include finitely generated free products of cyclic groups. We will also discuss examples in the case when U is the complement of a plane curve in CP^2.
Singularities, Friday 11:30-12:20 Room 260-024

Constructive Torelli Theorem for Regular Matroids

Alec Elhindi[1]

[1]The University of Sydney

A variant of the Discrete Torelli Theorem states that the lattice of integer flows of a regular matroid (without co-loops) determines the matroid up to isomorphism (Su-Wagner 2010). In this talk we outline an explicit construction of the regular matroid M, given its lattice of integer flows F(M). The ingredients include understanding the relationship between the geometry of the Voronoi cell of F(M) and the structure of M (Amini and Dancso-Lim), and a strong version of the Torelli Theorem. Via specialising to graphs, the construction has applications in knot theory. This talk is based on joint work with Zsuzsanna Dancso and Stavros Garoufalidis.
Algebraic Combinatorics and Matroids, Wednesday 11:30-11:55 Room 303-B09

Orientable and bipartite twisted duals of graph embeddings

Blake Dunshee[2], **Mark Ellingham**[1]

[1]Vanderbilt University, [2]Belmont University

Twisted duals of embeddings of graphs in surfaces were introduced by Ellis-Monaghan and Moffatt in 2012. They generalize edge twists, well known since the representation of embeddings using rotation schemes and edge signatures was introduced in the 1970s, and partial duals, defined by Chmutov in 2009. We have recently shown that several important properties of embedded graphs are linked to parity conditions for closed walks in the *gem* (graph-encoded map) or *jewel*, combinatorial representations of the embedding. Using this, we can provide characterizations of when a twisted dual of a graph embedding is orientable or is bipartite. We discuss these and other consequences of our approach to embedding properties.

Structural aspects of matroids and graphs, Wednesday 10:30-10:55 Room 303-B11

Commutator estimates and Poisson bounds for Dirichlet-to-Neumann operators with variable coefficients

Tom ter Elst[1], *El Maati Ouhabaz*[2]

[1]University of Auckland, [2]Université de Bordeaux

We consider the Dirichlet-to-Neumann operator $\mathcal{N}$ associated with a general elliptic operator

$$\mathcal{A}u = -\sum_{k,l=1}^{d} \partial_k(c_{kl}\,\partial_l u) + \sum_{k=1}^{d} \Big(c_k\,\partial_k u - \partial_k(b_k\,u)\Big) + c_0\,u \in \mathcal{D}'(\Omega)$$

with possibly complex coefficients. We study three problems:
1) Boundedness on C^ν and on L_p of the commutator $[\mathcal{N}, M_g]$, where M_g denotes the multiplication operator by a smooth function g.
2) Hölder and L_p-bounds for the harmonic lifting associated with $\mathcal{A}$.
3) Poisson bounds for the heat kernel of $\mathcal{N}$.
We solve these problems in the case where the coefficients are Hölder continuous and the underlying domain is bounded and of class $C^{1+\kappa}$ for some $\kappa > 0$. For the Poisson bounds we assume in addition that the coefficients are real-valued. We also prove gradient estimates for the heat kernel and the Green function G of the elliptic operator with Dirichlet boundary conditions. This is joint work with E.M. Ouhabaz.

Functional analysis and partial differential operators, Tuesday 15:00-15:25 Room 260-020

Deformations of 3-orbifold holonomy groups and applications

Alexander Elzenaar[1]

[1]Monash University

The deformation theory of infinite volume geometrically finite 3-dimensional hyperbolic manifolds has been well-studied from a number of viewpoints. In recent work together with G.J. Martin and J. Schillewaert, the Keen–Series pleating coordinates for the deformation space of four-punctured sphere groups (the "Riley slice") were generalised to the case of 2-orbifold groups with cone points arising in pairs (that is, Kleinian groups which are the free product of two cyclic elliptic groups and which support nontrivial quasiconformal deformations). We describe this coordinate system from both algebraic and geometro-topological viewpoints along with some computational methods used in its study and survey related work on the discreteness problem for this family of groups which has applications to the study of q-rational numbers (joint with J. Gong, G.J. Martin, J. Schillewaert) and the enumeration of arithmetic and thin groups (upcoming joint work with G.J. Martin and J. Schillewaert).

Early Career Showcase in Low-Dimensional Topology, Wednesday 10:30-10:55 Room 260-073

A double-choice secretary problem with a random horizon

Hugh Entwistle[1], *Georgy Sofronov*[1]

[1]Macquarie University

The classic 'secretary problem' where one wishes to maximise their probability of selecting the best candidate, with only one choice, when observing a random permutation of N secretaries sequentially is a well-studied problem. Two additional variants of this problem are when the number of objects is random; and when the objective is to instead maximise the probability of selecting the best and second best with two choices. This talk investigates the variant where both of these assumptions hold – we are faced with a random number of observations and wish to stop on the best and second best observation. We specifically explore the structure of the optimal rule and show-case some interesting results based on the closure of the stopping sets.

Probability and Mathematical Statistics, Monday 16:00-16:10 Room 260-098

Assessing the Impact of Blended Learning Mathematics Intervention on Civil Engineering Students' Performance: A Post-Pandemic Evaluation Using Hierarchical Linear Modeling and Sensitivity Analysis

Jan Denniel Escaño[1], *Jozel Bryan Terrible*[1], *John Leander Landicho*[1], *Jake Leonera*[1]

[1]National University Philippines

The global shift to online education brought about by the COVID-19 pandemic was unprecedented and drastically altered teaching approaches in many academic fields. This shift highlighted the challenges posed by removing foundational subjects such as algebra, trigonometry, and geometry from the Philippines' 2017 Civil Engineering curriculum, which requires a strong mathematical foundation. National University closed this gap by maximizing a blended learning approach that combined face to face lecture sessions on campus and live online lectures on Microsoft Teams. This study focuses on the impact of these intervention courses on civil engineering students' academic performance, specifically in their professional subjects. With a focus on rigorous quantitative analysis, the study uses regression analysis and Hierarchical Linear Modeling (H.L.M.) to compare the outcomes of students who took the intervention courses to those who did not, including transferee students who completed their mathematics coursework on their previous universities. Examinations or assessment tests given before and after the intervention courses provided additional information about the students' mathematical proficiency development. This study investigates the effectiveness of blended learning, specifically how it impacts student engagement and comprehension, going beyond statistical comparisons. The results demonstrate that, despite the difficulties associated with remote learning, a well-designed intervention can greatly enhance students' performance in challenging engineering courses and their ability to think analytically. The results of this study will have a significant impact on curriculum development not only in the Philippines but also in engineering education worldwide. As the post-pandemic educational landscape changes, this study provides evidence-based recommendations for incorporating technology-driven learning models to improve student outcomes. By addressing the academic and practical challenges of teaching mathematics in a blended learning environment, this study adds to the ongoing discussion about the future of engineering education. It provides valuable insights for educators, institutions, and policymakers.
MATHEMATICS EDUCATION, FRIDAY 12:00-12:25 ROOM 260-115

Sequential topological complexity of aspherical spaces and sectional categories of subgroup inclusions

Arturo Espinosa[1], *Michael Farber*[2], *Stephan Mescher*[3], *John Oprea*[4]

[1]Adam Mickiewicz University, [2]University of London, [3]Halle-Wittenberg University, [4]Cleveland State University

The sequential topological complexities of a space are homotopy invariants that are motivated by the motion planning problem from robotics. One of the most important open problems on the field is the characterization on purely algebraic terms of the (sequential) topological complexity of aspherical spaces. One of the possible approaches to this problem is through the study of the sectional categories of subgroup inclusions, as natural generalizations of sequential TC for this algebraic setting. We will discuss how to obtain new lower bounds for sectional categories of subgroup inclusions through homological algebra methods, and discuss their consequences for sequential TC of aspherical spaces. If time permits, we will also mention how some of our methods allow as well to obtain results on spaces that are not necessarily aspherical. This is joint work with Michael Farber, Stephan Mescher and John Oprea.
APPLIED AND COMPUTATIONAL TOPOLOGY, THURSDAY 14:30-14:55 ROOM 260-223

B cell phylodynamics

Steven Evans[1]

[1]University of California At Berkeley

Germinal centers (GC) are micro-anatomical structures that transiently form in lymph nodes during an adaptive immune response. In a GC, B cells—the cells that make antibodies—diversify and compete based on the ability of the antibodies they express to recognize a foreign antigen molecule. As GC B cells proliferate, they undergo targeted mutations in the genomic locus encoding the antibody protein that can modify its antigen binding affinity. Via signaling from other GC cell types, the GC can monitor the binding phenotype of the B cell population it contains and provide survival signals to B cells with the highest-affinity antibodies (i.e., birth and death rates depend on type). Motivated by this mechanism, we develop a mean-field model that couples the birth and death rates in a focal multi-type birth and death process (MTBDP) with d types to the empirical distribution of states—i.e., the mean-field over an exchangeable system of N replica MTBDPs. The empirical distribution process of the N replicas converges to a deterministic probability measure-valued flow as N goes to infinity. In the limit, the focal process evolves as a multi-type birth and death process with rates governed by the probability measure-valued flow which is in turn the flow of one-dimensional marginal distributions of the focal process. Individual focal processes become independent in the limit and this holds out the hope of inference being feasible for this model. This is joint work with William S. DeWitt, Ella Hiesmayr, and Sebastian Hummel.

Probability and Mathematical Statistics, Thursday 11:30-11:55 Room 260-098

Traditional lectures versus active learning – a false dichotomy?

Tanya Evans, *Heiko Dietrich*

[1]University of Auckland

Traditional lectures are commonly understood to be a teacher-centered mode of instruction where the main aim is a provision of explanations by an educator to the students. Recent literature in higher education overwhelmingly depicts this mode of instruction as inferior compared to the desired student-centered models based on active learning techniques. First, using a four-quadrant model of educational environments, we address common confusion related to a conflation of two prevalent dichotomies by focusing on two key dimensions: (1) the extent to which students are prompted to engage actively and (2) the extent to which expert explanations are provided. Second, using a case study, we describe an evolution of tertiary mathematics education, showing how traditional instruction can still play a valuable role, provided it is suitably embedded in a student-centered course design. We support our argument by analyzing the teaching practice and learning environment in a third-year abstract algebra course through the lens of Stanislas Dehaene's theoretical framework for effective teaching and learning. The framework, comprising "four pillars of learning", is based on a state-of-the-art conception of how learning can be facilitated according to cognitive science, educational psychology and neuroscience findings. In the case study, we illustrate how, over time, the unit design and the teaching approach have evolved into a learning environment that aligns with the four pillars of learning.

We conclude that traditional lectures can and do evolve to optimize learning environments and that the erection of the dichotomy "traditional instruction versus active learning" is no longer relevant. Additionally, we present the findings of our scoping review on research related to Inquiry-Based Mathematics Education (IBME)— a widely promoted alternative to traditional lectures in undergraduate mathematics education. Contrary to the assertions frequently made by IBME advocates, our analysis shows that the call for a sweeping reform of undergraduate mathematics education is not substantiated by evidence. Specifically, the general claim that students would learn better (and acquire superior conceptual understanding) if they were not taught is not supported by evidence. Neither is the claim that IBME effectively addresses equity issues in mathematics classrooms.

References:
Dietrich, H., & Evans, T. (2022). Traditional lectures versus active learning - a false dichotomy? STEM Education, 2(4), 275-292. https://doi.org/https://doi.org/10.3934/steme.2022017
Evans, T., & Dietrich, H. (2022). Inquiry-based mathematics education: a call for reform in tertiary education seems unjustified. STEM Education, 2(3), 221-244. https://doi.org/10.3934/steme.2022014

Mathematics Education, Monday 14:00-14:25 Room 260-115

The mathematical ekklesia: active learning inspired by the ancients

Bartek Ewertowski[1]

[1]University of Auckland

Designing active learning activities for mathematics lectures can be tricky–especially for large classes, such as our 100- and 200-level courses at the University of Auckland. In this talk I will discuss the challenges that arise when posing questions in lectures and trying to stimulate discussions. For example, most students are shy to answer–usually just a few confident students will be willing to share their thoughts. To address some of these issues, I will discuss my personal approach to designing engaging in-lecture quizzes which manage to get most students to participate in the discussion. These activities have generated positive feedback in both student and peer teaching evaluations.

Mathematics Education, Friday 11:30-11:55 Room 260-115

Mimicking

Jie Yen Fan[1]

[1]Monash University

Motivated by questions in finance, we are interested in constructing new processes from existing ones while preserving the marginal distributions and the martingale property. We call this mimicking. This would enable us to develop alternative models for asset prices, with the hope of improving upon the existing ones, while retaining the (European) option prices. In this talk,

I will give some results around mimicking. Joint work with Kais Hamza and Fima Klebaner.
Probability and Mathematical Statistics, Friday 12:00-12:25 Room 260-098

Learnability of neural networks under heavy-tailed noise

Jun Fan[1]

[1]Hong Kong Baptist University

Neural networks have witnessed remarkable success in recent years, demonstrating their ability to learn intricate patterns and achieve accurate predictions across various domains. However, the behaviour of neural networks in the presence of heavy-tailed noise presents a challenging and captivating problem. This presentation seeks to explore how neural networks adapt to heavy-tailed noise, unveiling the fundamental mechanisms that shape their performance. Our emphasis is on establishing fast learning rates for algorithms based on neural networks when the noise adheres to weak moment conditions.
Recent developments in data science and machine learning, Thursday 12:00-12:25 Room 402-220

Connecting W-algebras and their representations

Justine Fasquel[1]

[1]The University of Melbourne

W-algebras form a large family of vertex algebras of great importance for two-dimensional conformal field theories. They provide an additional framework to study WZW models. Indeed, W-algebras can be obtained from the latter by applying certain quantized Hamiltonian reductions associated to nilpotent orbits of simple Lie algebras. It is believed that most of the time this reduction procedure can be reversed to reconstruct the representations of the underling affine Lie algebra. In this talk, we will discuss inverse reductions as well as their consequences on the representation theory based on examples in small ranks.
Mathematical Physics, Tuesday 12:00-12:25 Room 260-221

How Strong Are Topological Descriptors?

Brittany Terese Fasy[1]

[1]Montana State University

We investigate topological descriptors for shapes immersed in $\mathbb{R}^d$. In particular, we consider the persistence diagram, the Euler characteristic function, the Betti function, and their verbose counter-parts. We investigate how small faithful sets can be, and we provide some experimental studies demonstrating the gap between theory in practice. Building from this knowledge, we establish a framework that allows for a quantitative comparison of topological descriptors and use this framework to define a total order on the descriptors. We hope that this investigation will assist researchers when choosing among different topological descriptors for their data analysis tasks.

Applied and Computational Topology, Thursday 14:00-14:25 Room 260-223

Modelling the Dynamics of Infectious Bursal Disease in Poultry: A Sero-Epidemiological Approach

Hammed Olawale Fatoyinbo[1], *Bernard J. Phiri*[2], *Nelly Marquetoux* [2], *Emilie Vallee*[3]

[1]Department of Mathematical Sciences, Auckland University of Technology, [2]Biosecurity Surveillance, Ministry for Primary Industries, [3]EpiCentre, School of Veterinary Science, Massey University

Infectious bursal disease (IBD) causes significant economic losses in poultry globally and undermines global food security. However, New Zealand is one of a handful countries where IBD virus serotype 1 (IBDV-1), the most pathogenic type, is absent. This study develops a mathematical model to examine the transmission dynamics of IBDV-1 transmission within a naïve and unvaccinated commercial poultry flock housed in a single pen. The objective was to understand disease dynamics that could facilitate early detection of the disease if it entered a commercial poultry flock in New Zealand. We leveraged simulation modelling to investigate how the rates of seroconversion, viral shedding, and antibody decline influence the diagnostics and detection of IBDV-1. Diagnostic sensitivity and specificity were included as variables when estimating the daily probability of detection using ELISA (Enzyme-linked immunosorbent assay) and PCR (polymerase chain reaction) tests. We evaluated the probability of detecting infection using a testing protocol involving 10 birds and found that the seroconversion rate and antibody decline for ELISA, as well as the shedding rate and disappearance of shedding for PCR, significantly affect the peak probability of positive detection of IBDV-1 within a flock. This approach offers valuable insights for developing IBD outbreak preparedness plans and mitigating the impact on poultry production systems.

Industrial Mathematics, Tuesday 15:00-15:25 Room 402-211

Pfaffian solutions to a coupled complex modified KdV equation and its discrete analogues under nonzero boundary condition

Baofeng Feng[1]

[1]University of Texas RGV

In this talk, we construct soliton solutions to a coupled complex modified KdV equation and its discrete analogues via Hirota's bilinear method. First, we derive bilinear forms of both coupled continuous and discrete complex mKdV equations under nonzero boundary condition. Then

we prove the general soliton solutions in terms of Pfaffian to both the continuous and discrete equation.
Discrete and continuous integrable systems: geometry analysis and applications, Thursday 12:00-12:25 Room 260-036

U-statistics for determinantal point processes

Renjie Feng[1]

[1]The University of Sydney

In this talk, I will discuss U-statistics for determinantal point processes (DPPs), a topic initiated by myself and my coauthors. I will begin by presenting a graphical formula for the cumulants of U-statistics of DPPs, which extends the well-known Soshnikov formula for linear statistics, i.e., 1-variable case. Using this new formula, we examine the U-statistics of the infinite Ginibre ensemble, which reveals a surprising connection to Wiener chaos.
Discrete and continuous integrable systems: geometry analysis and applications, Wednesday 11:30-11:55 Room 260-036

Extreme gap problems for classical random matrices

Renjie Feng[1]

[1]The University of Sydney

In this talk, I will present our findings concerning extreme gap problems, namely the smalles and largest spectral gaps, for classcial circular and Gaussian random matrices, and propose several conjectures.
Probability and Mathematical Statistics, Friday 15:00-15:10 Room 260-098

Evaluating Next-Generation Technology-enabled Tutorial Spaces for Small-group classes

Paul Fijn[1], *Christopher Duffy*[1]

[1]University of Melbourne

Following the rapid shift to online teaching in 2020, we discovered some unexpected benefits in having technology (particularly web-based applets and statistical software) readily available within all teaching environments and classes. Since 2022 the School of Mathematics and Statistics has been piloting some Next Generation tutorial rooms - small-group teaching spaces trialling new electronic whiteboard technology equipped with a fully-featured Windows PC. We

designed a project evaluating the effectiveness of these spaces in two subjects: a first-year introductory applied statistics course, and a second-year theoretical statistics course primarily for students pursuing a major. This project uses a mixed-methods approach, combining positivist and phenomenographic methodologies. Accordingly, we aimed to measure the effectiveness of the technology/spaces through assessing students self-efficacy, engagement and knowledge. This was done through two larger surveys at the start and end of semester, with very short monthly surveys in between. The surveys included validated instruments on self-efficacy, and open-ended questions for a phenomenographic analysis of students understanding of statistics. These were analysed in conjunction with demographic data, attendance records and student achievement in overall grades. We discuss the preliminary findings and future directions of this research.
Mathematics Education, Monday 15:00-15:25 Room 260-115

Galois connections, adjoints and duality in optimisation

James Foster[1]

[1]Commonwealth Scientific and Industrial Research Organisation

While duality is a central concept in optimisation theory, many other areas of mathematics exhibit corresponding concepts of duals, adjoints and Galois connections. In this work, I will show how adjoints and Galois connections in the context of optimisation theory enable a unified perspective on existing theoretical ideas such as the Fenchel conjugate and eigenvalue relations, with applications to the better understanding of structural theorems in linear, conic quadratic and semidefinite programming.
Optimisation, Tuesday 14:00-14:25 Room 402-221

Optimal Recovery of Multivalued Functions

Simon Foucart[1]

[1]Texas A&M University

The theory of Optimal Recovery provides a worst-case focused alternative to Statistical Learning Theory for the task of predicting a linear functional of an unknown function f acquired through the data $y_m = f(x^{(m)})$, $m = 1, \ldots, M$. For instance, under an approximability assumption which is often implicit in learning scenarios, it guarantees that an optimal prediction process returns an output depending linearly on y. However, this result does not apply for the prediction of $f(x^{(0)})$ if $f = [f_1; \ldots; f_N]$ is a multivalued function. The theory then needs to be refined and we will present initial results under convex assumptions of the type $f_1 \geq 0, \ldots, f_N \geq 0$, and $f_1 + \cdots + f_N = 1$. We will show that in such a case a worst-case (near) optimal prediction process is now affine and we will make it explicit in the contexts of reproducing kernel Hilbert spaces and of spaces of continuous functions.
Recent developments in data science and machine learning, Tuesday 14:30-14:55 Room 402-220

The finite-rank property of inverse problems and computation

Colin Fox[1]

[1]University of Otago

The forward map in inverse problems is almost finite rank, which is perhaps the defining property since oft quoted analytic difficulties follow directly. On the other hand, this property can be used to advantage when designing computation for practical inverse problems where uncertainty is unavoidable, because even infinite-dimensional, function-space computation can be performed with finite-dimensional representations. We analyze the popular Metropolis–Hastings algorithms with auto-regressive proposals that are ergodic for the distribution over function-space solutions and characterize conditions for dimension-independent performance.
Microlocal analysis and inverse problems, Monday 16:00-16:25 Room 260-009

Posterior exploration for high-contrast EIT with Cleveland prior

Colin Fox[1], *Dave Higdon*[2], *Mikkel Lykkegaard*[3]

[1]University of Otago, [2]University of Exeter, [3]Virginia Tech

We consider posterior exploration for EIT (electrical impedance tomography) when using a Gibbs–Markov random field prior defined by Cleveland's tricube energy function, that induces a multi-modal posterior distribution. The latter property appears to be necessary if one wishes to recover the fine details in high-contrast conductivity fields using a low-level prior. We present a comparative study of posterior exploration using MCMC (Markov chain Monte Carlo), starting with single-site Metropolis from 1953, through to Adaptive Multi-level Delayed Acceptance that appeared in 2023. Many recent algorithms, advertised as efficient, turn out to be slower than Metropolis' 1953 algorithm. The most efficient algorithm we test is Adaptive Multi-step Delayed Acceptance leveraging an approximation that has lower rank than the forward map (!). All computing is performed with the free and open-source python package tinyDA.
Stochastic and Deterministic Inverse Problems, Thursday 15:00-15:25 Room 260-040

Fourier series and algorithmic randomness

Johanna Franklin[1]

[1]Hofstra University

We characterize Martin-Löf randomness in terms of the convergence of the Fourier series of functions on $L^p[-\pi, \pi]$. This is joint work with Diego Rojas.
Computability Theory and Applications, Tuesday 16:00-16:25 Room 303-B07

A computational approach to Riemann surfaces with applications in Physics

Jörg Frauendiener[1]

[1]University of Otago

Integrable systems have a wide range of applications in fluid mechanics, general relativity and other areas of science. Many such systems have solutions which can be described in terms of Theta functions defined on Riemann surfaces. In this talk, we discuss our computational approach to evaluate these functions given data to define a Riemann surface. We show how to obtain a homology basis, the independent holomorphic differentials and from those the corresponding Riemann matrix. We demonstrate some applications, such as solutions to some integrable equations, the visualisation of stationary, axisymmetric relativistic systems. Finally, we discuss an application to the Schottky problem.

Computations and applications of algebraic geometry and commutative algebra, Thursday 11:30-11:55 Room 303-B05

On the geometry of the Humbert surface of square discriminant

Sam Frengley[1]

[1]University of Bristol

The Humbert surface $\mathcal{H}_{N^2}$ of discriminant N^2 parametrises genus 2 curves which admit a morphism $C \to E$ of degree N (which does not factor through an elliptic curve). The rational points on $\mathcal{H}_{N^2}$ are closely related to a conjecture of Frey–Mazur on pairs of elliptic curves with isomorphic mod N Galois representations. We discuss recent work where, building on results of Hermann and Kani–Shanz, we classify the Enriques–Kodaira type of the surfaces $\mathcal{H}_{N^2}$ for every positive integer N.

Arithmetic Geometry and Number Theory, Friday 14:00-14:25 Room 405-430

Congruence Lattices of Finite Twisted Brauer and Temperley-Lieb Monoids

Matthias Fresacher[1]

[1]Western Sydney University

In 2022, East and Ruškuc published the congruence lattice of the infinite twisted partition monoid. As a by product, they established the congruence lattices of the finite d-twisted partition monoids. This talk is a first step in adapting the work of East and Ruškuc to the setting of the Brauer and Temperley-Lieb monoid. Specifically, it presents the newly established congruence lattice of the 0-twisted Brauer and Temperley-Lieb monoids. With simple to grasp visual multiplication and applications in theoretical physics and representation theory, the family of diagram monoids are of particular interest to a number of fields as well are of stand alone interest.

50 years of Communications in Algebra, Thursday 12:00-12:25 Room 303-G15

Complete orthonormal sequences for representing general three-dimensional states of residual stress

Eliot Fried[1], *Sankalp Tiwari*[1]

[1]Okinawa Institute of Science and Technology

Residual stresses are self-equilibrated stresses on unloaded bodies. Owing to their complex and diverse origins, it is useful to develop functions that can be linearly combined to represent any sufficiently regular residual stress field. We develop orthonormal sequences that span the set of all square-integrable residual stress fields on a given three-dimensional region. These sequences are obtained by extremizing the most general quadratic, positive-definite functional of the stress gradient on the set of all sufficiently regular residual stress fields subject to a prescribed normalization condition; each such functional yields a sequence. It is important to note that any residual stress state can be expressed as a linear combination of each of these sequences without knowledge of the physical mechanisms that may have caused the residual stress. For a special case in which the sixth-order coefficient tensor in the functional is homogeneous and isotropic and the fourth-order coefficient tensor in the normalization condition is proportional to the identity tensor, we obtain a three-parameter subfamily of sequences. Upon a suitable parameter normalization, we find that the viable parameter space corresponds to a semi-infinite strip. For a further specialized spherically symmetric case, we obtain analytical expressions for the sequences and the associated Lagrange multipliers. Remarkably, these sequences change little across the entire parameter strip. To illustrate the applicability of our theoretical findings, we employ three such spherically symmetric sequences to accurately approximate two standard residual stress fields — one corresponding to a shrink-fitted cylinder and another to a non-uniformly heated elastic sphere. Our work opens avenues for future exploration into the implications of different sequences, achieved by tuning the spatial distribution and the material symmetry class of the coefficient tensors, toward specific objectives.

Mathematical methods in continuum mechanics and wave theory, Thursday 11:30-11:55 Room 401-307

Shape-preserving everting motions of orientable or nonorientable, unkotted or knotted, bands

Eliot Fried[1], *Vikash Chaurasia*[1]

[1]Okinawa Institute of Science and Technology

We introduce a framework for achieving continuous, periodic everting motions of orientable and nonorientable bands, including those with unknotted and knotted topologies, thereby extending the traditional scope of eversion beyond simple objects like halved tennis balls and latex tubes. We derive a kinematic evolution equation and analytically construct its general traveling

wave solution. The solution describes the configuration of a band at any time, using periodic extensions of the initial data for orientable bands and antiperiodic extensions for nonorientable bands. Each motion is isometric, preserving distances between points on the band, and isoenergetic, maintaining the elastic energy throughout the motion. These motions expand the known classes of shape-preserving transformations, which were previously limited to rigid rotations and translations. Our findings may influence the design of adaptive materials and soft robotic systems, potentially enhancing innovations in fields such as medical, aerospace, and architectural engineering.
Contributed Session B, Friday 12:00-12:25 Room 260-028

Chemical pattern formation on the surface of an elastic solid

Eliot Fried[1], *Francisco Forte Neto*[2], *Fernando Duda*[2]

[1]Okinawa Institute of Science and Technology, [2]Universidade Federal do Rio de Janeiro

Pattern formation is a fundamental phenomenon observed in various natural systems, where intricate processes underpin the emergence of spatiotemporal structures. At the cellular level, for instance, the distribution of proteins within a cell is central to regulating essential functions such as cell division and migration. This distribution is influenced by factors including the shape and mechanical properties of the cell and the dynamics of signaling molecules. Although pattern formation in purely chemical systems has been explored extensively, the interplay between chemistry and mechanics is relatively unexplored due to its inherent complexity. We focus on studying the effect of bulk deformation on surface-diffusion-driven instabilities in a system encompassing deformation, bulk and surface diffusion, and surface reactions. The interplay between chemistry and mechanics considered here arises from the distortion induced by the diffusing constituent in bulk. Distortion is concomitantly accompanied by stress, which affects the transport and absorption of the diffusing constituent. Employing linear stability analysis and detailed numerical simulations, we systematically vary dimensionless parameters that encompass all salient geometric features and physical properties, the latter including mechanical moduli, bulk and surface diffusivities, and surface reaction kinetics. Our findings provide insights into how mechanical effects influence the conditions under which Turing-like patterns emerge on the surface of an elastic solid.
New directions in pattern formation, Friday 14:00-14:25 Room 303-B11

Quenched statistics for piecewise-continuous random dynamical systems: thermodynamic formalism, open dynamics, extreme value theory, and hitting time distributions.

Gary Froyland[1], *Jason Atnip*[2], *Cecilia Gonzalez-Tokman*[2], *Sandro Vaienti*[3]

[1]UNSW Sydney, [2]University of Queensland, [3]University of Marseille

I will summarise recent results on quenched statistical properties of random dynamical systems obtained by the authors, in the difficult piecewise-continuous setting and with general ergodic

driving. Quenched results refer to statements that hold almost surely across all random realisations, as opposed to annealed results, which typically hold only in some average sense. Depending on available time, topics covered may include the existence of a quenched random thermodynamic formalism and associated rates of decay (in closed and open random dynamics), a quenched extreme value theory with random dynamics, observations and thresholds, and quenched hitting time statistics for random dynamics and targets.
Ergodic Theory and Dynamical Systems, Friday 14:00-14:25 Room 303-G23

Elementary abelian p-subgroups and their local structure in classical groups

Meizheng Fu[1]

[1]University of Auckland

Many open conjectures in the representation theory of finite groups, such as the Alperin Weight Conjecture and the Dade Conjecture, can be studied by reducing to quasi-simple groups. An important tool in such studies is p-radical subgroups and their local structure. In fact, radical subgroups play an important role in many areas of modular representation theory. For instance, defect groups of blocks are radical; the subgroup R of a weight (R, ϕ) is radical. A p-radical subgroup is a subgroup R of G such that it equals the largest normal p-subgroup of its normalizer. A subgroup of a finite group G is p-local if it is the normalizer of a nontrivial p-subgroup of G. One can show that every p-radical subgroup R of G is radical in some maximal-proper p-local subgroup M of G. And it can be shown that every M can be realized as the normalizer of an elementary abelian p-subgroup. Thus, to classify p-radical subgroups of a finite group G, one can first classify elementary abelian p-subgroups. To classify elementary abelian p-subgroups of finite groups, we first carry out the classification and obtain the local structure in a linear algebraic group G and then use a one-to-one correspondence derived from the Lang-Steinberg theorem to transfer the results to finite groups of Lie type G^F, the fixed point subgroup of G of the Steinberg endomorphism F. This approach was used in [1] to classify and obtain local structure of elementary abelian p-subgroups in finite exceptional groups of Lie type. I will report briefly on my work to solve this problem for classical groups.

[1] Jianbei An, Heiko Dietrich, and Alastair J Litterick. "Elementary Abelian Subgroups: From Algebraic Groups to Finite Groups." https://arxiv.org/abs/2303.02364

Groups, actions and computations, Wednesday 10:30-10:55 Room 260-051

Measuring the Effects of Active Learning on Student Learning Outcomes in Calculus Using a Randomized Trial

Edgar Fuller[1]

[1]Florida International University

Active learning in STEM classrooms has been shown to increase student outcomes in multiple ways. We will discuss the implementation of an active-learning approach to calculus based on the Modeling Practices in Calculus (MPC) approach developed at FIU (described in more detail here

https://www.science.org/doi/10.1126/science.ade9803). This curriculum focuses on cultivating multiple aspects of a cooperative, inclusive classroom including: • Practices of Mathematicians: Replicating practices such as: reasoning, sense-making, higher-order thinking, procedural fluency, use of multiple representations, logically precise definitions, argumentation, constructive perseverance, use of examples and counterexamples, etc. • Cooperative Learning: Collaborative learning where students in small groups work face-to-face on structured activities. Groups share their ideas, improve their skills, develop interpersonal skills and receive ongoing formative assessment by the instructional team. • Argumentation/Metacognition: Students engage in meaningful discourse and argumentation on the course topics, providing justifications and evaluating claims in both group and whole class discussions. Students become generators of knowledge out of their reasoning and sense-making. • Mathematical Fluency: Students build fluency through the exploration and discussion of various concepts as well as using reasoning and mathematical strategies to develop general methods for problem solving, leading to thorough understanding the concepts and mathematical procedures. • Culturally Responsive Environment: MPC is an immersive, transformational learning experience that allows students to construct their understanding by working with each other and near-peer LAs. These reduce activation of math anxiety, build a sense of community and foster persistent formative assessment to identify and tend to potential knowledge conflicts in real time. MPC's instructional design intentionally integrates ambitious teaching as intentional instructional design for developing conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive dispositions and as outlined specifically for Calculus in the Mathematics Association of America's 2015 report Mathematical Association of America National Study of College Calculus. We will discuss outcomes from a large-scale randomized study of its implementation that collected student work over three semesters and give an overview of the classroom practices and approaches used by the curriculum and associated professional development. We will then compare models of student learning outcomes to establish an estimated effect of the curriculum change on those outcomes.
Mathematics Education, Thursday 14:00-14:50 Room 260-115

Partial Reduction for W-Algebras

Ethan Fursman[1]

[1]University of Melbourne

Vertex Operator Algebras (VOAs) provide a mathematical framework for studying conformal field theories. W-algebras are an important class of VOAs proving increasingly important in physics. They are constructed using Quantum Hamiltonian Reduction (QHR) - and this can also be used to relate various W-algebras to one another. In this talk I will discuss some new approaches to QHR along with their applications to W-algebras and their representation theory.
Mathematical Physics, Monday 16:30-16:55 Room 260-221

Pseudo-Trisections of Four-Manifolds with Boundary

Shintaro Fushida-Hardy[1]

[1]Stanford University

We introduce pseudo-trisections of four-manifolds with boundary. These are a decomposition of four-manifolds into three standard pieces which allows them to be diagrammatically studied. The main feature of pseudo-trisections is that they have lower complexity than relative trisections.

Early Career Showcase in Low-Dimensional Topology, Thursday 14:30-14:55 Room 260-073

Surprising representations in cohomology of compacified configurations in graphs

Nir Gadish[1]

[1]University of Pennsylvania

Configuration spaces of points in graphs are nonsmooth analogs of braid arrangements, appearing in robotics applications and the theory of tropical curves. While their cohomology is extremely difficult to understand, and depends on the combinatorics of the underlying graph, their one-point compactification is a fascinating homotopy invariant. We'll discuss some mysteriously familiar representations of the symmetric group appearing in their cohomology and how they got there. This work is joint with Louis Hainaut.

Algebraic Combinatorics and Matroids, Friday 15:00-15:25 Room 303-B09

On the density of periodic windows for the Rössler system

Zbigniew Galias[1]

[1]AGH University of Krakow

In this study, we consider the problem whether for the Rössler system periodic windows are dense in the parameter space. Specifically, we consider the Rössler system defined by $\dot{x} = -y-z$, $\dot{y} = x+by$, $\dot{z} = b+z(x-a)$ with parameter values close to the classical case $a = 5.7$, $b = 0.2$. Let us define the Poincare map $P_{a,b}$ with the return plane $\Sigma = \{v = (x, y, z)\colon x = 0, \dot{x} = -y-z > 0\}$, and let $((y_k, z_k))_{k=0}^{N}$ be a trajectory of $P_{a,b}$. If $P_{a,b}$ is chaotic then plots of the first return map, where y_{k+1} is plotted versus y_k, are very close to plots of a one-dimensional map with a single extremum. Moreover, numerical simulations suggest that the complexity of $P_{a,b}$ measured in terms of the topological entropy changes monotonically with the parameter a (or b). The logistic map $f_a(x) = ax(1-x)$ has similar properties: it is a one-dimensional map with a single maximum and its complexity (the number of periodic orbits) grows with the parameter

a. It is known that for the logistic map periodic windows are dense in the parameter space $a \in [0, 4]$. Therefore, one may expect that a similar property holds also for the Rössler system in the considered parameter region. To study this problem we define symbolic representation of trajectories of $P_{a,b}$. We construct the ordering of symbol sequences with a property that for periodic symbol sequences their order agrees with the layout of corresponding periodic windows when the parameter a (or b) is modified. Using symbolic descriptions of periodic window and the bisection method we attempt to find periodic windows whose positions converge to the classical case. We show that this procedure is successful and we find periodic windows as close as 10^{-16} to the classical case. However, for smaller distances the procedure fails. Possible reasons of this failure are discussed.
Computational Methods and Applications of Dynamical Systems, Thursday 15:00-15:25 Room 303-G20

Angular Momentum in General Relativity

Joseph Galinski[1], *Chris Stevens*[1]

[1]University of Canterbury

Useful physical quantities such as energy and momentum correspond to symmetries of physical systems. While general spacetimes in Einstein's theory of general relativity need not possess any symmetries, it is possible to obtain useful conserved quantities by considering the asymptotic symmetry group of asymptotically flat spacetimes, the Bondi-Metzner-Sachs (BMS) group. This naturally leads to an unambiguous definition of energy and linear momentum, however angular momentum suffers from the so-called supertranslation ambiguity. The goal of this project is to compute conserved quantities corresponding to BMS symmetries for numerically computed spacetimes, and use this to quantify the supertranslation ambiguity of angular momentum in a practical setting. We aim to use our results to show that a non-rotating Schwarzschild black hole becomes a rotating Kerr black hole due to interaction with gravitational waves.
Recent advances in geometric PDE, Wednesday 11:15-11:25 Room 260-057

All-Frequency-Stable Continuous and Discrete Models for RCS Computations of Penetrable 3D Scatterers

Mahadevan Ganesh[1], *Stuart Hawkins, Darko Volkov*

[1]Colorado School of Mines, [2]Macquarie University, [3]Worcester Polytechnic Institute

Accurately simulating quantities of interest, such as the radar cross section (RCS) of penetrable scatterers, is crucial for advancements in electromagnetic wave-based technologies. When exposed to an incident wave, penetrable scatterers induce electromagnetic fields both inside and outside their boundaries. In many applications, the exterior region is unbounded free space, and the RCS serves as a measure of the far-field electromagnetic response. We utilize the time-harmonic Maxwell partial differential equations (PDEs) to model wave propagation in three-dimensional (3D) space, which includes a closed penetrable scatterer (characterized by either a real or complex constant refractive index) and its unbounded free-space complement. Our PDE model incorporates interface continuity conditions and the Silver-Müller radiation condition at infinity, which is essential for accurately modeling the far-field behavior. Exact surface-integral representations of the far field can be derived from unknown surface electromagnetic fields defined on the bounded manifold interface separating the scatterer from free space. Surface integral equations (SIEs), equivalent to the time-harmonic Maxwell PDEs, provide an efficient framework for directly modeling these surface electromagnetic fields and, consequently, the RCS. This approach ensures the radiation condition is satisfied and avoids the need to truncate the unbounded region. Despite more than a century of research on SIEs for Maxwell PDEs, developing a well-posed and stable SIE system for all frequencies—at both continuous and discrete levels—without requiring external constraints remains a significant challenge. Our presentation focuses on our solution to this open problem. (This work is a collaboration with Stuart Hawkins and Darko Volkov.)

Computational Mathematics, Monday 14:00-14:25 Room 402-231

Exploring Gender Differences in Tertiary Mathematics-Intensive Fields: A Critical Review of Social Cognitive Career Theory

Huayu Gao[1], *Tanya Evans*[1], *Gavin Brown*[1]

[1]University of Auckland

Social Cognitive Career Theory (SCCT) has been extensively employed to elucidate the enduring gender differences in mathematics-intensive fields, with a particular emphasis on the complex interplay of motivational factors and extra-personal influences contributing to the underrepresentation of women. The theory proposes a reciprocal feedback loop in which individual career choices are shaped by self-efficacy beliefs, outcome expectations, and personal goals, which are in turn influenced by a myriad of contextual factors, such as societal norms, family background, and educational experiences. While a plethora of empirical studies corroborate the fundamental tenets of SCCT, three crucial aspects for refinement have come to the fore, warranting further investigation and theoretical development. First, the theory should place a more substantial emphasis on how cultural and contextual diversity influences academic choices. In an increasingly globalised world, it is imperative to recognise that individuals' experiences and decision-making processes are deeply rooted in their unique cultural backgrounds and social contexts. By incorporating a more nuanced understanding of cultural diversity, SCCT can better capture the complex dynamics that shape career trajectories across different populations and settings. Second, given the dynamic nature of motivation, which evolves over time in response to various personal and environmental factors, more longitudinal analyses are imperative to capture its temporal trajectory. While SCCT has been extensively applied in empirical research, the vast majority of studies to date have employed cross-sectional designs, providing only a static snapshot of motivational processes at a specific point in time. However, to comprehensively understand the long-term development and influence of motivation on academic choices, it is essential to examine how these processes unfold over extended temporal dimensions. Finally, considering the intricate interplay between emotion and motivation, integrating the dimension of emotion into SCCT would significantly augment its explanatory power and provide a more comprehensive understanding of academic selection processes.

Mathematics Education, Monday 16:00-16:10 Room 260-115

Student Explanation Strategies in Tertiary Mathematics and Statistics Education: A Scoping Review

Huixin Gao[1], *Tanya Evans*[1], *Anna Fergusson*[1]

[1]University of Auckland

This scoping review investigates the application of student explanation strategies in higher education mathematics and statistics. We examined 34 peer-reviewed articles published over the past decade (2014-2024), identifying three primary categories of student explanations: self-explanation, peer explanation, and explanation to fictitious others. Our analysis synthesizes the theoretical foundations underlying these approaches, including the retrieval practice hypothesis, generative learning hypothesis, and social presence hypothesis. Our findings suggest that self-explanation and explaining to fictitious others primarily enhance individual cognitive processes and generative thinking. In contrast, peer explanation methods potentially combine these benefits with the advantages of collaborative learning. Interestingly, the strategy of explaining to fictitious others may help mitigate some challenges associated with peer explanations, such as the tendency for more knowledgeable students to dominate discussions. We observed that the effectiveness of these methods varies depending on their implementation, duration, and context. This review contributes to the expanding research on generative learning strategies in tertiary education and offers insights for effectively incorporating student explanation techniques in mathematics and statistics instruction.
MATHEMATICS EDUCATION, MONDAY 16:30-16:40 ROOM 260-115

Discrete Lyapunov functional for a system of differential equations with time-variable and state-dependent delay

Ábel Garab

[1]University of Szeged

Consider nonautonomous cyclic systems of delay differential equations of the form

$$\dot{x}^i(t) = f^i(t, x^i(t), x^{i+1}(t - \tau^i(t))) \qquad (0 \le i \le N),$$

with time variable delays $\tau^i(t)$ and where the coordinates i are meant modulo $N + 1$. Under suitable assumptions – including a feedback condition in the third variable – we define an (integer valued) Lyapunov functional, related to the number of sign-changes on certain intervals of the coordinate functions x^i of solutions. Moreover, we prove that this functional possesses properties known from the constant delay case [2] and from the scalar case (i.e. $N = 0$) with negative feedback [1]. The results can be applied to equations with state-dependent delays, as well. Joint work with István Balázs (University of Szeged).

References

[1] T. Krisztin, O. Arino, The two-Dimensional attractor of a differential equation with state-dependent delay, *J. Dyn. Differerential Equations*, **Vol. 13, No. 3** (2001), 453–522.

[2] J. Mallet-Paret, G. Sell, Systems of differential delay equations: Floquet multipliers and discrete Lyapunov functions, *J. Differential Equations*, **125** (1996), 385-440.

Differential delay equations and their applications, Tuesday 15:00-15:25 Room 303-B05

Optimising workshop and problem design to maximise engagement and independent discovery

Sean Gardiner[1]

[1]University of New South Wales

Optimising workshop and problem design to maximise engagement and independent discovery
Engagement with mathematics through communication and outreach, Monday 16:00-16:25 Room 260-040

(Cancelled) q-central idempotents and radical classes of rings

Barry Gardner[1], *Elena Cojuhari*

[1]University of Tasmania

We examine connections between ring radicals and corners, subrings of the form eAe, where e is an idempotent of a ring A. Our principal focus is on idempotents which are q-central in the sense of T. Y. Lam. These latter are defined in terms of the Peirce decomposition, but an idempotent e of a ring A is q-central if and only if eAe is an endomorphic image of A via the map which sends each element a to eae. All radical classes are therefore hereditary for corners defined by q-central idempotents, though the analogous statement for idempotents in general is false. We explore conditions under which the radical of a ring contains all corners (or all those defined by certain types of idempotents) which are members of the radical class, and radical properties defined by the presence or absence of idempotents of various kinds.
Contributed Session B, Tuesday 14:30-14:55 Room 260-036

Critical speeding-up in high-dimensional dynamical percolation

Tim Garoni[1], *Eren Elci*

[1]Monash University

We study the autocorrelation time of the size of the cluster at the origin in discrete-time dynamical percolation. We focus on high-dimensional tori, and show that the autocorrelation time is linear in the volume in the subcritical regime, but strictly sublinear in the volume at criticality. This establishes rigorously that the cluster size at the origin in these models exhibits

critical speeding-up. The proof involves controlling relevant Fourier coefficients, which we do by employing a randomised algorithm argument introduced by Schramm and Steif in the context of noise sensitivity.

Probability and Mathematical Statistics, Wednesday 11:00-11:25 Room 260-098

Duality for ASEP on the half line

Cengiz Gazi[1]

[1]Melbourne University

We consider the Asymmetric Simple Exclusion Process (ASEP) on the half line with open boundaries where a particle can enter with rate α if the boundary site is free and if it is occupied then it can exit with rate γ. We are interested in the moments of the total number of particles at time t. We explain in detail how a duality argument allows us to calculate these observables.

Mathematical Physics, Tuesday 15:00-15:25 Room 260-221

Length-constrained elastic flow of planar curves inside cones

Mashniah Gazwani[1], *James A. McCoy*[1]

[1]University of Newcastle

We study families of smooth, embedded, regular planar curves $\alpha : [-1, 1] \times [0, T) \to \mathbb{R}^2$ with generalised Neumann boundary conditions inside cones, satisfying the fourth-order nonlinear L_2- gradient flow for the elastic energy and elastic flow with fixed length. For general initial data, we show that a smooth solution exists for all time, provided neither end reaches the cone tip. For cone angles not too large and with suitable smallness conditions on $\|ks\|_{22}$ of the initial curve, we prove smooth exponential convergence of solutions in the C^∞-topology to particular circular arcs.

Contributed Session B, Friday 11:30-11:55 Room 260-028

Dynamics of a state-dependent delay-differential equation

Tomas Gedeon[1], *Anthony Humphries*[2], *Michael Mackey*[2], *Hans-Otto Walther*[3], *Zhao Wang*[2]

[1]Montana State University, [2]McGill University, [3] Universität Giessen

In this paper we present a detailed study of a scalar differential equation with threshold state-dependent delayed feedback. This equation arises as a simplification of Goodwin models of both inducible and repressible operons with state-dependent delays. There are two monotone

nonlinearities in the model: one describes the dependence of delay on state, and the other is the feedback nonlinearity. Both increasing and decreasing nonlinearities are considered. Our analysis is exhaustive both analytically and numerically as we examine the bifurcations of the system for various combinations of increasing and decreasing nonlinearities. We identify rich bifurcation patterns including Bautin, Bogdanov-Takens, cusp, fold, homoclinic, and Hopf bifurcations whose existence depend on the derivative signs of nonlinearities. Our analysis confirms many of these patterns in the limit where the nonlinearities are switch-like and change their value abruptly at a threshold. Perhaps one of the most surprising findings is the existence of a Hopf bifurcation to a periodic solution when the nonlinearity is monotone increasing but the time delay is a decreasing function of the state variable–something that is impossible in the case of a constant delay.
Differential delay equations and their applications, Monday 16:00-16:25 Room 303-B05

Long-time Behaviour of Stochastic Heat Equations in the Hyperbolic Space

Xi Geng[1]

[1]The University of Melbourne

In this talk, we investigate the long-time behaviour of stochastic heat equations in the hyperbolic space with regular Gaussian potentials. We discuss both moment and almost-sure asymptotics with emphasis on understanding how the geometry of the underlying space interplays with large-scale properties of the dynamics. This is based on joint works with Weijun Xu (Peking University), Cheng Ouyang (University of Illinois at Chicago) and my PhD student Sheng Wang.
Stochastic Differential Equations, Monday 14:30-14:55 Room 260-016

On Fourier-Stieltjes Algebras of Locally Compact Groupoids

Joseph DeGaetani, **Mahya Ghandehari**

[1]State University of New York at Oswego, [2]University of Delaware

The Fourier transform and its analogues are the cornerstone of classical harmonic analysis. In the absence of Fourier transform in the general non-commutative setting, function algebras related to Fourier analysis (and representation theory) of non-Abelian groups have been seriously studied. The Fourier algebra and Fourier-Stieltjes algebra, which are associated with the regular representation and universal representation of the ambient group respectively, are fundamental examples of such function algebras. The definition of these function algebras has been extended to important classes of locally compact groupoids. In this talk, we discuss some Banach algebraic behaviors of the Fourier and Fourier-Stieltjes algebra of various classes of locally compact groupoids, and show how these algebras enjoy certain functorial properties. This talk is based on a joint work with J. DeGaetani.
Functional Analysis and Operator Algebras, Wednesday 10:30-10:55 Room 260-055

Arithmetic of automorphic forms on quaternion algebras

Alex Ghitza[1], *Yiannis Fam*[2]

[1]University of Melbourne, [2]Imperial College

Serre found an elegant connection between modular forms with coefficients in a finite field of characteristic p and certain function spaces arising from the rational quaternion algebra ramified at p and ∞. Although his work has been repeatedly and vastly generalised, these results lack much of the explicit nature of the original approach. We report on a recent generalisation where the rational quaternion algebra is allowed to ramify at an arbitrary odd number of primes and ∞. On the geometric side, the modular curves are replaced by Shimura curves. The emphasis of the talk will be on the quaternionic side, where we aim to give a precise description of the structure of the relevant function spaces.
Arithmetic Geometry and Number Theory, Wednesday 11:30-11:55 Room 405-430

Robust chaos in piecewise-linear maps

Indranil Ghosh[1], *David Simpson*[1]

[1]Massey University

The two-dimensional border-collision normal form is a family of piecewise-linear maps exhibiting chaotic attractors robustly. In this talk, I will show how computational methods based on renormalisation can be used to explain changes to the topology of these attractors. Specifically, we compute curves of codimension-one bifurcations where the number of connected components of the attractor doubles (or halves) by finding zeros of functions composed with a renormalisation operator. The functions correspond to homoclinic or heteroclinic bifurcations depending on whether the maps are orientation-preserving, orientation-reversing, or non-invertible. We also show the bifurcation curves can be detected by brute-force numerical computations of the attractor. Specifically, we use a little-known numerical method of Eckstein and Avrutin that estimates the number of connected components from common factors in return times. I will also show how robust chaos can be verified formally in higher-dimensional families of piecewise-linear maps.
Computational Methods and Applications of Dynamical Systems, Friday 14:00-14:25 Room 303-G20

Evolution of time-fractional stochastic hyperbolic diffusion

Quoc Thong Le Gia[1], *Tareq Alodat*[2], *Ian Sloan*[1]

[1]University of New South Wales, Sydney, [2]La Trobe University

We examines the temporal evolution of a two-stage stochastic model for spherical random

fields. The model uses a time-fractional stochastic hyperbolic diffusion equation, which describes the evolution of spherical random fields on the unit sphere in time. The diffusion operator incorporates a time-fractional derivative in the Caputo sense. In the first stage of the model, a homogeneous problem is considered, with an isotropic Gaussian random field on the unit sphere serving as the initial condition. In the second stage, the model transitions to an inhomogeneous problem driven by a time-delayed Brownian motion on the sphere. To obtain an approximation, the expansion of the solution is truncated at a certain degree of spherical harmonics. The analysis of truncation errors reveals their convergence behavior, showing that convergence rates are affected by the decay of the angular power spectra of the driving noise and the initial condition. To illustrate the theoretical findings, numerical examples and simulations inspired by the cosmic microwave background (CMB) are presented.
Stochastic Differential Equations, Wednesday 10:30-10:55 Room 260-016

Bayesian inference calibration of the modulus of elasticity

Quoc Thong Le Gia[1], *Josef Dick*[1], *Kassem Mustapha*[1]

[1]University of New South Wales, Sydney

In this work, we use the Bayesian inference technique to determine the Young modulus based on the linear elasticity equation with random Young modulus. The random Young modulus is approximated by a finite Karhunen Loéve expansion, while the solution to the linear elasticity equation is approximated by the finite element method. The high dimensional integral involving the posterior density and the quantity of interest is approximated by a higher-order quasi-Monte Carlo method.
Computational Mathematics, Friday 15:00-15:25 Room 402-231

Arithmetic geometry of additive character varieties

Stefano Giannini[1]

[1]The University of Queensland

We aim to understand the cohomology of character varieties associated to surface groups. These varieties have deep connections to various fields of mathematics and physics, including non-abelian Hodge theory, mirror symmetry, Yang-Mills theory, and the Langlands program. Understanding their geometry is therefore an important problem. These spaces may be studied via their additive counter parts. We discuss some recent results concerning the cohomology of additive character varieties. This talk contains recent work with Masoud Kamgarpour, GyeongHyeon Nam and Bailey Whitbread found in our preprint https://arxiv.org/abs/2409.04735.
Arithmetic Geometry and Number Theory, Monday 14:15-14:25 Room 405-430

Vertex model constructions of symmetric functions and exclusion processes

Jan de Gier[1]

[1]University of Melbourne

Macdonald symmetric functions can be elegantly constructed as statistical mechanical partition functions of Yang-Baxter solvable vertex models, and used to derive dualities and describe stationary measures of integrable exclusion processes. I will discuss recent progress on other types of symmetric functions that can be employed to derive transition probabilities for exclusion processes with particle non-conserving boundaries.

Discrete and continuous integrable systems: geometry analysis and applications, Monday 14:00-14:50 Room 260-036

Master stability curves for traveling waves

Andrus Giraldo[1], *Stefan Ruschel*[2]

[1]Korea Institute for Advanced Study, [2]University of Leeds

Studying the existence and stability of periodic traveling waves in networks of ordinary differential equations (such as discrete rings and lattices) is a challenging problem to tackle when dealing with a large number of nodes. In this talk, we will present a theoretical and numerical framework for effectively determining the spectrum and stability of such waves in networks with Z_n-equivariance. In this framework, a delay-advance differential equation (master equation) is derived and used to set up a suitable two-point boundary problem (2PBVP) that captures the stability of the wave in the network. Since the defined 2PBVP is independent of the network size, it is suitable for numerical continuation. In this way, we compute a master stability curve containing the spectrum of the traveling wave, which also captures its spectrum when embedded in even larger networks with higher wavenumber. Thanks to this stability curve, instability and multistability in networks can be understood by varying the wave number as a continuous parameter and observing crossings of the master stability curve with the imaginary axis. To showcase our framework, we consider a dissipatively coupled ring of Fitzhugh-Nagumo oscillators and study the coexistence of different attracting traveling waves at different network sizes.

Computational Methods and Applications of Dynamical Systems, Monday 16:30-16:55 Room 303-G20

Representation theory of crystallographic groups and combinatorics of interlocking assemblies

Tom Goertzen

[1]The University of Sydney

Planar crystallographic groups act naturally on the Euclidean plane, and their action can be extended to three-dimensional space. This extension leads to new geometric structures through the deformation of fundamental domains, yielding higher-dimensional crystallographic space groups. A notable feature of these structures is the emergence of interlocking mechanisms, where the immovability of certain blocks is enforced by their neighboring blocks. In this talk, we will present how this phenomenon can be analyzed using the Lie algebra se(3) and its action on three-dimensional space. Specifically, we show that the convex set of admissible infinitesimal motions is reduced to the zero vector, implying the rigidity of the structure. We will cover foundational aspects of crystallographic groups and their representations, introducing interlocking assemblies and exploring their relevance across various scientific fields. Additionally, we will demonstrate how these geometric structures give rise to intriguing combinatorial problems involving lozenges, tilings, and graphs.
Representation Theory and Tensor Categories, Monday 16:00-16:25 Room 303-G14

The q-Onsager algebra and the quantum torus

Owen Goff[1]

[1]University of Wisconsin-Madison

$$(1-q+q^5-2q^6+2q^7-q^8+q^{12}-q^{13})/(1-q)(1-q^4)(1-q^6)(1-q^8)$$

has only non-negative terms.
Special Functions, q-Series and Beyond, Wednesday 11:30-11:55 Room 401-312

The complexity of unfriendly partitions in countable graphs

Jun Le Goh[1], *David Belanger[2]*, *Vittorio Cipriani[3]*, *Sanjay Jain[1]*, *Linus Richter[1]*, *Frank Stephan[1]*

[1]National University of Singapore, [2]Nanyang Technological University, [3]Vienna University of Technology

Every finite graph admits an unfriendly partition, that is, a bipartition of its vertices such that every vertex has at least as many neighbors in the opposite partition as it has in its own partition. It remains open whether every countable graph has an unfriendly partition. We investigate effective aspects of this problem. We construct a computable graph with an unfriendly partition

(using work of Berger), all of whose unfriendly partitions compute all hyperarithmetic sets. This is essentially best possible from the perspective of Turing complexity. On the other hand, every computable rayless graph must have a hyperarithmetic unfriendly partition (effectivizing work of Bruhn, Diestel, Georgakopoulos, Sprüssel). We show this is optimal in the sense that for every hyperarithmetic set A, there is a computable rayless graph, all of whose unfriendly partitions compute A. It follows that the statement “every rayless graph has an unfriendly partition” is a theorem of hyperarithmetic analysis.
Computability Theory and Applications, Thursday 11:30-12:20 Room 303-B07

From micro to macro in modeling sea ice

Kenneth Golden[1]

[1]University of Utah

Polar sea ice forms a key component of Earth’s climate system. As a material it exhibits composite structure on many length scales. A principal modeling challenge is how to use information on small scale structure to find the effective or homogenized properties on larger scales relevant to climate and ecological models. From tiny brine inclusions to ice pack dynamics on oceanic scales, and from microbes to polar bears, we’ll tour recent advances in modeling sea ice and the ecosystems it hosts. We’ll encounter many areas of mathematics, including fractal geometry, percolation, random matrix theory, topological data analysis, and uncertainty quantification for dynamical systems.
Mathematical methods in continuum mechanics and wave theory, Tuesday 14:00-14:50 Room 401-307

Differentiability of transition semigroup of generalized Ornstein-Uhlenbeck process: a probabilistic approach

Beniamin Goldys[1]

[1]The University of Sydney

We will derive a probabilistic formula for the gradient of the transition semigroup of a linear stochastic differential equation on a Banach space.
Stochastic Differential Equations, Thursday 11:30-11:55 Room 260-016

Infinitesimal Homeostasis

Marty Golubitsky[1]

[1]The Ohio State University

Homeostasis is a regulatory mechanism that keeps a specified variable x approximately constant as an input parameter I is varied. Infinitesimal homeostasis can be rigorously formulated when the model has a stable equilibrium. Here, infinitesimal homeostasis can be defined as x'(I) = 0 at the equilibrium. Combining this approach with graph-theoretic ideas from combinatorial matrix theory provides a systematic framework for calculating infinitesimal homeostasis points in models and classifying different homeostasis types in input-output networks. This theory extends to homeostasis patterns, defined as a set of nodes that are simultaneously infinitesimally homeostatic. We discuss why each homeostasis type leads to a distinct homeostasis pattern. The various notions will be illustrated in terms of 3-node input-output networks of ODEs.
Ergodic Theory and Dynamical Systems, Thursday 12:00-12:25 Room 303-G23

Existence of non convex V-states

Javier Gomez-Serrano[1]

[1]Brown University

V-states are uniformly rotating vortex patches of the 2D Euler equation. The only known explicit examples are circles and ellipses: the rest of positive existence results use local or global bifurcation arguments and don't give any quantitative information of the solutions. In this talk I will prove the existence of solutions far from the perturbative regime, being able to extract nontrivial features of them and a precise quantitative description. The proof uses a combination of analysis and computer-assisted techniques. Joint work with Gerard Castro-López.
Recent advances in mathematical fluid dynamics, Thursday 11:30-11:55 Room 401-311

Dirichlet-to-Neumann Operators via Layer Potentials

Simon Goodwin[1]

[1]University of Auckland

The Dirichlet to Neumann operator combines two ubiquitous problems in partial differential equations, the Dirichlet and Neumann problems. Let $\Omega \subset \mathbb{R}^d$ be a domain with boundary Γ and let $\phi, \psi \in L_2(\Gamma)$. We define the Dirichlet to Neumann operator, $\mathcal{N}$, by letting $\mathcal{N}\phi = \psi$ if and only if there exists a harmonic function in $H^1(\Omega)$ simultaneously solving the Dirichlet problem with boundary data ϕ and the Neumann problem with boundary data ψ. One well known method for solving the Dirichlet and Neumann problems is layer potentials. Using layer potentials, we have obtained results that relate $\mathcal{N}_i$, the interior Dirichlet-to-Neumann operator on a bounded domain Ω, to $\mathcal{N}_e$, the exterior Dirichlet-to-Neumann operator on the unbounded exterior domain $\mathbb{R}^d \setminus \overline{\Omega}$. We have shown that $\mathcal{N}_i - \mathcal{N}_e$ extends to a bounded operator on $L_2(\Gamma)$ when Ω is a C^2 domain. In addition, for all $\alpha \in (0, 1)$ we have constructed a $C^{1,\alpha}$ domain for which $\mathcal{N}_i - \mathcal{N}_e$ is unbounded with respect to the $L_2(\Gamma)$ norm. However, we have shown that $\mathcal{N}_i - \mathcal{N}_e$ is relatively compact, with respect to $\mathcal{N}_i$, for all C^1 domains. Lastly, we have shown that the domain of $\mathcal{N}_e$ is $H^1(\Gamma)$ for all Lipschitz domains. This is joint work with A.F.M. ter Elst

Functional analysis and partial differential operators, Tuesday 14:30-14:55 Room 260-020

Which trees are almost isomorphic to cocompact trees?

Roman Gorazd[1]

[1]University of Newcastle

Cocompact trees are trees that have finitely many orbits of their automorphism group. This allows us to easier describe actions of groups on these trees (for example, via local action diagrams). Relatively little is known about their almost structure. In this talk, I will describe these trees as unfolding trees of finite directed rooted graphs and introduce a labelling on graphs that determines when their unfolding trees are cocompact. This, together with previous work on almost isomorphic unfolding trees, shows what trees are almost isomorphic to cocompact trees.

Groups and Geometry, Tuesday 16:30-16:55 Room 260-092

Does self-paced online learning prepare a student for first-year mathematics?

Chris Gordon[1]

[1]Macquarie University

A significant number of students entering science and engineering majors do not have a sufficient level of mathematics from school to enter directly into their chosen disciplines. Macquarie University provides a unit which provides the pathway into the required mainstream mathematics units. This pathway mechanism has been provided to students in a traditional lecture/tutorial/exam format for decades. In 2022, the preparatory was repackaged into a form in which the passing and credit requirements of the unit were online with self-paced interactive learning modules and tests also online, with timing determined by each student. Assessments could be taken unlimited times. Lectures did not address this level of material. Students consolidated the module learning in a tutorial environment. Higher level grades were obtained from optional face-to-face lecture material, followed up by optional short hand written exams; the right to sit these exams required marks of 90% of the pass/credit online tests. We examine the impact on the performance of students in later mathematics units, compared with the performance of students who entered the regular mathematics units who did not have to undertake

the preparatory unit.
Mathematics Education, Tuesday 12:00-12:25 Room 260-115

Divisibility and ascending chains of principal ideals

Felix Gotti[1]

[1]MIT

We can use (principal) ideal theory as a convenient alternative language to approach questions about divisibility in commutative rings and monoids. In this talk, we will discuss some recent progress about ascending chains of principal ideals in the setting of integral domains. Our primary focus will be on the almost and quasi-ACCP, which are two generalizations of the ACCP (i.e., the ascending chain condition on principal ideals), which is a well-studied condition in ideal theory. Both generalizations are based on the existence of certain common divisors for finite sets, and so they are naturally related to divisibility theory. We will highlight some recent progress on these two variations of the ACCP in connection to factorization theory
50 years of Communications in Algebra, Tuesday 12:00-12:25 Room 303-G15

Conformal Yang-Mills renormalisation and higher Yang-Mills energies

Rod Gover[1]

[1]University of Auckland

Given a gauge connection on a Riemannian 4-manifold, the norm squared of its curvature gives a Lagrangian density whose integral is the Yang-Mills action/energy – the variation of which gives the celebrated Yang-Mills equations. An important feature of both this energy and the equations is their conformal invariance in dimension 4. A natural question is whether there are analogous objects in higher dimensions. We prove that there are such conformally invariant objects on even dimensional manifolds equipped with a connection. One proof, in dimension six, uses a type of Q-curvature that one can associate to connections, and we investigate applications of the result to conformal gravity type equations. Another proof uses a Poincare-Einstein manifold in one higher dimension and a suitable Dirichlet problem for the interior Yang-Mills equations on this structure. The higher Yang-Mills equations arise from an obstruction to smoothly solving the asymptotic problem, while the higher energy is a log term (the so-called anomaly term) in the asymptotic expansion of the divergent interior energy. More arises including links to the non-local renormalised Yang-Mills energy, and a related higher non-linear Dirichlet-Neumann operator. This is joint work with Emanuele Latini, Andrew Waldron, and Yongbing Zhang.
Index Theory in Geometry and Mathematical Physics, Monday 14:00-14:25 Room 260-022

Recent advances on the Adaptive Eigenspace Inversion method: Bayesian formalism

Marie Graff[1], *Bamdad Hosseini*[2]

[1]University of Auckland, [2]University of Washington

Parameter estimation is a fundamental task in engineering and science such as medical imaging and seismology. The aim of imaging is to infer characteristics of a medium from indirect measurements. Imaging problems are often cast as PDE-constrained optimization problems that are typically ill-posed in the sense of Hadamard. Therefore, regularisation is needed to define a well-posed problem and stabilise the solution. We propose to analyse and extend a novel regularisation technique called Adaptive Eigenspace Inversion (AEI).We develop a probabilistic analogue of the method using the Bayesian formalism to bring uncertainty quantification to our reconstruction using AEI. The method has been adapted to include the prior distribution, which also enhances the performance and relaxes the choice of the regularisation parameters. Numerical tests are performed on inverse source problems for the Helmholtz equation.
Stochastic and Deterministic Inverse Problems, Monday 16:30-16:55 Room 260-223

Embedding uncountable partial orderings into the Turing degrees

Noam Greenberg[1]

[1]Victoria University of Wellington

Sacks asked whether every partial ordering of size at most continuum that has the countable predecessor property is embeddable into the Turing degrees. To this day, very little progress has been made. Recent work of Higuchi and Lutz gives a partial explanation why: even a simple example has no Borel embedding. In joint work with J. Miller, we extend the known positive examples by showing that the 3-layer "saturated" partial ordering with first layer having size $\aleph_1$, is embeddable into the Turing degrees.
Computability Theory and Applications, Tuesday 14:00-14:25 Room 303-B07

Computational algebraic geometry for evolutionary biology

Travis Barton[4], **Elizabeth Gross**[1], *Colby Long*[3], *Joseph Rusinko*[2]

[1]University of Hawai'i At Mänoa, [2]Hobart and William Smith Colleges, [3]College of Wooster, [4]Meta

A main goal of phylogenomics is to understand the evolutionary history of a set of species. These histories are represented by directed graphs where the leaves represent living species and the interior nodes represent extinct species. While it is common to assume the evolutionary history is a tree, when events such as hybridization are present, networks are more realistic. However,

allowing for networks, rather than simply trees, complicates the process of inference. One recent approach to phylogenetic network inference is rooted in computational algebraic geometry. In this talk, we discuss the role computational algebraic geometry and symbolic computation has played in the statistical problems related to network inference with a focus on problems related to identifiability and model selection.
Computations and applications of algebraic geometry and commutative algebra, Thursday 12:00-12:25 Room 303-B05

Quadratic fusion categories

Pinhas Grossman[1]

[1]UNSW Sydney

A fusion category is a tensor category which "looks like" a category of representations of a finite group; or dually, like a category of vector spaces graded by a finite group. In addition to finite groups, fusion categories arise in the representation theory of quantum groups at roots of unity. Quadratic fusion categories are a class of fusion categories of which a number of examples are known to exist through ad hoc constructions, but whose general theory is not well understood. This talk will describe work-in-progress on the construction and classification of certain families of quadratic categories. This is joint work with Masaki Izumi.
Representation Theory and Tensor Categories, Thursday 14:00-14:25 Room 303-G14

Connecting the Dots

Patrick Guidotti[1]

[1]University of California Irvine

We revisit the well-known kernel method of interpolation and, by taking a slightly unusual point view, show how it can be used (and modified in a natural way) for the purpose of gaining insight into the (geometric) structure of scattered (possibly noisy) data points such as point clouds. One of the advantages of the method is that it is global and does not require any direct explicit understanding of data points neighborhoods.
Functional analysis and partial differential operators, Tuesday 11:30-12:20 Room 260-020

Fully-connected lattice models and 3-manifolds

Sergei Gukov[1]

[1]Caltech

In this talk, I will describe a new class of lattice models on graphs which naturally emerge in the study of 3-manifold invariants and logarithmic vertex algebras. On the one hand, these models can be viewed as generalizations of N-state Potts models, where N is allowed to be infinite, and all interactions are long-range. Their mathematics is described by representation theory of quantum groups at generic values of the parameter q. On the other hand, state sums in such models turn out to be characters of logarithmic vertex algebras (log-VOAs), where the choice of a graph (or, a lattice) determines log-VOA. When the graph is a plumbing graph of a 3-manifold, the state sum gives a 3-manifold invariant related to the lattice homology.
Mathematical Physics, Monday 14:00-14:50 Room 260-221

Learning Green's functions from data

Jiading Liu[1], *Hien Nguyen*[2, 3], **Xin Guo**[1], *Lei Shi*[4, 5]

[1]The University of Queensland, [2]La Trobe University, [3]Kyushu University, [4]Fudan University, [5]Shanghai Artificial Intelligence Laboratory

We studied the problem of learning the Green's functions of partial differential equations from data, through reproducing kernel methods. With the help of a novel kernel design, we derived an algorithm of time complexity $O(m^3 + m^2N)$ only, where N was the size of training sample, and m was the number of grid points. We demonstrated that the kernel we designed could safely replace general kernels without constraining the hypothesis spaces. Minimax lower bound and upper bound of learning rates were derived.
Stochastic and Deterministic Inverse Problems, Monday 14:00-14:25 Room 260-223

Capacity dependent analysis for functional online learning algorithms

Xin Guo[1], *Zheng-Chu Guo*[2], *Lei Shi*[3, 4]

[1]The University of Queensland, [2]Zhejiang University, [3]Fudan University, [4]Shanghai Artificial Intelligence Laboratory

This research provides convergence analysis of online stochastic gradient descent algorithms for functional linear models. Adopting the characterizations of the slope function regularity, the kernel space capacity, and the capacity of the sampling process covariance operator, significant improvement in the convergence rates is achieved. Both prediction problems and estimation problems are studied, where we show that capacity assumption can alleviate the saturation of the convergence rate as the regularity of the target function increases. We show that with a properly selected kernel, capacity assumptions can fully compensate for the regularity assumptions for prediction problems (but not for estimation problems). This demonstrates the significant difference between the prediction problems and the estimation problems in functional data analysis.
Recent developments in data science and machine learning, Friday 14:30-14:55 Room 402-220

Online Learning in Reproducing Kernel Hilbert Space

Zhengchu Guo[1]

[1]Zhejiang University

Analyzing and processing large-scale data sets is becoming ubiquitous in the era of big data. Online learning has attracted increasing interest in recent years due to its low computational complexity and storage requirements, it has been applied to various learning tasks. In this talk, we will present some results of online learning algorithms in reproducing kernel Hilbert space. This talk is based on joint work with Prof. Lei Shi and Prof. Andreas Christmann and Prof. Yunwen Lei.

Recent developments in data science and machine learning, Thursday 14:30-14:55 Room 402-220

Global solutions to 3D quadratic nonlinear Schrödinger-type equation

Zihua Guo[1]

[1]Monash University

We consider the Cauchy problem to the 3D fractional Schrödinger equation with quadratic interaction of $u\bar{u}$ type. We prove the global existence of solutions and scattering properties for small initial data. This is a joint work with Naijia Liu and Liang Song.

Deterministic and Probabilistic Aspects of Dispersive Partial Differential Equations, Friday 14:00-14:50 Room 260-022

Nonlinear Reconstruction of Optical Parameters in Photoacoustic Tomography

Madhu Gupta[1], *Rohit Kumar Mishra*[2], *Souvik Roy*[3]

[1]Flame University, [2]IIT Gandhinagar, [3]The University of Texas at Arlington

We will discuss an optimization framework for solving an inverse problem aimed at reconstructing the single-photon and two-photon absorption coefficients in photoacoustic computed tomography. The framework comprises of minimizing an objective functional involving least squares fit of the interior pressure field data corresponding to two boundary source functions, where the absorption coefficients and the photon density are related through a semi-linear elliptic partial differential equation (PDE) arising in photoacoustic tomography. The objective functional consists of an L1-regularization term that promotes sparsity patterns in absorption coefficients and H1-regularizer to reduce the artifacts in the reconstruction. We provide a proof of existence and uniqueness of a solution to the semi-linear PDE. Further, a proximal method, involving a Picard solver for the semi-linear PDE and its adjoint, is used to solve the optimiza-

tion problem. Several numerical experiments are presented to demonstrate the effectiveness of the proposed framework. We will conclude the presentation by discussing another framework where the minimizing functional consists of fractional Sobolev norm of absorption coefficient and diffusion coefficient as a regularizer for better reconstruction.
Stochastic and Deterministic Inverse Problems, Monday 14:30-14:55 Room 260-223

Some remark about relative entropy method for long time asymptotic in fluid dynamics

Piotr Gwiazda[1]

[1]University of Warsaw

The talk will consist two topics, connected thru methodology. The first one will be application of relative entropy method to passage from compressible euler to porous media equation in high friction and long time asymptotic. In second part of the talk we will prove convergence of solution to compressible Navier Stokes equation to some steady solutions in long time asymptotics
Recent advances in mathematical fluid dynamics, Wednesday 11:30-11:55 Room 401-311

Nonlinear backward diffusion, an exact solution, and regularisation options

Bronwyn Hajek[1], *Tom Miller, Robert Marangell, Martin Wechselberger*

[1]University of South Australia

Nonlinear reaction-diffusion equations are used widely to model many different systems and processes, particularly in biology. In particular, backward diffusion, where the nonlinear diffusivity is negative for a range of densities, is sometimes used to model aggregation and can produce sharp travelling fronts and shocks in the solution. In this talk, I'll show how a nonclassical symmetry can be used to construct an analytic shock-fronted solution. The solution is multi-valued in a narrow region which can be resolved by inserting a shock where the location of the shock is determined by a new shock condition. The nonlinear reaction-diffusion equation can also be regularised, and geometric singular perturbation theory (GSPT) can be used to show that the new shock selection rule is equivalent to both a nonlinear regularisation and a composite regularisation, and the correct travelling wave speed can be predicted.
Mathematics of nonlinear diffusion processes, Tuesday 11:30-12:20 Room 260-018

Arriving on Time: Punctuality in Structures, Isomorphisms and 1-Decidability

Ellen Hammatt[1]

[1]Victoria University of Wellington

In this talk we investigate what happens when we take concepts from computable structure theory and forbid the use of unbounded search. In other words, we discuss the primitive recursive content of structure theory. This central definition is that of punctual structures, introduced by Kalimullin, Melnikov and Ng in 2017. We investigate various concepts from computable structure theory in the primitive recursive case. For example, categoricity, finite dimension and 1-decidability. A common theme is that new techniques are required in the primitive recursive case. We also discuss a degree structure within punctual presentations which is induced by primitive recursive isomorphisms. This degree structure offers interesting insight into the use of unbounded search. In particular we consider lattice embeddings into the punctual degrees of various linear orders. We highlight the complexity of the punctual degrees of the dense linear order. This is perhaps surprising for computable structure theorists due to the simplicity of its computable presentations.

Computability Theory and Applications, Thursday 14:00-14:25 Room 303-B07

Extending the Torelli map to alternative compactifications of the moduli space of curves

Changho Han[1]

[1]Korea University

It is well-known that the Torelli map, that turns a smooth curve of genus g into its Jacobian (a principally polarized abelian variety of dimension g), extends to a map from the Deligne—Mumford moduli of stable curves to the moduli of semi-abelic varieties by Alexeev. Moreover, it is also known that the Torelli map does not extend over the alternative compactifications of the moduli of curves as described by the Hassett—Keel program, including the moduli of pseudostable curves (can have nodes and cusps but not elliptic tails). But it is not yet known whether the Torelli map extends over alternative compactifications of the moduli of curves described by Smyth; what about the moduli of curves of genus g with axis-like singularities? As a joint work with Jesse Kass and Matthew Satriano, I will describe moduli spaces of curves with axis-like singularities and describe how far the Torelli map extends over such spaces into the Alexeev compactifications.

Computations and applications of algebraic geometry and commutative algebra, Friday 14:30-14:55 Room 303-B05

Challenges in modelling particle laden flow as a continuum in an inertial microfluidics setting

Brendan Harding[1]

[1]Victoria University of Wellington

Inertial particle migration is a phenomena which causes particles to migrate across streamlines and is observed in a number of microfluidic settings. The effect arises from the finite size of particles, causing a disturbance of the surrounding fluid which, in turn, has an action back on the particles. Developing models of this which are accurate in a broad range of circumstances has proven challenging, largely owing to difficulties in using a continuum treatment of particles. I will talk through some of the different approaches that have been tried and the general direction in which studies appear to be headed.

Mathematical methods in continuum mechanics and wave theory, Friday 15:00-15:25 Room 401-307

The Goldbach-Vinogradov theorem with restricted primes

Michael Harm[1]

[1]UNSW

Assume GRH. We prove that any sufficiently large, odd integer N is the sum of three primes, one of which is smaller than some small power of $\log N$. Results of this type can be viewed as an approximation to the still widely open binary Goldbach Problem.

Arithmetic Geometry and Number Theory, Monday 15:15-15:25 Room 405-430

Interpolation Categories for Classical Groups

Nate Harman[1], *Andrew Snowden*

[1]University of Georgia

Deligne defined certain tensor categories “interpolating” the representation theory of symmetric groups. Knop extended this framework to other families of finite groups including the family of general linear groups over a finite field, however his approach does not apply to other families of classical groups of Lie type. I will discuss using oligomorphic groups to construct interpolating categories of representations for symplectic, orthogonal, and unitary groups over a finite field and how this compares to other constructions.

Representation Theory and Tensor Categories, Wednesday 11:30-11:55 Room 303-G14

Calculating Minimum Volume Covering Ellipsoids Using Leverage Score Sampling

Elizabeth Harris[1]

[1]University of Newcastle

The Minimum Volume Covering Ellipsoid (MVCE) problem seeks to find the ellipsoid of minimum volume covering a set of n data points in d-dimensional Euclidean space. Although solution algorithms exist for the MVCE problem, computation times can be very expensive when n and d are large. Using leverage score sampling, we reduce the number of points considered by the algorithm, and hence speed up computation times. Additionally, under some conditions, we can prove that the computed solution is close to the exact solution.
Computational Mathematics, Tuesday 14:30-14:55 Room 402-231

Scott complexity of linear orders

Matthew Harrison-trainor[1]

[1]University of Illinois Chicago

Scott showed that every countable structure is characterized up to isomorphism by a sentence of infinitary logic. The Scott complexity of a structure is the least complexity of a Scott sentence for that structure, and measures not only the difficulty of describing the structure but also equivalently the complexity of the automorphism orbits. In this talk I will explain why linear orders have two particularly interesting properties which make their behaviour quite different from structures in general while still highly non-trivial.
Computability Theory and Applications, Monday 14:30-15:20 Room 303-B07

History of the Tangent: al-Biruni and his Shadows

Nathan Hartmann[1]

[1]University of Canterbury

The history behind the tangent is extensive. Long before it was known as a trigonometric function, shadows found from sundials were used in its place for astronomical purposes, relying on differing lengths to determine time of day and the time of year. This talk focuses on one pivotal episode in the story behind the tangent, focusing on Medieval Islamicate polymath al-Bīrūnī (973CE - c. 1050) and his works on shadows. We examine two tables that he made, found in the 12th Chapter of The Exhaustive Treatise on Shadows and The Mas'ūdī Canon. This research is conducted under the supervision of Clemency Montelle and Glen Van Brummelen.
Contributed Session A, Tuesday 14:30-14:55 Room 260-016

Non-Markovian models of collective dynamics

Jan Haskovec[1]

[1]King Abdullah University of Science And Technology

I will give an overview of recent results for models of collective behavior governed by functional differential equations with non-Markovian structure. The talk will focus on models of interacting agents with applications in biology (flocking, swarming), social sciences (opinion formation) and engineering (swarm robotics), where latency (delay) plays a significant role. I will characterize two main sources of delay - inter-agent communications ("transmission delay") and information processing ("reaction delay") - and discuss their impacts on the group dynamics. I will give an ovierview of analytical methods for studying the asymptotic behavior of the models in question and their mean-field limits. In particular, I will show that the transmission vs. reaction delay leads to fundamentally different mathematical structures and requires appropriate choice of analytical tools. Finally, motivated by situations where finite speed of information propagation is significant, I will introduce an interesting class of problems where the delay depends nontrivially and nonlinearly on the state of the system, and discuss the available analytical results and open problems here.
Differential delay equations and their applications, Monday 16:30-16:55 Room 303-B05

Stochastic Landau-Lifshitz-Gilbert equations (SLLGEs) driven by a rough path

Erika Hausenblas[1]

[1]Montanuniversität Leoben

Physics Informed Deep Neural Networks (PIDNN) concept integrates physical laws with deep learning techniques to enhance the speed, accuracy and efficiency of the above mentioned problems. The main idea behind this concepts can be summarized as follows:
Stochastic Differential Equations, Monday 14:00-14:25 Room 260-016

Development in constructive Banach algebra theory

Robin Havea[1]

[1]University of The South Pacific

We take constructive mathematics in the Richman sense which is doing mathematics using intuitionistic logic. Working within the framework of Bishop-style constructive mathematics, we show some recent results on constructive Banach algebra theory. In particular, we discuss some relatively elementary results in Banach algebra theory without requiring either commutativity or existence of an involution. In order to recover constructively as much as possible of the classical

spectral mapping theorem, we touch on some preliminary materials on monoids, metric space topology and complex analysis. We show how challenging it can be when doing mathematics constructively as opposed to the classical approach to Banach algebra theory. We focus on state space, Hermitian, and positive elements of a Banach algebra.
Contributed Session B, Monday 14:30-14:55 Room 303-B05

A neural-network surrogate Bayesian algorithm for the Helmholtz inverse-shape problem

Stuart Hawkins[1]

[1]Macquarie University

We present a novel approach for the classical inverse problem of reconstructing the shape of a bounded object from scattered-field data obtained by illuminating the object with several incident plane waves. Our method is based on incorporating the data into a Bayesian framework, and sampling the resulting posterior probability distribution using a Markov Chain Monte Carlo (MCMC) method. The mathematical model associated with the forward problem is the Helmholtz equation, posed in the unbounded region outside the object, whose shape is parametrised by a vector in a high-dimensional space associated with the Bayesian prior distribution. The key to our method is to accelerate the MCMC sampling using an efficient surrogate for the forward problem. Our surrogate is based on a neural network, and we address the challenges of training the neural network on the high-dimensional prior space by exploiting rotational symmetries. We demonstrate the effectiveness of our method by reconstructing the shapes of a catalogue of challenging test scatterers.
Stochastic and Deterministic Inverse Problems, Friday 11:30-11:55 Room 260-040

Efficient Fibre Sampling for Statistical Linear Inverse Problems

Martin Hazelton[1]

[1]University of Otago

Modern methods of automated data collection often record what is easily measured rather than what we really want to know, resulting in statistical inverse problems. Inference typically involves sampling possible values for the latent variables of interest conditional on the indirect observations. This talk is concerned with linear inverse problems for count data, for which the latent variables are constrained to lie on a fibre comprising the integer lattice within a convex polytope. An illustrative example arises in transport engineering where we want to sample possible interzonal patterns of traffic flow consistent with traffic counts at various waypoints on a network. Other areas of application include estimation of non-compliance rates in biosecurity surveillance, contingency table resampling, multi-list problems in public health, and capture-recapture modelling in ecology. Sampling can be conducted using a random walk on the fibre. A major challenge is finding sampling directions sufficient to ensure connectivity of the walk. In principle this challenge can be addressed by employing Markov bases. In practice the mixing

properties of the sampler are highly dependent on the choice of Markov basis. This talk explores why this is the case, and describes some new results that can guide design of efficient samplers for certain types of model.
Recent developments in data science and machine learning, Tuesday 16:00-16:25 Room 402-220

Effective Whitney Stratification and Applications

Martin Helmer[1]

[1]North Carolina State University

In this talk I will describe two algorithms to compute Whitney stratifications of real and complex algebraic varieties. I will begin with an overview of how the structure of the conormal variety is related to this problem and how we can exploit this to give an algorithm to compute a Whitney stratification. The main computational step in this algorithm involves finding the associated primes of a polynomial ideal. I will then explore how this approach can be made more efficient by using techniques for equidimensional decomposition of varieties rather than computing the full set of associated primes. This modified algorithm will yield a quite significant speedup but may fail to produce a minimal Whitney stratification. Time permitting, I will additionally present an algorithm to coarsen any Whitney stratification of a complex variety to a minimal Whitney stratification. Finally I will illustrate applications of the methods to the study of Feynman integrals in mathematical physics. This talk contains content of three separate joint works, one with Vidit Nanda (Oxford), one with Rafael Mohr (Sorbonne Université), and one with Felix Tellander (Oxford) and Georgios Papathanasiou (City University, London).
Computations and applications of algebraic geometry and commutative algebra, Thursday 14:30-14:55 Room 303-B05

Perfect quantum strategies for XOR games

Bill Helton[1]

[1]University of California San Diego

The talk will describe some of the structure associated with 'perfect quantum strategies' for a class of cooperative games. In such problems one has a (noncommutative) algebra A which encodes quantum mechanical laws and a list of matrix equations. A solution to these amounts to a perfect quantum strategy; 1×1 matrix solutions give a perfect classical strategy. The focus will be on 3XOR games. There is now a way to determine if a perfect quantum strategy exists and construct it if it does. The core of the construction is a variant on the classical 3XOR SAT problem. The talk will describe current understanding of this variant, in particular the sharp transition between solvability and unsolvability as numbers of constraints vs unknowns vary. The work is joint with Adam Bene Watts , Zehong Zhao, Jared Huges and Daniel Kane.
Functional Analysis and Operator Algebras, Thursday 12:00-12:25 Room 260-055

The effect of incorporating infectious disease dynamics into a social cost–benefit framework for COVID-19 policy decisions

Shaun Hendy[1]

[1]Toha

The New Zealand Productivity Commission proposed a framework for cost–benefit analyses for policy decisions regarding COVID-19 responses. They illustrated this in a worked example, considering the New Zealand Cabinet's decision in April 2020 to extend alert level 4 restrictions by five days. In their analysis they compared the extension to a counterfactual scenario where alert level 3 is resumed immediately, finding that this scenario outperforms the extension made by Cabinet. However, using a simple extension of this method that better captures the stochastic dynamics towards the end of an outbreak, I find the opposite: Cabinet's decision significantly outperforms the counterfactual. I conclude that an improved treatment of disease dynamics better describes the costs and benefits of the policy choices facing Cabinet in April 2020. This improved framework or similar may be of use to future decision-makers.
Industrial Mathematics, Monday 14:00-14:25 Room 402-211

A monoid of infinitely generated projective modules and its applications to direct sum decompositions of modules

Dolors Herbera[1]

[1]Universitat Autònoma De Barcelona, [2]Centre de Recerca Matemàtica

In this talk I will describe a particular kind of monoid of isomorphism classes of countably generated projective modules. The initial idea to introduce it is to make a relative version of Bass' Big projective modules, that is, the countably generated projective modules we consider are big with respect to a trace ideal. There are interesting classes of rings such that all countably generated projective modules are relatively big as, for example, one sided noetherian PI rings. We will also present applications of the theory to infinite direct sum decompositions of suitable classes of modules. Particularly interesting is the class of the direct sum of finitely generated torsion-free modules over a commutative domain. The idea of considering these relatively big projectives goes back to work of P. Prihoda (2010), and in the talk we will survey on joint work with P. Prihoda and with R. Alvarez and P. Prihoda.
50 years of Communications in Algebra, Wednesday 11:00-11:25 Room 303-G15

Generic Upper Bounds of Cyclicity Problem

Yovani Adolfo Villanueva Herrera[1], *Warwick Tucker*[1]

[1]Monash University

Hilbert's 16th problem remains without a definitive solution, even for quadratic systems, and the center-focus problem has also proven elusive for polynomial vector fields of degree $n \geq 3$. In this lecture we provide novel results to get a local analytic first integral of a singularity at the origin, using Lyapunov formula and computer-assisted tools, for generic polynomial differential systems with center linearization in $\mathbb{R}^2$. From those results, upper bounds of the number of center conditions and small limit cycles are obtained in polynomial vector fields of any finite degree at the origin.
Computational Methods and Applications of Dynamical Systems, Friday 15:00-15:25 Room 303-G20

Concordances in Positive Scalar Curvature and Index Theory

Thorsten Hertl[1]

[1]University of Melbourne

Scalar curvature is a local invariant of a Riemannian manifold. It measures asymptotically the volume growth of geodesic balls. Understanding the topological space of all positive scalar curvature metrics on a closed manifold has been an active field of study during the last 30 years and Index Theory has been a major tool in this endeavour. So far, these spaces have been considered from an isotopy viewpoint. I will describe a new approach to study this space based on the notion of concordance. To this end, I construct with the help of cubical set theory a comparison space that only encodes concordance information and in which the space of positive scalar curvature metrics canonically embeds. After the presentation of some of its properties, I will show that the index difference, the most commonly used invariant in this discipline, factors through the comparison space using a new model of real K-theory that is based on pseudo Dirac operators.
Index Theory in Geometry and Mathematical Physics, Monday 14:30-14:55 Room 260-022

Redesigning First-Year Mathematics for Student Success

Poh Hillock[1]

[1]The University of Queensland

First-year mathematics should be a gateway to success, yet it is often an impediment to student progress. In this presentation, I share how the School of Mathematics at The University of Queensland has transformed first-year mathematics through a coordinated support network and course redesign, to enable student success. The support initiatives incorporate high-impact practices such as personalized and collaborative learning, while the course redesign offers flexibility and high-value on-campus experiences. Student engagement and outcomes have greatly improved, as reflected in quantitative data and feedback from staff and students.
Mathematics Education, Wednesday 10:30-10:55 Room 260-115

A projection-free method for solving convex bilevel optimization problems

Nam Ho-Nguyen[1]

[1]The University of Sydney

When faced with multiple minima of an inner-level convex optimization problem, the convex bilevel optimization problem selects an optimal solution which also minimizes an auxiliary outer-level convex objective of interest. Bilevel optimization requires a different approach compared to single-level optimization problems since the set of minimizers for the inner-level objective is not given explicitly. In this paper, we propose a new projection-free conditional gradient method for convex bilevel optimization which requires only a linear optimization oracle over the base domain. We establish $O(t^{-1/2})$ convergence rate guarantees for our method in terms of both inner- and outer-level objectives, and demonstrate how additional assumptions such as quadratic growth and strong convexity result in accelerated rates of up to $O(t^{-1}$ and $O(t^{-2/3})$ for inner- and outer-levels respectively. Lastly, we conduct a numerical study to demonstrate the performance of our method.

Optimisation, Wednesday 10:30-10:55 Room 402-221

Growth in the complexity of arithmetic invariants of 3-manifolds

Paul Fili, **Neil Hoffman**[1], *Kathleen Petersen*

[1]University of Minnesota Duluth

The trace field of a hyperbolic 3-manifold group is a number field generated by all traces of elements in the group. It remains an open question what fields arise as trace fields in this way. Recently, Garoufalidis and Jeon described the behavior of the trace field when Dehn filling a common manifold as parametrized by the slope of the Dehn filling. However, their results depend on assuming Lehmer's conjecture, a major unsolved question in number theory. Our results remove the dependence on Lehmer's conjecture, while also connecting growth in the degree of the trace field to other standard notions of complexity, e.g. the number of tetrahedra needed to triangulate the associated manifold. From this perspective, we can give recipes to get fast growth in the complexity of trace field while constraining the complexity of the manifold. This is joint work with Paul Fili and Kate Petersen.

Early Career Showcase in Low-Dimensional Topology, Friday 12:00-12:25 Room 260-073

Viscous Burgers' equation on the half-line

John Holmes[1]

[1]The Ohio State University

We investigate the well-posedness of the viscous Burgers' equation on the half-line using Fokas'

novel unified transform method. We show that the Cauchy problem is well posed for initial data $u_0(x) \in H^s(0,\infty)$ and boundary data $g_0(t) \in H^{(2s+1)/4}$ when $-1/2 < s < 0$. In particular, the solution $u \in C([0,T]; H^s(0,\infty)) \cap L^\infty((0,\infty); H^{(2s+1)/4})$. We establish this result by finding the correct subsets of H^s for which we can show appropriate linear and bi-linear estimates, and then apply the contraction mapping theorem for the solution operator constructed via the unified transform method. Our proof also shows that the solution, u, has the same regularity in the time variable as the boundary data, and is slightly smoother in the spatial variable then the initial data. It is known that index $s = -1/2$ is critical for the whole line problem; the Cauchy problem on the line is ill-posed for initial data below this index and well-posed for initial data at or above this index.
Harmonic analysis and Hamiltonian PDE, Thursday 14:00-14:25 Room 260-028

Partial differential equations from quantitative finance and their analysis

John Holmes[1]

[1]The Ohio State University

Mathematical finance develops and implements mathematical and statistical methods to analyze and model financial markets and investment strategies. For several decades, practitioners have found that problems in mathematical finance can be solved using partial differential equations (PDEs). Indeed, the connection between Brownian motion (often used to model financial assets) and PDEs has been known for over 100 years. In this talk, we will discuss how PDEs arise in mathematical finance and allow us to better understand risk in order to make better decisions. When modeling financial assets, such as stock prices, the domain of interest is naturally the positive real numbers. Therefore, a particularly relevant area of analysis of PDEs, are initial-boundary value problems on the half line. We will briefly discuss some recent advances in the mathematical theory of such problems, and how these new tools may be applicable to mathematical finance in the future.
Industrial Mathematics, Thursday 14:30-14:55 Room 402-211

All in!

Mark Holmes[1], *Omer Angel*[2]

[1]University of Melbourne, [2]University of British Columbia

A game involves 3 players, starting with amounts of money (stack sizes) x, y, z. At each step of the game two of the players are selected at random to bet on the outcome of a fair coin toss. The value of the bet is the minimum of their two stack sizes at that time (i.e. the player with less money is betting all of their money). We can continue this game until a player's stack size reaches 0. That player is declared the "loser". The other two players may continue until one of them (the "winner") has all the money. In this talk we will discuss some remarkable features of this very simple model. (Joint work with Omer Angel.)
Probability and Mathematical Statistics, Monday 14:00-14:25 Room 260-098

Generative probabilistic models for experimental design, teaching statistics and goodness of fit testing.

Susan Holmes[1]

[1]Stanford University

By linking conceptual theories with observed data, probabilistic generative models can support reasoning and learning in complex situations involving high levels of stochasticity. These generative models have come to play a central role both within and beyond statistics, providing the basis for power analysis in molecular biology, theory building in particle physics, and resource allocation in epidemiology. This talk will survey some applications of modern generative models and show how they inform experimental design, didactic engagement for non mathematicians, iterative model refinement, goodness-of-fit evaluation, and agent based simulation. We emphasize a modular view of generative mechanisms and discuss how they can be flexibly recombined in new problem contexts. This is joint work with Kris Sankaran that was recently published and for which practical illustrations are available at https://github.com/krisrs1128/generative_review
PROBABILITY AND MATHEMATICAL STATISTICS, MONDAY 14:30-14:55 ROOM 260-098

On Polynomial Functional Regression

Markus Holzleitner[1]

[1]MalGA center University of Genoa

Functional Regression (FR) revolves around datasets composed of functions sampled from a population. Most FR research is rooted in a modified version of the functional linear model initially introduced by Ramsay and Dalzell in 1991. Recently, Yao and Müller (2010) discussed a more expansive form of polynomial functional regression, highlighting quadratic functional regression as a prominent case. Constructing FR models entails addressing a pivotal challenge: the combination of information both across and within observed functions, denoted as replication and regularization by Ramsay and Silverman (1997). In this presentation, we will unveil a comprehensive approach for analyzing regularized polynomial functional regression of arbitrary order, by formulating it as an inverse problem. We will explore the potential utilization of a technique developed recently in the realm of supervised learning. Additionally, we will delve into the application of multiple penalty regularization within the FR framework, showcasing its advantages, and we also present a theoretically grounded strategy for dealing with the associated parameters. Finally, we will touch upon the application of FR in stenosis detection. This is based on joint work with Sergei Pereverzyev (RICAM, Linz).
RECENT DEVELOPMENTS IN DATA SCIENCE AND MACHINE LEARNING, WEDNESDAY 11:30-11:55 ROOM 402-220

Geometry, spectral analysis and inverse problems on gas giants

Maarten De Hoop[1]

[1]Rice University

On gas giant planets the speed of sound is isotropic and goes to zero at the surface. Geometrically, this corresponds to a Riemannian manifold whose metric tensor has a conformal blow-up near the boundary. The blow-up is tamer than in asymptotically hyperbolic geometry: the boundary is at a finite distance. We study the basic geometry of gas giant Riemannian metrics, including properties of geodesics near the boundary, the Hausdorff dimension of the boundary, and discreteness of the spectrum of the Laplace–Beltrami operator. We present the spectral analysis of this operator and derive the Weyl law. The involved exponents depend on the Hausdorff dimension which, in the supercritical case, is larger than the topological dimension. We solve two inverse problems for simple gas giants planets, proving that the metric is uniquely determined by its boundary distance data and that the geodesic ray transform is injective. The study of Weyl asymptotics, which reflects some properties of the singular metric, is a preliminary step towards analyzing other inverse problems. Joint research with Y. Colin de Verdière, C. Dietze, J. Ilmavirta, A. Kykkänen, R. Mazzeo and E. Trélat.
Microlocal analysis and inverse problems, Monday 14:00-14:50 Room 260-009

Solving inverse problems using transport maps

Bamdad Hosseini[1]

[1]University of Washington

In this talk I will discuss various theoretical and algorithmic aspects of recent methods for likelihood-free solution of inverse problems using measure transport. In particular, I will introduce the idea of triangular transport maps and their characterization from various aspects including optimal transport. Then I will present various algorithms that enable efficient computation of such maps for some interesting applications in solving inverse problems.
Stochastic and Deterministic Inverse Problems, Friday 14:30-14:55 Room 260-040

Essential checkerboard surfaces for some m-almost alternating links

Joshua Howie[1]

[1]Monash University

Conditions are imposed on an m-almost alternating link diagram which guarantee that both checkerboard surfaces are π_1-essential in the link exterior. Such knots can then be shown to satisfy the Neuwirth conjecture and the meridian length conjecture.
Early Career Showcase in Low-Dimensional Topology, Wednesday 11:00-11:25 Room 260-

073

On compounded random walks and the space-fractional Fokker-Planck equation

Boris Huang[1]

[1]University of New South Wales

Models for anomalous superdiffusion, with mean squared displacement scaling faster than linearly in time, often involve non-local operators, such as the fractional order Laplacian. Due to their relevance in modelling phenomena like the motion of particles and cells, random walks have become a common approach in deriving these models. Current random walk models encounter various challenges when modified to account for boundaries and potentials. We will show how a generalisation of the space-fractional order Laplacian, the space-fractional Fokker-Planck equation, can arise by considering a compound (continuous time) random walk on a lattice. This surprisingly versatile result arises from properties of the Sibuya distribution, a heavy tailed discrete distribution. We will address some of the computational challenges in simulating these random walks as well as how its framework can be adapted for generalisations.

Contributed Session A, Tuesday 16:00-16:25 Room 260-016

Enhancing Mathematics Engagement through Learner-Centred Experiences

Cindy Huang[1], *Dominic Maderazo*[1], *Susan James*[1], *Cait Pryse*[1], *Paul Fijn*[1]

[1]The University of Melbourne

Mathematics and statistics are underrepresented in the landscape of STEM outreach in Australia with many opportunities tending to highlight science, technology, and engineering. Further, mathematics in conventional classrooms tend to emphasise didactic instruction followed by students completing set exercises to consolidate ‘learning’. In this session, we discuss an alternative model for a mathematics learning experience featuring hands-on activities, team-based challenges, and inquiry-based explorations. This model emphasises learner-centred activity over direct instruction. Such a learning experience has potential to help learners develop collaboration, communication, creativity, and critical thinking; all of which are important skills for young learners. We present the methodology and design considerations of Micro Mathematicians, our popular outreach program, which employs these elements. Additionally, we discuss elements embedded in program delivery which help to promote learner confidence, agency, and engagement. We share some example activities that make use of household materials, low-floor high-ceiling concepts, cooperative and competitive tasks to create meaningful student-centred learning experiences.

Engagement with mathematics through communication and outreach, Tuesday 15:00-15:25 Room 260-040

Piecewise sum-of-squares-convex moment optimisation via semi-definite programs

Queenie Yingkun Huang[1], *V. Jeyakumar*[1], *G. Li*[1]

[1]UNSW Sydney

In this talk, we present exact Semi-Definite Program (SDP) reformulations for a class of moment optimisation problems involving piecewise Sums-of-Squares (SOS) convex functions and projected spectrahedral support sets. These moment problems cover real-world applications such as the newsvendor and revenue maximisation problems with higher-order moments. Generally, solving moment problems is computationally intractable because evaluating a multi-dimensional integral for the expectations and searching through the infinite-dimensional space of probability distributions is numerically hard. Our approach involves establishing an SOS representation for the non-negativity of a piecewise SOS-convex function on a projected spectrahedron and employing conic program duality. We show that both the optimal value and an optimal probability measure of the original moment problem can be found by solving a single SDP, which can be solved efficiently using commonly available software. This talk is based on: Huang, Q.Y., Jeyakumar, V. and Li, G., 2024. Piecewise SOS-convex moment optimization and applications via exact semi-definite programs. EURO Journal on Computational Optimization, p.100094. https://doi.org/10.1016/j.ejco.2024.100094

Optimisation, Monday 16:00-16:25 Room 402-221

The Range of Projection Pair Operators

Richard Huber[1]

[1]DTU Compute

Tomographic techniques have become a vital tool in medicine, allowing doctors to observe patients' interior features. Modeling these approaches' measurement process (and the underlying physics) is a class of line integration operators we call (tomographic) projection operators. Those feature the integration of functions with two-dimensional argument along collections of curves (most classically straight lines representing paths of radiation) with additional weight factors representing physical effects (e.g., attenuation suffered by radiation). These operators are subdivided into individual projections, collections of integrals with respect to curves bijectively covering the region of interest. These typically relate to a specific step in the measurement process or the data captured by one specific detector. For example, computed tomography (CT) utilizes various X-ray images from different directions, forming different projections. It is reasonable to expect that the data of two projections carry some overlapping information, e.g., the total mass in two (parallel-beam) X-ray images of the same object from different directions coincide. Using such information, one can verify whether the data associated with a pair of projections is consistent with the model. Hence, such (pairwise) consistency conditions have proven useful in various tomography-related applications, such as geometric calibration, parameter identification, or corruption detection. While such conditions are known for the most widely used projection operators, they remain unknown for more specialized tomographic methods. We present a unified framework for the investigation of consistency conditions as

range conditions for these operators. Thus, we discuss these operators' ranges, finding that at most one consistency condition exists for any projection pair and discussing a method for determining it. In fact, unlike previously suspected, there is no guarantee for the existence of consistency conditions. Indeed, the existence is connected to the algebraic properties of the curves and weights in the operators and are quite restrictive, implying that many models do not yield pairwise consistency conditions. Moreover, we discuss analytical properties of such operator's range, finding them closed and thus fully characterized by range conditions. In particular, we discuss the effect of these findings on the exponential fanbeam transform, which is relevant in modeling pinhole single photon emission tomography (SPECT) measurements.
MICROLOCAL ANALYSIS AND INVERSE PROBLEMS, TUESDAY 15:00-15:25 ROOM 260-009

Poisson's equation for G_2-Laplacian on homogeneous spheres

Stepan Hudecek[1]

[1]The University of Queensland

Riemannian manifolds whose holonomy group lies inside the exceptional Lie group G_2 are called G_2-manifolds. They have been of interest in geometric analysis as well as in string theory and other fields. However, the examples are quite scarce. Given some topological constraints, there is an associated non-linear Laplacian-type operator whose kernel essentially determines whether a compact manifold is G_2. We will present uniqueness and existence results for the Poisson's equation of this operator on homogeneous spheres.
DIFFERENTIAL GEOMETRY AND GEOMETRIC ANALYSIS, MONDAY 16:30-16:55 ROOM 260-005

Poincaré duality for families of supermanifolds

John Heurta[1]

[1]University of Lisbon

It is well known to experts, but seldom discussed explicitly, that smooth supergeometry is best done in families. This is also called the relative setting, and it implies that we need relative versions of standard supergeometric constructions. Such constructions include the de Rham complex familiar from ordinary differential geometry, but in the supergeometric setting, they also include more exotic objects, such as the Berezinian line bundle (whose sections are the correct objects to integrate over supermanifolds) and the related complex of integral forms, where the super version of Stokes' theorem lives. To work in families, we introduce relative versions of the de Rham complex and the integral form complex, and we prove that they satisfy a relative version of Poincaré duality. No background in supergeometry will be assumed for this talk.
REPRESENTATION THEORY AND TENSOR CATEGORIES, THURSDAY 15:00-15:25 ROOM 303-G14

Volume bounds for hyperbolic rod complements in the 3-torus

Norman Do, **Connie On Yu Hui**[1]*, Jessica S. Purcell*

[1]Monash University

The study of rod complements is motivated by rod packing structures in crystallography. Each rod packing can be viewed as a union of geodesic link components, called rods, in the 3-torus. Earlier works have completely characterised when a rod complement admits a hyperbolic structure. However, the characterisation did not give information on how to compute the hyperbolic structure, nor how to determine hyperbolic invariants such as volume. In this talk, we will focus on volume. We provide upper and lower bounds for the volumes of all hyperbolic rod complements in terms of rod parameters, and show that these bounds may be loose in general. We introduce better and asymptotically sharp volume bounds for a family of rod complements. The bounds depend only on the lengths of the continued fractions formed from the rod parameters.

Early Career Showcase in Low-Dimensional Topology, Thursday 11:30-11:55 Room 260-073

Arithmetic and Algorithms for formal extensions

Alexander Hulpke[1]

[1]Colorado State University

Polycyclic presentations are one of the success stories of Computational Group Theory. This is not only because they provide effective arithmetic, but also because they work well in relation to subgroups, factor groups, and extensions. They arise as the natural output of quotient algorithms. But of course they only exist for solvable groups. The recent Hybrid Quotient Algorithm [Dietrich and Hulpke, J.Alg, 2020] finds quotients of finitely presented group that can have a nontrivial nonsolvable factor. This indicates that a similar approach makes it possible to represent arbitrary finite groups as extensions of a Fitting-free group, represented by a rewriting system, with a solvable normal subgroup. Such a representation provides the similar good properties as Polycyclic presentations do, and offers a feasible way of working with exceedingly large groups. I will describe the basic setup for such arithmetic; how to adapt existing algorithms; and describe an implementation that has recently been used by the presenter to construct the maximal subgroup $2^{10+16}.O_{10}^{+}(2)$ of the Monster group.

Groups, actions and computations, Tuesday 11:30-12:20 Room 260-051

Correlation functions of conserved higher-spin supercurrents in 4D N=1 SCFT

Jessica Hutomo[1]

[1]National Institute for Nuclear Physics (INFN)

The analysis of correlation functions of conserved currents is an active area of research. In (super)conformal field theories, it is known that three-point functions of conserved currents are determined up to a small number of arbitrary constants. The study of three-point functions can be carried out in diverse dimensions and with various amounts of supersymmetry. This talk will review the recent results of arXiv 2208.07057 and 2407.17106. Specifically, I am interested in finding how N=1 superconformal symmetry in four dimensions constrains the general structure of three-point functions of conserved currents of arbitrary spins. I will sketch a new, manifestly supersymmetric formalism aimed at deriving all constraints imposed by N=1 superconformal symmetry and conservation laws on the three-point functions. Time permitting, I will discuss the number of independent parity even and odd structures, into which these three-point functions can be decomposed in superspace.

Mathematical Physics, Tuesday 14:00-14:25 Room 260-221

From ideal to one-vertex triangulations

Dionne Ibarra[1], *Daniel V. Mathews, Jessica S. Purcell, Jonathan Spreer*

[1]Monash University

In this talk we will discuss 1-vertex triangulations of the 3-sphere obtained from ideal triangulations of knot complements. In particular, by using the techniques of fully augmented links we show that for any knot in the 3-sphere, there is a 1-vertex triangulation of the 3-sphere with an edge forming the knot.

Early Career Showcase in Low-Dimensional Topology, Wednesday 11:30-11:55 Room 260-073

On characterizations of unlinking pathways

Kai Ishihara[1]

[1]Hiroshima University

We can consider an unlinking pathway that passes through several links as a model of the phenomenon in which a vortex knot is untied by reconnection or a DNA link is resolved by site-specific recombination. We will explore how to characterize these unlinking pathways using the signature and the crossing number. Additionally, we will demonstrate that certain pathways

can be characterized in a stronger sense.
Topology, geometry and combinatorics of biopolymers, Wednesday 11:00-11:25 Room 260-221

Dynamics induced by a heteroclinic network comprising five nodes

Md. Azmir Ibne Islam[1], *Claire M. Postlethwaite*[1], *Hinke M Osinga*[1]

[1]Department of Mathematics, The University of Auckland

Intransitivity plays an important role in ecological models of competition where no single species dominates. The behaviour of such models is organised by a heteroclinic network. In simple terms, a heteroclinic orbit is a solution that connects two equilibria of a system. A heteroclinic network is a union of several heteroclinic cycles, which are closed loops of heteroclinic orbits. The classic Rock-Paper-Scissors game is one example that serves as a basic model for competition between three species. When the game is translated into a system of differential equations in continuous time, it gives rise to a heteroclinic cycle that connects three equilibria, each of which represents the dominance of a single species. In this talk, we consider a spatially extended model of intransitive competition between not three, but five species; the dynamics can be viewed as an expansion of the Rock-Paper-Scissors game with two additional strategies. In this game of Rock-Paper-Scissors-Lizard-Spock, each strategy beats two of the strategies and loses to the remaining two. The system contains more equilibria, which represent dominance of only a subset of the species; the resulting heteroclinic network contains several different heteroclinic cycles. We will introduce the model and convey the richness of possible dynamics close to the heteroclinic network. We will present examples of new periodic orbits that bifurcate from specific cycles in the heteroclinic network and show how they change as parameters vary.
Computational Methods and Applications of Dynamical Systems, Tuesday 15:00-15:25 Room 303-G20

Global Attractivity and Periodicity in a Delay Differential Model

Anatoli Ivanov[1], *Hideaki Matsunaga*[2]

[1]Pennsylvania State University, [2]Osaka Metropolitan University

The delay differential equation of the form

$$\frac{dN(t)}{dt} = b(N(t-\tau))N(t-\tau) - \lambda(N(t))N(t) \tag{1}$$

was proposed as a mathematical model describing the dynamics of fly populations. The equation also represents a general mathematical model for a variety of real world phenomena, in particular from biological sciences. Though some of the dynamics of partial cases of the equation are known, there are several other important theoretical aspects of general equation (1) which need to be further studied and advanced. Those are in particular the problems of global asymptotic stability of equilibria and the existence of slowly oscillating periodic solutions, which need to be derived for equations in general settings and applied to specific models from applications. This

work is aimed at such theoretical advancements in the mathematical research of the equation and their subsequent translation to and use in particular applied models describing real world phenomena. Sufficient conditions for the global asymptotic stability of the unique positive equilibrium of equation (1) are derived. They are given in terms of the global attractivity for an underlying interval map which is constructed explicitly based on the functions $b(N)$ and $\lambda(N)$. Another complementary set of conditions is derived which guarantees that equation (1) has a periodic solution slowly oscillating about the unique positive equilibrium. This happens when there is the negative feedback property about the equilibrium in the equation and the linearized about the equilibrium delay differential equation is unstable. Extensive numerical simulations are performed on particular cases of the nonlinear delay differential equation (1). They include generalizations of several well-known types, such as Mackey-Glass physiological models and Nicholson's type population models. The numerical outcomes justify the theoretical findings; they also provide an additional insight into more complex dynamics in the original equation.
DIFFERENTIAL DELAY EQUATIONS AND THEIR APPLICATIONS, TUESDAY 14:00-14:25 ROOM 303-B05

Algebraic models of exponential and combinatorial laws

Marcel Jackson[1], *Tumadhir Al Sulami[1]*

[1]La Trobe University

In the 1960s, Alfred Tarski asked whether the usual index laws for exponentiation (and the other obvious additive and multiplicative laws) are compete for all equational properties of exponentiation. Surprisingly, the answer is no (Wilkie, 1980), and in fact, no finite system of valid laws is complete, as was later shown by Gurevic (1990). This talk will survey some of the interesting interplay between universal algebra, model theory, real analysis, and number theory that has emerged from 60 years of sporadic exploration of this and interrelated problems. A number of new results will be reported, including for variants of Tarski's problem involving combinatorial operations. This is joint work with Tumadhir Al Sulami.
50 YEARS OF COMMUNICATIONS IN ALGEBRA, WEDNESDAY 10:30-10:55 ROOM 303-G15

Optimal linear response for SDE via kernel perturbations

Gianmarco Del Sarto[2], *Stefano Galatolo[3]*, **Sakshi Jain[1]**

[1]Monash University, [2]Scuola Normale Superiore, [3]University of Pisa

We consider optimal control problems of the dynamical system on $\mathbb{R}^d$ given by Stochastic Differential Equation with Brownian motion by considering an associated transfer operator which in this case is a kernel operator. For a given observable, we study which infinitesimal perturbation in the kernel produces the greatest change in the expectation of the observable and find conditions under which such perturbation uniquely exists. We produce a numerical method to compute such perturbation and apply it to a concrete example.
ERGODIC THEORY AND DYNAMICAL SYSTEMS, MONDAY 14:00-14:25 ROOM 303-G23

Developing a Successful Outreach Program

Susan James[1], *Cindy Huang*[1], *Paul Fijn*[1], *Dominic Maderazo*[1], *Cait Pryse*[1]

[1]The University of Melbourne

Outreach is playing an increasingly important role as universities around the world seek to widen participation from more diverse student groups. Outreach is a particularly powerful force in response to a widespread decrease in student participation in higher mathematics at school. As a team, our goal is primarily to engage with school-aged students to expose them to concepts outside the curriculum and provide them opportunities to develop their collaboration and critical thinking skills with the intention of encouraging more positive engagement with mathematics and statistics in their lives. We detail the successes and challenges associated with growing outreach from a sequence of informal ad-hoc engagements run by a single academic to a dedicated team responsible for delivering a suite of programs to thousands of young people across Australia and New Zealand. We explain the benefits of having a targeted strategy for specific audiences and discuss how to approach developing different programs to cover a wide range of targeted audiences. Some examples of our programs will be provided.

Engagement with mathematics through communication and outreach, Monday 14:00-14:25 Room 260-040

The Super Combinatorics of Normal Toric Supervarieties

Eric Jankowski[1]

[1]University of California, Berkeley

We consider the category of normal supervarieties, each equipped with an action of a quasitoral supergroup for which there is a dense open orbit. In contrast to the classical story of toric varieties, these “toric supervarieties” are not purely combinatorial objects, as they also depend on some linear algebraic data arising from the odd structure of the supergroup. We nevertheless use these data to establish an equivalence of categories with a category of decorated polyhedral fans, from which useful geometric information can be extracted. Special attention will be given to examples and representation-theoretic considerations.

Representation Theory and Tensor Categories, Monday 14:30-14:55 Room 303-G14

How field characteristic impacts ideal structure in the Steinberg algebras of the two- and three-headed snakes

Ramla Abdellatif [2], *Lisa Orloff Clark* [1], **Roy Jansen**[1], *Stephen Marsland* [1]

[1]Victoria University of Wellington, [2]Université de Picardie Jules Verne

The two-headed snake is a standard example of a non-Hausdorff groupoid. We study the

Steinberg algebra, a convolution algebra of linear combinations of continuous functions from the groupoid to a field K, for the two- and three-headed snake groupoids. We are interested in elements of this algebra that are no longer continuous, known as singular functions. The set of singular functions SK forms an ideal of the Steinberg algebra. We prove that in the two-headed snake algebra, SK has no proper subideals regardless of the choice of field K. However, in the three-headed snake algebra, SK has proper subideals if and only if the field characteristic is either 3 or prime $p \equiv 1 \mod 3$.
Contributed Session B, Tuesday 14:00-14:25 Room 260-036

On the rate of vortex stretching for axisymmetric flows without swirl

In-jee Jeong[1], *Deokwoo Lim*[1]

[1]Seoul National University

For axisymmetric flows without swirl, we prove the optimal upper bound of $t^{4/3}$ for the growth of the vorticity maximum, confirming a prediction by Childress in [Phys. D, 237:1921–1925, 2008].
Recent advances in mathematical fluid dynamics, Friday 12:00-12:25 Room 401-311

Geometric inverse problems on asymptotically conic manifolds: a microlocal approach

Qiuye Jia[1], *András Vasy, Andrew Hassell*

[1]Australian National University

In this talk, I'll discuss the injectivity of the tensorial X-ray transform on asymptotically conic manifolds, and its relationship between the boundary rigidity of asymptotically conic manifolds. The main novelty from the microlocal perspective is the application of the recently developed 1-cusp pseudodifferential algebra. If time permits, I'll discuss its applcation in the scattering theory of time-dependent Schrodinger equations, and related inverse problems.
Microlocal analysis and inverse problems, Monday 15:00-15:25 Room 260-009

The second microlocalization and the non-relativistic limit of Klein-Gordon equations

Qiuye Jia[1], *András Vasy*[2], *Andrew Hassell*[1], *Ethan Sussman*[2]

[1]Australian National University, [2]Stanford University

It has been known for a very long time that solutions to the Klein-Gordon equation, after

suitable modulation, degenerates to solutions to the Schrodinger equation in the limit c (the speed of light) tends to infinity. There has been rigorous justifications of this fact in varous settings for convergences in various norms. But these results are using norms in fixed time slices hence not taking the oscillation in time into account. We give a spacetime approach which can overcome this and more imptantly, we can encode the positron and electron solutions of two different Schrodinger equations simultaneously in a very natural manner, and this method is robust enough to treat curved spacetimes. In addition, we can obtain detailed information of the convergence on the phase space level. This is based on the second microlocalization and Fredholm method developed by Vasy and other microlocal analysts, which has turned out to be very successful in the mathematical study of general relativiy.
Mathematical Physics, Thursday 12:00-12:25 Room 260-009

Topology of real matroid Schubert varieties

Leo Jiang[1], *Yu Li*[1]

[1]University of Toronto

Every linear representation of a matroid determines a matroid Schubert variety whose geometry encodes combinatorics of the matroid. When the representation is over the real numbers, we study the topology of the real points of the variety. Our main tool is an explicit cell decomposition, which depends only on the oriented matroid structure and can be extended to define a combinatorially interesting topological space for any oriented matroid.
Algebraic Combinatorics and Matroids, Wednesday 11:00-11:25 Room 303-B09

Recent progress in bounding the error term in the prime number theorem

Daniel Johnston[1]

[1]UNSW Canberra at ADFA

In analytic number theory, one of the most central objects of study is $\pi(x)$, the number of primes less than or equal to x. Historically, there has been very slow progress on improving bounds for $\pi(x)$, both unconditionally and assuming the Riemann hypothesis (or generalisations thereof). However, in recent years, there has been a flurry of activity on making small to moderate improvements on our knowledge of the Riemann-zeta function. In this talk, we will discuss how these improvements directly impact bounds for $\pi(x)$, and also present some natural questions for future research.
Computational Number Theory and Applications, Tuesday 15:00-15:10 Room 405-422

Engineering tertiary chirality in helical biopolymers

Natasha Jonoska[1]

[1]University of South Florida

Bottom-up self-assembly of DNA nanostructures have been proposed for variety of biotech uses. Here we focus on tertiary chirality which describes the handedness of supramolecular assemblies and relies not only on the primary and secondary structures of the building blocks but also on topological driving forces that have been sparsely characterized. Helical biopolymers, especially DNA, have been extensively investigated as they possess intrinsic chirality that determines the optical, mechanical, and physical properties of the ensuing material. We employ the motif of DNA tensegrity triangle as a model system to locate the tipping points in chirality inversion at the tertiary level by X-ray diffraction. We construct a mathematical model that accurately predicts and explains the molecular configurations in both this work and previous studies. We verify our model through experimentally engineered tensegrity triangle crystals with incremental rotational steps between immobile junctions from 3 to 28 base pairs (bp). Our design framework is extendable to other supramolecular assemblies of helical biopolymers and can be used in the design of chiral nanomaterials, optically active molecules, and mesoporous frameworks, all of which are of interest to physical, biological, and chemical nanoscience.
Topology, geometry and combinatorics of biopolymers, Thursday 12:00-12:25 Room 260-221

Bi-elliptic integrable maps

Nalini Joshi[1], *Frank Nijhoff* [2], *Allan Steel*[1]

[1]The University of Sydney, [2]University of Leeds

The family of mappings of the plane possessing a biquadratic in- variant, which is known as the QRT maps, is composed of two involutions, one preserving a vertical shift and the other preserving a horizontal shift in the plane. In this talk, we outline an extension when each shift is replaced by the group homorphism on each of two interlacing elliptic pencils.
Ergodic Theory and Dynamical Systems, Monday 16:30-16:55 Room 303-G23

On q-difference Painlevé equations and their Riemann–Hilbert problems

Nalini Joshi[1]

[1]The University of Sydney

Felix Klein said that the study of new transcendental functions defined by differential equations was “the central problem of the whole of modern mathematics”. A widely used method of studying such transcendental functions is through their formulation as Riemann–Hilbert prob-

lems, i.e., given functions in certain domains and jumps across their common boundaries, the problem of finding a global function that agrees with the given information. The corresponding formulation for functions that solve difference equations was initiated by Birkhoff in 1913. In this talk, I give an overview, outline some recent results for q-Riemann–Hilbert problems, and their ramifications for special functions that solve q-difference Painlevé equations.
SPECIAL FUNCTIONS, q-SERIES AND BEYOND, WEDNESDAY 10:30-11:20 ROOM 401-312

Efficient learning with projected histograms

Zhanliang Huang[1], **Ata Kaban**[1], *Henry Reeve*[1]

[1]University of Birmingham

High dimensional learning is a perennial problem due to challenges posed by the "curse of dimensionality"; learning typically demands more computing resources as well as more training data. In differentially private (DP) settings, this is further exacerbated by noise that needs adding to each dimension to achieve the required privacy. In this paper, we present a surprisingly simple approach to address all of these concerns at once, based on histograms constructed on a low-dimensional random projection (RP) of the data. Our approach exploits RP to take advantage of hidden low-dimensional structures in the data, yielding both computational efficiency, and improved error convergence with respect to the sample size—whereby less training data suffice for learning. We also propose a variant for efficient differentially private (DP) classification that further exploits the data-oblivious nature of both the histogram construction and the RP based dimensionality reduction, resulting in an efficient management of the privacy budget. We present a detailed and rigorous theoretical analysis of generalisation of our algorithms in several settings, showing that our approach is able to exploit low-dimensional structure of the data, ameliorates the ill-effects of noise required for privacy, and has good generalisation under minimal conditions. We also corroborate our findings experimentally, and demonstrate that our algorithms achieve competitive classification accuracy in both non-private and private settings.
RECENT DEVELOPMENTS IN DATA SCIENCE AND MACHINE LEARNING, FRIDAY 14:00-14:25 ROOM 402-220

The trace of a random walk in random environments on trees

Alexis Kagan[1]

[1]University of Auckland

We will consider a randomly biased random walk on a supercritical Galton-Watson tree. When the bias towards the root is strong enough, the random walk turns out to be recurrent. Focusing on the null recurrent regime, I will present interesting results about the behaviour of this random walk and I will pay a particular attention to its trace, the subtree made up of visited vertices, up to some (possibly random) finite time.
PROBABILITY AND MATHEMATICAL STATISTICS, MONDAY 15:00-15:25 ROOM 260-098

A Homotopy Invariant of Image Simple Fold Maps to Oriented Surfaces

Liam Kahmeyer[1], *Rustam Sadykov*[2]

[1]Missouri Valley College [2]Kansas State University

In 2019, Osamu Saeki showed that for two homotopic generic fold maps $f, g : S^3 \to S^2$ with respective singular sets $\Sigma(f)$ and $\Sigma(g)$ whose respective images $f(\Sigma)$ and $g(\Sigma)$ are smoothly embedded, the number of components of the singular sets, respectively denoted $\#|\Sigma(f)|$ and $\#|\Sigma(g)|$, need not have the same parity. From Saeki's result, a natural question arises: For generic fold maps $f : M \to N$ of a smooth manifold M of dimension $m \geq 2$ to an oriented surface N of finite genus with $f(\Sigma)$ smoothly embedded, under what conditions (if any) is $\#|\Sigma(f)|$ a $\mathbb{Z}/2$-homotopy invariant? The goal of this talk is to explore this question. Namely, we show that for smooth generic fold maps $f : M \to N$ of a smooth closed oriented manifold M of dimension $m \geq 2$ to an oriented surface N of finite genus with $f(\Sigma)$ smoothly embedded, $\#|\Sigma(f)|$ is a modulo two homotopy invariant provided one of the following conditions is satisfied: (a) $\dim(M) = 2q$ for $q \geq 1$, (b) the singular set of the homotopy is an orientable manifold, or (c) the image of the singular set of the homotopy does not have triple self-intersection points. Finally, we conclude with a few low-dimensional applications of the main results.

Early Career Showcase in Low-Dimensional Topology, Friday 14:30-14:55 Room 260-073

Towards Geometry of Aesthetic Shape: Klein Geometry, Integrability and Self-Affinity

Kenji Kajiwara, *Shun Kumagai*

[1]Kyushu University

Starting from the log-aesthetic curve (LAC), a family of planar curves identified among the curves that car designers regard as "aesthetic", we consider the extension of LAC from the viewpoint of the symmetry called "self-affinity" and Klein geometry. LAC has been identified as the similarity geometry analogue of Euler's elastica in Euclidean geometry in the sense that they are shape-invariant curves of the integrable deformations. LAC also has the following property: take an arbitrary subcurve of a given planer curve, and change the scales arbitrarily. The obtained curve coincides with the original curve by a suitable affine transformation. Researchers in industrial design pointed out that such "self-affinity" is a characteristic property of "aesthetic" curves. We reconsider the self-affinity of plane curves and show that the quadratic curves have a certain self-affinity in the framework of equiaffine geometry (SL(2, R) Klein geometry). Our result may imply that there is another family of "aesthetic curves" including the quadratic curves in equiaffine geometry. Together with the previous results on LAC under similarity geometry, it suggests that the two families of aesthetic curves may be unified under the framework of Möbius geometry, where "geometry of aesthetic shape" might be developed.

Industrial Mathematics, Wednesday 10:30-10:55 Room 402-211

Remarks on the conjectures of Capparelli, Meurman, Primc and Primc

Shashank Kanade[1]

[1]University of Denver

A few years ago, in a sequence of two papers, S. Capparelli, A. Meurman, A. Primc, M. Primc and then M. Primc proposed three remarkable sets of combinatorial conjectures regarding coloured integer partitions. On the other hand, about a decade ago, M. Griffin, K. Ono and S. O. Warnaar proved their much celebrated Rogers–Ramanujan-type q-series identities related to the characters of certain affine Lie algebras. In this talk, I'll present connections between these two worlds. This is a joint work with M. C. Russell, S. Tsuchioka and S. O. Warnaar.
SPECIAL FUNCTIONS, q-SERIES AND BEYOND, TUESDAY 15:00-15:25 ROOM 401-312

Homotopy type of finitely propagated unitary operators and its applications

Tsuyoshi Kato[1]

[1]Kyoto University

I will explain our computational results of homotopy type of finitely propagated unitary operators. As applications, we induce new properties on distributions of zeros of vector fields over amenable covering spaces of compact manifolds. These are based on joint works with D. Kishimoto and M. Tsutaya.
INDEX THEORY IN GEOMETRY AND MATHEMATICAL PHYSICS, WEDNESDAY 10:30-10:55 ROOM 260-022

Iwasawa Theory for Supersingular Elliptic Curves over Deformation Local Rings

Timotheus Keanu[1]

[1]Victoria University of Wellington

For a number field K, the Mordell-Weil theorem tell us that the group of rational points E(K) is finitely generated. The works of Mazur (1972) showed us how to apply Iwasawa theory to deal with elliptic curves over certain types of infinite extensions. However, there are still a few limitations to his results. Notably, it assumed that the curve has good ordinary reduction. Since then, there have been many results that extended Iwasawa theory to curves with good non-ordinary reduction. In particular, we will explore some recent results that employed Fontaine's theory of group schemes. Then, I will explain how we might extend this methodology by investigating deformations of local rings.
ARITHMETIC GEOMETRY AND NUMBER THEORY, TUESDAY 15:00-15:10 ROOM 405-430

Increasing sensitivity of analytical chemistry measurements using (very) applied mathematics.

Anthony Kearsley[1]

[1]NIST

The National Institute of Standards and Technology (NIST), formerly the National Bureau of Standards (NBS) was established in 1901 making it one of the oldest physical science laboratories in the USA. In addition to other areas of science, engineering and technology NIST is the home to the Applied and Computational Mathematics Division (ACMD), whose role is to provide mathematical support for measurement science especially as it pertains to commerce. In this talk I will survey research results on improving sensitivity in measurements for two classes of laboratory techniques, Polymerase Chain Reaction (PCR)/quantitative PCR (qPCR) and Mass Spectrometry (MS). In both examples, motivated by applications in healthcare and law-enforcement, relatively simple mathematics is used to increase the efficacy of measurements.
Industrial Mathematics, Wednesday 11:30-11:55 Room 402-211

Towards a database of hypergeometric L-functions

Kiran S. Kedlaya[1], *Edgar Costa, David Roe*

[1]University of California San Diego

Hypergeometric L-functions are a class of Hasse-Weil L-functions (associated to algebraic varieties over $\mathbb{Q}$, or more generally to motives) that are simultaneously diverse (e.g., in their Hodge numbers) and easily computable. In particular, the Fourier coefficients indexed by primes can be computed using an "average polynomial time" approach that is quite efficient in practice (presented at ANTS-XIV and ANTS-XVI). We report on the project of building large-scale tables of hypergeometric L-functions, with an eye towards using ML/AI techniques to investigate aggregate behavior of various features (Sato-Tate groups, order of vanishing at special values, "murmurations", etc).
Computational Number Theory and Applications, Thursday 11:30-12:20 Room 405-422

Epi-Consistent Approximation of Stochastic Dynamic Programs

Dominic Keehan[1], *Johannes Royset*[2]

[1]University of Auckland, [2]University of Southern California

In practice the probability distributions of random variables in multistage stochastic optimisation problems must be approximated. Often these approximations are constructed empirically from random sampling and then solved via stochastic dynamic programming. We study the set convergence of optimal solutions to these approximations in the asymptotic sampling limit.

Utilising results of the epi-convergence of expectation functions with varying measures and integrands, we show that consistency of minima can be assured even if the number of samples in each stage is increased jointly, or if the cost functions are unbounded, as long as the solutions to the stochastic dynamic programming equations can be embedded in a compact set that satisfies certain equi-continuity properties. We extend our results to infinite-horizon problems using the Attouch-Wets distance and a consistency-of-fixed-points result. A number of examples are discussed.
Optimisation, Tuesday 12:00-12:25 Room 402-221

Generalised Twisted Groupoids and their C*-Algebras

Michael Kelly[1]

[1]Victoria University of Wellington

Twisted groupoids are a central object of study to C*-algebraists; twisted groupoid C*-algebras were introduced even before the usual groupoid C*-algebras in the thesis of Renault, and large classes of C*-algebras have been shown to arise as the C*-algebra of some twisted groupoid. A twisted groupoid is defined in terms of a bundle with fibre set T, where T is the complex unit circle. I will talk about extending this idea from T to any locally compact Hausdorff group, and about different possible ways we can use that to construct a groupoid and in turn a C*-algebra, as well as how these constructions relate to each other. I will also discuss the possible generalisation to this setting of some useful theorems relating to twisted groupoids.
Functional Analysis and Operator Algebras, Monday 14:30-14:55 Room 260-055

The decomposability property for lattice equations

Andrew Kels[1], *Wolfgang Schief*[1]

[1]UNSW

In this talk I will present the concept of decomposability of lattice equations, which provides a relatively straightforward way to investigate integrability of lattice equations. This concept is based on analysis of lattice equations whose solutions turn out to also satisfy lattice equations of a different type, where the latter are defined on a subset of vertices for the original lattice equation. I will demonstrate how decomposability works for a general form of 4-point lattice equation called QV, through which this equation decomposes into a 5-point equation which we denote SV. Through decomposability an additional parameter is obtained that may be interpreted as a Bäcklund parameter for SV, where the QV equation may be interpreted the Bäcklund equation for SV.
Discrete and continuous integrable systems: geometry analysis and applications, Monday 16:30-16:55 Room 260-036

Two-component boundary Yang-Baxter maps

Andrew Kels[1], *Cheng Zhang*[2]

[1]UNSW, [2]Shanghai University

Previously, the speaker has introduced a set of 16 two-component Yang-Baxter maps which satisfy the set-theoretical form of the Yang-Baxter equation either individually or in pairs. These Yang-Baxter maps were derived from certain equations which can be interpreted as equations associated to two halves of a cuboctahedron. In this talk I will present how related two-component boundary Yang-Baxter maps can be obtained from equations which are associated to two halves of a rhombicuboctahedron, based on the ideas of Zhang et. al.
Mathematical Physics, Thursday 11:30-11:55 Room 260-009

Lens elliptic gamma function and extensions of elliptic hypergeometric integrals

Andrew Kels[1], *Masahito Yamazaki*[2]

[1]UNSW, [2]University of Tokyo

In this talk I will present the lens elliptic gamma function, which is an extension of the elliptic gamma function that depends on an additional variable that takes values in integers modulo n. It first appeared in the study of supersymmetric gauge theories and it may be simply written as a product of two regular elliptic gamma functions with different arguments and a specifically chosen normalisation. This special function can be used to construct extensions of elliptic hypergeometric integrals that depend on independent complex and integer parameters and involve both summation and integration. These satisfy identities that extend the identities satisfied by elliptic hypergeometric integrals (which correspond to the n=1 case), including the elliptic beta integral introduced by Spiridonov, and the multivariate transformation formulas introduced by Rains. Certain degenerations lead to analogue hyperbolic and q identities that involve both summation and integration.
Special Functions, q-Series and Beyond, Friday 14:30-14:55 Room 401-312

From sectional to Ricci curvature via symmetry

Lee Kennard, *Lawrence Mouillé*

[1]Syracuse University

Ricci curvature can be expressed as a sum of sectional curvatures, so lower sectional curvature bounds imply lower Ricci curvature bounds. By computing only partial sums, one obtains a ladder of curvature conditions that interpolate between, for example, positive sectional and positive Ricci curvature. Recent joint work with Lawrence Mouillé seeks to extends results

from the Grove Symmetry Program from the case of positive sectional curvature to the case of positive intermediate curvature in the above sense. Of interest is the fact that one finds new examples at each step up the ladder from sectional to Ricci curvature.
Recent advances in geometric PDE, Tuesday 14:00-14:25 Room 260-057

Comparing the effectiveness of different modes of attendance in a maths preparation course for medical science students

Carolyn Kennett[1]

[1]Macquarie University, Sydney

An increasing number of Australian students elect not to undertake advanced mathematics in the final years of their secondary schooling. Most higher education providers now offer pathways for these students to pursue courses with high school mathematics prerequisites. Due to COVID-19 pandemic restrictions, many previously on-campus mathematics preparatory and bridging programs were moved online. Since the lifting of COVID restrictions, the mathematics preparatory programs at Macquarie University have been offered both online and on campus. The online version of the courses has gone through several stages of development in order to meet the needs of students. Initially offered using synchronous instruction, the material was further developed to allow for asynchronous instruction. This talk examines the effectiveness of the courses to prepare students for further studies, including comparing student outcomes based on mode of attendance.
Mathematics Education, Monday 14:30-14:55 Room 260-115

Solutions and conservation laws of a nonlinear (3+1)-dimensional fifth-order partial differential equation

Chaudry Masood Khalique[1]

[1]North West University

In this talk, we explore the closed-form solutions and conserved vectors of a nonlinear (3+1)-dimensional fifth-order integrable partial differential equation. We employ Lie group analysis to identify the Lie point symmetries associated with the equation. Using these symmetries, we reduce the equation, leading to group-invariant solutions. As a result, we obtain several closed-form solutions of interest. Finally, we develop the conserved vectors related to the equation.
Mathematical methods in continuum mechanics and wave theory, Wednesday 11:15-11:25 Room 401-307

A Study on Mathematics Anxiety and its Effect on Mathematics Performance of School Students in Fiji

Kaushal Neelam Devi[1, 2], **M.G.M Khan**[1], *Bibhya Nand Sharma*[1]

[1]School of Information Technology, Engineering, Mathematics & Physics, The University of the South Pacific, [2]School of Mathematical and Computing Sciences, College of Engineering and Technical Vocational Education and Training, Fiji National University

Mathematics anxiety, which encompasses the fear and related emotions an individual experiences when engaging with mathematical tasks, has been identified as a prevalent factor contributing to poor performance in mathematics globally. Fiji has also experienced poor mathematics performance in school students in recent years, resulting in a decreased number of students perusing STEM fields at both secondary school and tertiary levels. Thus, it is pertinent to investigate the factors contributing to mathematics anxiety. The objective of this research is to determine how a student's demographics and their level of mathematics anxiety affect their performance in mathematics in Fiji. Using a survey design, the 25-item Revised Mathematics Anxiety Rating Scale (RMARS) was administered to assess the level of mathematics anxiety of 856 randomly selected primary and secondary school students across the country. The participants, comprised of 366 males and 490 females, were drawn from Year 6 and Year 12. A multiple linear regression model is developed to study if any of the demographic characteristics and mathematics anxiety have an impact on the mathematics performance of students. The results indicate that demographics, such as level of study and school location, influence mathematics performance whereas gender does not appear to have a significant effect. The findings also reveal that mathematics anxiety has a negative impact on the mathematics performance of the students. Therefore, mathematics anxiety can be identified as a contributing factor to the poor mathematics performance observed in Fiji.
Keywords: Mathematics anxiety; Mathematics performance; RMARS scale; Multiple linear regression.
Mathematics Education, Thursday 12:15-12:25 Room 260-115

An inverse source problem for Navier-Stokes-Voigt system

Khonatbek Khompysh[1]

[1]Gent university, [2]Institute of Mathematics and Mathematical Modelling

In this work, we will discuss on uniquely solvability of an inverse source problem for Navier-Stokes-Voigt system governing an incompressible viscoelastic fliud flow. An inverse problem consists of recovering a time dependent intensity of density of external forces by an additional measurment in integral form. Under suitable assumptions on the data, we establish the global and local in time existence and uniqueness of weak/strong solutions of the possed inverse problem.
Recent advances in mathematical fluid dynamics, Friday 14:00-14:25 Room 401-311

Defining algorithmically presented structures in first order logic

Bakh Khoussainov[1]

[1]University of Electronic Sciences And Technology

We aim to describe the isomorphism types of infinite structures in the language of first-order logic. This pursuit holds importance in logic in computer science, encompassing model theory, descriptional complexity, and the foundations of computability. We introduce the notion of quasi-axiomatizability aimed at describing the isomorphism types of structures. Our focus centers on two classes of algorithmically presented structures. The first is the class of structures for which the positive atomic diagrams are computably enumerable.We call these structures positive structures. The second is the class of structures for which the negative atomic diagrams are computably enumerable. We call these structures negative structures. We study quasi-axiomatizability of structures from these classes by ∃, ∀, ∃∀, and ∀∃-sentences in expansions of languages. Our work is a contribution to the interplay between expressive power of first-order logic, computability, and model theory.
Computability Theory and Applications, Tuesday 14:30-15:20 Room 303-B07

Generalized iterated function system for common attractors in partial metric spaces

Melusi Khumalo[1]

[1]University of South Africa

In this presentation, we portray some new common attractors with the assistance of finite families of generalized contractive mappings, that belong to the special class of mappings defined on a partial metric space. Consequently, a variety of results for iterated function systems satisfying a different set of generalized contractive conditions are acquired. We present some examples to reinforce the results proved herein. These results generalize, unify and extend a variety of results that exist in current literature.
Contributed Session B, Tuesday 16:30-16:55 Room 303-B11

Strong Iterated Limit Theorems for Dynamical Systems

Yuri Kifer[1]

[1]Hebrew University of Jerusalem

I will discuss strong moment and almost sure invariance principles and laws of iterated logarithm for normalized multiple iterated sums and integrals of the form $\mathbb{S}_N^{(\nu)}(t) = N^{-\nu/2} \sum_{0 \le k_1 < \ldots < k_\nu \le Nt} g \circ F^{k_1} \otimes \cdots \otimes g \circ F^{k_\nu}$, $t \in [0,T]$ and $\mathbb{S}_N^{(\nu)}(t) = N^{-\nu/2} \int_{0 \le s_1 \le \ldots \le s_\nu \le Nt} g \circ F^{s_1} \otimes \cdots \otimes g \circ F^{s_\nu} ds_1 \cdots ds_\nu$, where g is a vector function such that $\int g dP = 0$ and F is a P-preserving sufficiently well

mixing transformation or a suspension flow on Ω. The results are applicable, in particular, to hyperbolic and expanding dynamical systems with their Gibbs measures, Gibbs-Markov maps and some systems which can be represented via the Young towers construction. Sums (or sequences) of such iterated sums and integrals were called signatures in recent papers in rough paths, data science and machine learning.
Ergodic Theory and Dynamical Systems, Tuesday 14:30-14:55 Room 303-G23

An introduction of w-factor rings and their applications

Hwankoo Kim[1]

[1]Hoseo University

This presentation introduces w-factor rings and their applications. Specifically, we demonstrate how, through w-factor rings, we can characterize Krull domains multiplicatively and Gorenstein Krull domains (Gorenstein) homologically, as shown in two papers ([1], [2]) published in Communications in Algebra. [1] Chang, G. W., Kim, H. (2023). A characterization of Krull domains in terms of their w-factor rings. Commun. Algebra 51(3):1280–1292. [2] Xing, S. (2024). Gorenstein Krull domains and their factor rings. Commun. Algebra 52(8):3419–3426.
50 years of Communications in Algebra, Wednesday 11:30-11:55 Room 303-G15

Obstructions to knotless embedding

Hyoungjun Kim[1]

[1]Korea University

The Graph Minor Theorem of Robertson and Seymour implies a finite set of obstructions for any minor closed graph property. We show that there are only three obstructions to knotless embedding of size 23, which is far fewer than the 92 of size 22 and the hundreds known to exist at larger sizes. We describe several other topological properties whose obstruction set demonstrates a similar dip at small size. For order ten graphs, we classify the 35 obstructions to knotless embedding and the 49 maximal knotless graphs. This work is collaborated with Thomas Mattman.
Structural aspects of matroids and graphs, Tuesday 14:30-14:55 Room 303-B09

Lecture hall graphs and the Askey scheme

Sylvie Corteel[2], *Bhargavi Jonnadula*[3], *Jonathan Keating*[3], **Jang Soo Kim**[1]

[1]Sungkyunkwan University, [2]University of California Berkeley, [3]University of Oxford

Classification of weakly Einstein hypersurfaces in spaces of constant curvature

Jihun Kim[1, 2], *Yuri Nikolayevsky*[1], *JeongHyeong Park*[2]

[1]La Trobe University, [2]Sungkyunkwan University

A weakly Einstein Riemannian manifold is defined by a certain algebraic condition on the curvature tensor. In this talk, I will provide an overview of weakly Einstein manifolds and present a complete classification of weakly Einstein hypersurfaces in spaces of constant curvature. The main result states that any weakly Einstein hypersurface of dimension at least 4 is either Einstein (classification of those is known for a long time), or is a special, explicitly defined, rotation hypersurface, or the product of the hypersurfaces of constant curvature. This work is a joint project with Y. Nikolayevsky (La Trobe University, Australia) and J. H. Park (Sungkyunkwan University, Korea).

Differential geometry and geometric analysis, Tuesday 16:30-16:55 Room 260-005

Exploring Student Preferences for Collaboration in Mathematics: A Scale Validation Study

Sang Hyun Kim[1], *Tanya Evans*[1]

[1]University of Auckland

This talk will present exploratory research examining the collaborative preferences of undergraduate students in mathematics. To understand this aspect of student learning, the Collaborative Preferences for Learning Mathematics (CPLM) scale was developed and validated to measure student preferences for collaborative learning across various contexts and assessments. Although much research highlights the benefits and challenges of various collaborative practices in mathematics, few studies specifically examine students' preferences for these practices. The CPLM scale addresses this gap by providing a practical tool to assess student preferences, enabling educators to evaluate and understand students' preferences reliably, which can facilitate more responsive and tailored instructional approaches. An exploratory factor analysis identified a single-factor structure, and a confirmatory factor analysis confirmed a good model fit (CFI = .994, RMSEA = .050). Furthermore, measurement invariance testing provided additional evidence of the scale's reliability over time. The CPLM scale offers educators insights into student preferences regarding collaborative learning, presenting a useful factor to consider in future research and deepening our understanding of how collaborative dynamics influence learning outcomes. Potential implications and future research avenues for students' collaborative preferences will be discussed.

Mathematics Education, Tuesday 14:00-14:25 Room 260-115

Snaking of time-dependent localized structures

Edgar Knobloch[1]

[1]University of California At Berkeley

Spatially localized structures are ubiquitous in bistable pattern-forming differential equations. Of particular interest are steady structures present in the vicinity of the Maxwell point between a stable homogeneous and a stable spatially periodic state. Structures of this type are known to be organized in a snakes-and-ladders bifurcation diagram, and in long domains exhibit a high degree of multiplicity. In this talk I will describe collision properties of such structures when these travel and show that collisions are deeply inelastic. I will also describe stationary structures embedded in an oscillating homogeneous background and show that such structures inherit the instability of the background leading to disconnected branches of time-dependent states. Using a second parameter I will show that such states can be 'zipped up' into snaking branches of time-dependent states with properties that are very similar to those of steady localized states. Finally, I will describe a system with localized breathing states that exhibit similar behavior and that can likewise be 'zipped up' into a continuous snaking branch.
New directions in pattern formation, Tuesday 12:00-12:25 Room 303-B11

Discrete Morse theory on ΩS^2

Kevin Knudson[1]

[1]University of Florida

A classical result in Morse theory is the determination of the homotopy type of the loop space of a manifold. In this paper, we study this result through the lens of discrete Morse theory. This requires a suitable simplicial model for the loop space. Here, we use Milnor's $\mathrm{F}^+\mathrm{K}$ construction to model the loop space of the sphere S^2, describe a discrete gradient on it, and identify a collection of critical cells. We also compute the action of the boundary operator in the Morse complex on these critical cells, showing that they are potential homology generators. A careful analysis allows us to recover the calculation of the first homology of ΩS^2.
Applied and Computational Topology, Friday 14:30-14:55 Room 260-223

Maximal solvable subgroups

Mikko Korhonen[1]

[1]SUSTech

A subgroup of a group G is said to be maximal solvable if it is maximal among the solvable subgroups of G. In his 1870 Traité, Jordan gave a classification of the maximal solvable subgroups of symmetric groups. The classification reduces to the primitive case, which is equivalent to the

problem of classifying maximal irreducible solvable subgroups of $GL(d, p)$, where p is a prime. In $GL(d, p)$, the problem is reduced to the case of primitive irreducible solvable subgroups. These subgroups are then constructed in terms of maximal irreducible solvable subgroups of general symplectic groups $GSp(2k, r)$ (r prime) and orthogonal groups $O^{\pm(2k,2)}$. In this talk, we will discuss Jordan's classification in modern terms. More generally, we consider the complete classification of maximal irreducible solvable subgroups of classical groups such as $GL(n, q)$, $GSp(n, q)$, and $GO(n, q)$, where q is a power of a prime. From the classification we also get a recursive construction of the maximal irreducible solvable subgroups, and this works efficiently when implemented on a CAS such as Magma or GAP. We will also discuss the analogous problem for linear algebraic groups over algebraically closed fields.
Groups, actions and computations, Tuesday 15:00-15:25 Room 260-051

Computing degree-1 Vietoris-Rips persistent homology more efficiently

Musashi Koyama[1], *Facundo Memoli*[2], *Vanessa Robins*[1], *Katharine Turner*[1]

[1]Australian National University, [2]Ohio State University

Vietoris-Rips persistent homology is a widely used type of persistent homology to analyse the shape of point clouds. In particular, degree-1 Vietoris-Rips persistent homology is useful for detecting loop structures in space, but comes with the drawback of being computationally too expensive to apply to the large data sets encountered in the modern world. Ripser is currently one of the most widely utilised options for computing degree-1 Vietoris-Rips persistent homology, but typically struggles with analysing large point clouds due to memory limitations. We present a modified version of the standard reduction algorithm for point clouds in Euclidean space and show the results for code optimised to compute degree-1 persistent homology for point clouds in 2 and 3 dimensional Euclidean space.
Applied and Computational Topology, Tuesday 16:30-16:55 Room 260-223

Infinite configurations in large sets of integers

Bryna Kra[1]

[1]Northwestern University

Seeking a common generalization of Szemeredi's Theorem on arithmetic progressions in a set of integers with positive density and Hindman's Theorem on a monochromatic finite sumsets in any finite coloring of the integers, Erdos formulated several questions and conjectures. I will give the formulation of such a result and the role of ergodic theory in its proof, and discuss related questions. This is joint work with Joel Moreira, Florian Richter, and Donald Robertson.
Ergodic Theory and Dynamical Systems, Friday 12:00-12:25 Room 303-G23

An abundance of heterodimensional cycles via period doubling

Bernd Krauskopf[1], *Hinke M Osinga*[1], *Nelson Wong*[1]

[1]University of Auckland

A heterodimensional cycle consists of a pair of heteroclinic connections between two saddle periodic orbits with unstable manifolds of different dimensions. While any heterodimensional cycle is structurally unstable, amazingly, their existence is a robust phenomenon (in the C^1-topology) — showing that structural instability is not exceptional in phase spaces of sufficient dimension. We study heterodimensional cycles in a four-dimensional vector field (the minimal dimension in this context), where they are characterised by a connecting orbit that lies in the intersection of two two-dimensional manifolds; the return connection is given by a family of connecting orbits in the structurally stable two-dimensional intersection of two three-dimensional manifolds. We employ advanced continuation techniques, with a two-point boundary value problem set-up known as Lin's method, to find heterodimensional cycles and associated nearby global bifurcations. First of all, we study changes of the 'basic' heterodimensional cycle when it is continued in two system parameters and the Floquet multipliers of one of the periodic orbits change from real positive to real negative prior to a period-doubling bifurcation. We then focus on the transitions that occur near this period-doubling bifurcation and find that it generates new families of heterodimensional cycles with different geometric properties. Our careful numerical study shows how an abundance of heterodimensional cycles of different types is created in the limit of a period-doubling cascade.

Ergodic Theory and Dynamical Systems, Friday 11:30-11:55 Room 303-G23

A New Computationally Efficient and Consistent Estimator for Spatiotemporal Point Process Data

Conor Kresin[1]

[1]University of Otago Department of Mathematics And Statistics

A novel estimator for the parameters governing spatial-temporal point process conditional intensities is proposed. This estimator can be used for modelling point process data ranging from disease spread and wildfire occurrences to non-physical phenomena such as financial asset price movements. Models for point process data are often fit using maximum likelihood (MLE) or Markov Chain Monte Carlo (MCMC), but such methods are slow or computationally intractable for data with large n. In this talk, I will present a novel estimator based on the Stoyan-Grabarnik (sum of inverse intensity) statistic. Unlike MLE or MCMC approaches, the proposed estimator does not require approximation of a computationally expensive integral. I will show that under quite general conditions, this estimator is consistent for estimating parameters governing spatial-temporal point processes such as the Hawkes process and present simulations demonstrating the performance of the estimator.

Probability and Mathematical Statistics, Tuesday 16:00-16:25 Room 260-098

Homoclinic orbit for a Mackey-Glass type equation

Tibor Krisztin[1], *Le Bach Ngoc Pham*[1], *Monika Polner*[1]

[1]University of Szeged

The delay differential equation

$$y'(t) = -ay(t) + b\frac{y^2(t-1)}{1+y^n(t-1)} \tag{2}$$

with positive parameters a, b, n is a prototype model for an age-structured single-species population with strong Allee effect. A. Yu. Morozov et al. (J. Theor. Biol., 396(2016), 116–124) revealed numerically the rich phenomenon of the model, such as long-term transients, peakadding bifurcations, period-doubling bifurcations, complex dynamics. P. Hao et al. (DCDS-S, 10(2017), 973–993) proved the existence of periodic orbits via local and global Hopf bifurcations . In previous papers we studied equation (2) with $b > a$ and large n, and rigorously obtained complicated looking stable periodic orbits and connecting orbits between periodic orbits. If $b > a > 0$, and n is large then equation (2) has three equilibrium solutions $0 < y_1 < y_2$. y_1 is an unstable saddle, and its leading one-dimensional unstable set is very simple. It contains the constant function y_1, and segments of two solutions $y^{\pm} : (-\infty, \infty) \to (0, \infty)$ such that $\lim_{t\to-\infty} y^{\pm}(t) = y_1$, y^- decreases monotonically to 0 as $t \to \infty$, and y^+ is monotone increasing on $(-\infty, t_0)$ for some t_0. We show that, for $a \in (0, 1.64]$, and for sufficiently large n, there is a $b = b(a, n)$ such that $y^+(t) \to y_1$ as $t \to \infty$. Consequently, y^+ is a homoclinic solution of equation (2). For values of $a \approx 1.64$, and for the leading three eigenvalues $\lambda_0, \lambda_1, \overline{\lambda_1}$ of the generator of the linearization at y_1, the conditions

$$\operatorname{Re}\lambda_1 < 0 < \lambda_0 \quad \text{and} \quad \lambda_0 + \operatorname{Re}\lambda_1 > 0$$

hold. It is suspected that these spectral conditions with additional transversality peroperties guarantee Shilnikov type chaos near the homoclinic orbit. In the construction of the homoclinic solution the limiting version of equation(2)

$$x'(t) = -ax(t) + b\begin{cases} x^2(t-1) & \text{if } 0 \le x(t-1) \le 1 \\ 0 & \text{if } x(t-1) > 1 \end{cases}$$

plays an important role, in addition to tools from the theory of invariant manifolds, discrete Lyapunov functionals, monotone dynamicals systems, and techniques from rigorous numerics.

Differential delay equations and their applications, Tuesday 14:30-14:55 Room 303-B05

Interpolated Group Theory

Sophie Kriz[1]

[1]Princeton University

I will discuss a generalization of Tannakian duality using the interpolated groups of representations of general linear groups. This gives rise to a wide range of algebraic methods that apply to general symmetric monoidal categories with strong duality, and can be used to study their semisimplicity and deformations. I will also give several new examples that showcase aspects of

representation theory over interpolated groups, such as the categories of interpolated Weil-Shale and oscillator representations over finite fields and a new variant of the Delannoy category in trees.
Representation Theory and Tensor Categories, Wednesday 10:30-10:55 Room 303-G14

Formulas for integer partition functions and the usefulness of a forgotten technique.

Brandt Kronholm[1]

[1]University of Texas Rio Grande Valley

In this talk we will revisit a technique in q-series and proceed to establish a host of results found by using this technique. Our results are largely focused on integer partition functions, especially, $p(n, m, N)$, the function enumerating the partitions of n into at most m parts, none of which are larger than N, and $p(n, m)$ which enumerates the number of partitions of n into at most m parts. Some of the results we will discuss include the following:
Special Functions, q-Series and Beyond, Thursday 15:00-15:25 Room 401-312

Affine and Cyclotomic A-webs

Jonathan Kujawa[1]

[1]Oregon State University

Let A be an associate (super)algebra. We introduce diagrammatic categories that could be called A-webs. Finite A-webs describe the representation theory of polynomial representations of the general linear Lie algebra with entries from A — this includes the general linear lie algebra, the type Q Lie superalgebra, and current and loop algebras in type A, among others. We will explain the affine and cyclotomic versions of these constructions and the expected connection to KLR algebras associated to quivers of type ADE.
Representation Theory and Tensor Categories, Friday 15:00-15:25 Room 303-G14

Generalized Hamming weights and symbolic powers of Stanley-Reisner ideals of matroids

Michael DiPasquale[1], *Louiza Fouli*[1], **Arvind Kumar**[1], *Ştefan O. Tohăneanu*[2]

[1]New Mexico State University, [2]University of Idaho

It is well-known that the first generalized Hamming weight of a code, more commonly called *the minimum distance* of the code, corresponds to the initial degree of the Stanley-Reisner ideal of the matroid of the dual code. Our starting point in this paper is a generalization of this fact – namely, the r-th generalized Hamming weight of a code is the smallest degree of a squarefree monomial in the r-th symbolic power of the Stanley-Reisner ideal of the matroid of the dual code (in the appropriate range for r). It turns out that the squarefree monomials in successive symbolic powers of the Stanley-Reisner ideal of a matroid suffice to describe all symbolic powers of the Stanley-Reisner ideal. This implies that generalized Hamming weights – which can be defined in a natural way for matroids – are fundamentally tied to the structure of symbolic powers of Stanley-Reisner ideals of matroids. We illustrate this by studying initial degree statistics of symbolic powers of the Stanley-Reisner ideal of a matroid in terms of generalized Hamming weights and working out many examples that are meaningful from a coding-theoretic perspective. Our results also apply to projective varieties known as matroid configurations introduced by Geramita-Harbourne-Migliore-Nagel.

Computations and applications of algebraic geometry and commutative algebra, Thursday 15:00-15:25 Room 303-B05

Green's Function and Surface Wave

Hung-Wen Kuo[1]

[1]National Cheng Kung University

We propose a new method to solve the initial-boundary value problem for hyperbolic-dissipative partial differential equations (PDEs) based on the spirit of LY algorithm [T.-P. Liu and S.-H. Yu, Dirichlet-Neumann kernel for hyperbolic-dissipative system in half-space, Bull. Inst. Math. Acad. Sin. 7 (2012), 477–543]. The new method can handle more general domains than that of LYs'. Firstly, we convert the evolutionary PDEs into some general elliptic PDEs by the Laplace transformation. If the elliptic PDEs are self-adjoint, we can use the symmetric property of their fundamental solutions and the image method to construct the Green's functions for various boundary conditions. However, the structure of hyperbolic-dissipative PDEs means their fundamental solutions are non-symmetric and hence the image method does not work. We utilize the idea of Laplace wave train introduced by Liu and Yu in [T.-P. Liu and S.-H. Yu, Navier-Stokes equations in gas dynamics: Green's function, singularity and well-posedness, Comm. Pure Appl. Math. 75 (2022), 223–348] to generalize the image method. Then we are able to establish the boundary relation between the fundamental solutions and their reflections. With this boundary relation, we can construct the Green's functions for those non-self-adjoint elliptic PDEs. Finally, we obtain the Green's functions for the original evolutionary PDEs by inverting the Laplace transformation. Moreover, in the process of constructing the Green's functions, we will find out the formation of surface waves on the boundary for some particular boundary conditions.

Contributed Session B, Thursday 14:30-14:55 Room 405-430

Soliton resolution for Calogero–Moser derivative nonlinear Schrödinger

Soonsik Kwon[1], *Taegyu Kim*[1]

[1]Korea Advanced Institute of Science and Technology

I will present a soliton resolution result for the Calogero–Moser derivative nonlinear Schrödinger equation (CM-DNLS). A rigorous PDE analysis of (CM-DNLS) was recently initiated by Gérard and Lenzmann, who demonstrated its Lax pair structure. Additionally, (CM-DNLS) exhibits several symmetries, such as mass-criticality with pseudo-conformal symmetry and a self-dual Hamiltonian. Despite its integrability, finite-time blow-up solutions have been constructed. We establish soliton resolution for both finite-time blow-up solutions and global solutions in a fully general setting, *without imposing radial symmetry or size constraints.* A key aspect of our proof is the control of the energy of the outer radiation after extracting a soliton, referred to as the *energy bubbling* estimate. This benefits from two levels of convervation laws, mass and energy, and self-duality. This approach allows us to directly prove continuous-in-time soliton resolution, bypassing time-sequential soliton resolution. Importantly, our proof does not rely on the integrability of the equation, potentially offering insights applicable to other non-integrable models. This is a joint work with Taegyu Kim.

Deterministic and Probabilistic Aspects of Dispersive Partial Differential Equations, Monday 16:00-16:50 Room 260-022

Computing zeta functions of algebraic curves using Harvey's trace formula

Madeleine Kyng[1]

[1]UNSW

An important problem in computational number theory is the problem of computing the zeta function of a curve. Variants of Schoof's ℓ-adic algorithm can be used to efficiently compute the zeta function for curves of genus 1 or 2. In the case where the genus of the curve exceeds 2, the approach that has proven most successful to date is that of explicitly computing the action of Frobenius on a p-adic cohomology associated with the input curve. In 2001, Kedlaya published an impressive new p-adic algorithm for computing zeta functions of hyperelliptic curves. Over the years, Kedlaya's p-adic algorithm has been generalised to larger and larger classes of curves. These generalisations of Kedlaya's algorithm have resulted in practical algorithms that have been implemented in computer algebra systems like MAGMA. We present a p-adic algorithm for computing the zeta function that meaningfully differs from the Kedlaya-inspired family of p-adic algorithms. Our algorithm is not explicitly based on any cohomology theory, and our algorithm does not make any assumptions about the input plane model defining the curve. Rather than adopting Kedlaya's approach, we instead efficiently evaluate the elementary trace formula that was published by Harvey in 2015. Our new p-adic algorithm has been implemented in MAGMA. During this talk, we will give examples of curves that can be practically handled only by our algorithm, and we will give examples of curves where the runtime of our algorithm is vastly superior to that of an appropriately chosen Kedlaya-inspired algorithm.

Computational Number Theory and Applications, Wednesday 10:30-10:55 Room 405-422

Wave turbulence and some well-posedness results

Joonhyun La[1], *Pierre Germain*[1], *Zhiyuan Zhang*[1]

[1]Korea Institute For Advanced Study

Wave turbulence refers to the statistical theory of weakly nonlinear dispersive waves. In the weakly turbulent regime of a system of dispersive waves, its statistics can be described via a coarse-grained dynamics, governed by the kinetic wave equation. Remarkably, kinetic wave equations admit exact power-law solutions, called Kolmogorov-Zakharov spectra, which resemble Kolmogorov spectrum of hydrodynamic turbulence, and is often interpreted as a transient equilibrium between excitation and dissipation. In this talk, we will outline a local well-posedness result for kinetic wave equation for a toy model for wave turbulence. The result includes well-posedness near K-Z spectra, and demonstrates a surprising smoothing effect of the kinetic wave equation. The talk is based on the joint work with Pierre Germain (ICL) and Katherine Zhiyuan Zhang (Northeastern).

Recent advances in mathematical fluid dynamics, Thursday 14:00-14:25 Room 401-311

Ricci flows with symmetry

Ramiro Lafuente[1]

[1]The University of Queensland

In this talk, I will discuss old and new results on Ricci flow solutions with ‘large’ isometry groups. Here large will range from being homogeneous, to simply having some non-trivial Killing field. The focus will be on special solutions (Einstein and Ricci solitons) and the long-time behavior of the flow. If time permits, towards the end I will also present open questions and some conjectural answers. Many of the results in the talk are from various joint works with Christoph Böhm, Francesco Pediconi and Adam Thompson.

Differential geometry and geometric analysis, Monday 14:00-14:50 Room 260-005

Moving bumps in theta neuron networks

Carlo Laing[1], *Oleh Omel’chenko*

[1]Massey University

We consider large networks of theta neurons on a ring, synaptically coupled with an asymmetric kernel. Such networks support stable “bumps” of activity, which move along the ring if the coupling kernel is asymmetric. We investigate the effects of the kernel asymmetry on the existence, stability and speed of these moving bumps using continuum equations formally describing infinite networks. Depending on the level of heterogeneity within the network we find complex sequences of bifurcations as the amount of asymmetry is varied, in strong contrast

to the behaviour of a classical neural field model.
New directions in pattern formation, Tuesday 11:30-11:55 Room 303-B11

Curve shortening flow with boundary

Mat Langford[1]

[1]ANU

I shall present the free-boundary version of Grayson's theorem – that any simple, regular curve in a convex domain, which meets the boundary orthogonally, deforms under free boundary curve shortening flow either to a round half point (in finite time) or to a free-boundary geodesic (in infinite time). This is joint work with Jonathan Zhu.
Differential geometry and geometric analysis, Thursday 11:30-11:55 Room 260-005

Graph Theoretical Analysis of Biological and Ecological Systems

Angelyn Lao[1]

[1]De La Salle University

Graph theoretical methods are used more frequently to analyze and comprehend biological and ecological systems. Networks are being created to represent the relationships between components within these systems. In this presentation, the speaker will demonstrate how various graph theoretical approaches can be employed to examine these systems, providing fresh insights into established biological and ecological principles and offering solutions for emerging challenges.
Contributed Session A, Wednesday 10:30-10:55 Room 260-040

Analytic properties of groups via Vaughan Jones' technology

Christian De Nicola Larsen[1]

[1]UNSW Sydney

Vaughan Jones discovered a powerful technology for constructing representations of discrete groups, as part of the program to construct quantum field theories from subfactors. Brothier and Jones employed some of these representations to give a new analytic proof that Richard Thompson's groups F and T have the Haagerup property. We will discuss how this proof can be extended to the larger Thompson's group V, and how our techniques generalise to other "Thompson-like" groups. This is joint work with Dilshan Wijesena.
Functional Analysis and Operator Algebras, Tuesday 15:00-15:25 Room 260-055

A discussion on discrete multiple orthogonal polynomial systems

Tomas Lasic Latimer[1]

[1]UC Santa Cruz

In this talk we discuss the behavior of systems of discrete multiple orthogonal polynomials, where discrete refers to the fact that the measure of orthogonality is supported on a countable number of points. We discuss a Riemann-Hilbert approach to determining the asymptotics of these polynomials and compare our results to those previously found for 'standard' discrete orthogonal polynomials. We also include some examples of their applications to problems which arise in mathematical physics.

Discrete and continuous integrable systems: geometry analysis and applications, Thursday 11:30-11:55 Room 260-036

A priori estimates for generalized KdV equations in H^{-1}

Mihaela Ifrim[1], **Thierry Laurens**[1]

[1]University of Wisconsin–Madison

We will discuss local-in-time a priori estimates in H^{-1} for a family of generalized KdV equations on the line. This is the first estimate for any non-integrable perturbation in the PDE that matches the regularity of the sharp well-posedness theory for KdV. In particular, our analysis applies to models for long waves in a shallow channel of water with an uneven bottom. This is joint work with Mihaela Ifrim.

Harmonic analysis and Hamiltonian PDE, Monday 16:00-16:50 Room 260-028

Demazure weaves for reduced plabic graphs

Ian Le[1]

[1]ANU

It is well-known that plabic (planar bi-colored) graphs, up to equivalence, define cluster structures on the Grassmannian, or more generally on positriod varieties. Moreover, square moves on plabic graphs correspond to mutations between clusters. However, not all seeds in a cluster algebra correspond to plabic graphs. I will explain how weaves, another planar combinatorial object, generalize plabic graphs and give a more robust understanding of the cluster structure. As an application, one can give an explicit construction of the Donaldson-Thomas transformation on positroids.

Representation Theory and Tensor Categories, Thursday 11:30-11:55 Room 303-G14

Einstein Metrics, 4-Manifolds, and Gravitational Instantons

Claude LeBrun[1]

[1]Stony Brook University

A Riemannian metric is said to be Einstein if it has constant Ricci curvature. Certain peculiar features of 4-dimensional geometry make dimension four into a "Goldilocks zone" for Einstein metrics, with just the right amount of local flexibility managing to coexist with strong global rigidity results. This talk will first describe some aspects of the interplay between Einstein metrics and smooth topology on compact symplectic 4-manifolds without boundary. We will see how ideas from Kaehler and conformal geometry allow us to construct Einstein metrics on many such manifolds, while a complimentary tool-box shows that these existence results are optimal in certain specific contexts. The talk will then conclude with a brief discussion of analogous results concerning complete Ricci-flat 4-manifolds.

Differential geometry and geometric analysis, Wednesday 11:00-11:50 Room 260-005

Signed mosaic graphs and mosaic number of knots

Hwa Jeong Lee[1]

[1]Dongguk Univsersity WISE Campus

A *knot n-mosaic* is an $n \times n$ matrix of 11 kinds of specific mosaic tiles representing a knot or a link. In this talk, we consider the *alternating mosaic number* of an alternating knot K which is defined as the smallest integer n for which K is representable as a reduced alternating knot n-mosaic. We define a signed mosaic graph and a diagonal grid graph and construct Hamiltonian cycles derived from the diagonal grid graphs. Using the cycles, we completely determine the alternating mosaic number of torus knots of type $(2, q)$ for $q \geq 2$, which grows in an order of $q^{1/2}$.

Structural aspects of matroids and graphs, Tuesday 15:00-15:25 Room 303-B09

G-Mapper: Learning a Cover in the Mapper Construction

Enrique Alvarado[1], *Robin Belton*[2], *Emily Fischer*[3], **Kang-Ju Lee**[4], *Sourabh Palande*[5], *Sarah Percival*[6], *Emilie Purvine*[7]

[1]Iowa State University, [2]Vassar College, [3]Umqua Bank, [4]Seoul National University, [5]Michigan State University, [6]University of New Mexico, [7]Pacific Northwest National Laboratory

The Mapper algorithm is a visualization technique in topological data analysis (TDA) that outputs a graph reflecting the structure of a given dataset. However, the Mapper algorithm requires tuning several parameters in order to generate a "nice" Mapper graph. This paper focuses on selecting the cover parameter. We present an algorithm that optimizes the cover of a

Mapper graph by splitting a cover repeatedly according to a statistical test for normality. Our algorithm is based on G-means clustering which searches for the optimal number of clusters in k-means by iteratively applying the Anderson-Darling test. Our splitting procedure employs a Gaussian mixture model to carefully choose the cover according to the distribution of the given data. Experiments for synthetic and real-world datasets demonstrate that our algorithm generates covers so that the Mapper graphs retain the essence of the datasets, while also running significantly fast.
Applied and Computational Topology, Thursday 15:00-15:25 Room 260-223

Variational Bayes inference for gravitational wave detector

Kate Lee[1]

[1]University of Auckland

Gravitational wave detectors like the Einstein Telescope and LISA generate long multivariate time series, which pose significant challenges in spectral density estimation due to a number of overlapping signals as well as the presence of correlated noise. Addressing both issues is crucial for accurately interpreting the signals detected by these instruments. I will present an application of a variational inference spectral density estimation method specifically tailored for dealing with correlated noise in the data. The spectral density is estimated using the semiparametric approach and the optimization procedures are automated.
Stochastic and Deterministic Inverse Problems, Thursday 11:30-11:55 Room 260-040

The global dynamics of the Maxwell-Dirac system

Yonggeun Cho[2], **Kiyeon Lee**[1]

[1]KAIST, [2]Jeonbuk National University

In this talk, we study the (1+3) dimensional massive Maxwell-Dirac system in the context of global existence and asymptotic behavior of solutions under the Lorenz gauge condition, as well as the modified and linear scattering phenomena for the Dirac spinor and the electromagnetic potential, respectively. The primary ingredients of this talk are a vector fields energy method combined with a detailed analysis of the space-time resonance argument. This approach allows us to establish decay estimates and energy bounds crucial for proving the main theorems. Especially, we provide explicit phase correction arising from the strong nonlinear resonances.
Deterministic and Probabilistic Aspects of Dispersive Partial Differential Equations, Tuesday 16:00-16:50 Room 260-022

Phase resetting in two phase-locked coupled Van der Pol oscillators

Kyoung Hyun Lee[1, 3], *Neil Broderick*[2, 3], *Bernd Krauskopf*[1, 3], *Hinke M Osinga*[1, 3]

[1]Department of Mathematics, University of Auckland, [2]Department of Physics, University of Auckland, [3]Dodd–Walls Centre for Photonic and Quantum Technologies

Coupled oscillators are ubiquitous in many applications, such as coupled optical cavities in photonics and neurons in biological systems. Properties of these systems can be explored by studying their response to external perturbations, which leads to a phase shift after the system relaxes back to its stable oscillation. Analysing how this phase shift depends on the perturbation provides information about the phase space of the oscillatory system. We consider two coupled and 1:1 phase-locked Van der Pol oscillators. Unlike single oscillators, this system setup its four-dimensional phase space, and we employ a multi-segment boundary value problem to compute its phase resets. Notably, the basin of attraction of the stable synchronised solution features a complex boundary, and we show how this influences the phase resetting in ways not seen in single oscillator systems.

Computational Methods and Applications of Dynamical Systems, Tuesday 14:00-14:25 Room 303-G20

Computing the anatomy of the Monster

Melissa Lee[1]

[1]Monash University

The Monster group, discovered in the early 1980s, is the largest of the sporadic simple groups and has been the focus of intense study for the past 40 years. Due to its enormous size and lack of a small faithful representation, computing with this group presents significant challenges. In this talk, I will discuss computational work on the maximal subgroups of the Monster using mmgroup, a groundbreaking open-source python package published by Seysen in 2020. While the history and importance of this problem made it very compelling to work on in the first place, some unexpected surprises made it even more so. This project is joint work with Heiko Dietrich, Tomasz Popiel and Anthony Pisani.

Groups, actions and computations, Tuesday 16:00-16:50 Room 260-051

Modelling the shear stress experienced by the placental surface

Tet Chuan Lee[1, 2], *Teena K Gamage*[3], *Mary Spring*[3, 4], *Toby Jackson*[4], *Isha Ramanlal*[3], *Joanna L James*[3], *Alys R Clark*[4]

[1]Institute of Biomedical Technologies, Auckland University of Technology, [2]Department of Mechanical Engineering, Auckland University of Technology, [3]Department of Obstetrics and Gynaecology, School of Medicine, Faculty of Medical and Health Sciences, University of Auckland, [4]Auckland Bioengineering Institute, University of Auckland

The placenta is the fetal exchange organ where gas and nutrient exchange occurs between a developing fetus and its mother during pregnancy. It has a unique geometry in the circulatory system, whereby maternal blood flows over a complex branching tree-like structure that contains fetal capillaries, bringing the maternal and fetal circulations close to each other without mixing. It has been hypothesised that the shear stress caused by maternal blood flowing over this placental surface (the surface of these complex tree-like structures) may play an important role in placental development and in diseases like fetal growth restriction. It this work, we aim to predict the fluid shear stress experienced by the placental surface by combining two continuum mechanics models of the placenta at different scales. In the first model, we simulate the microscale variation in shear stress by performing explicit flow simulations of maternal blood flowing over the placental tissue. In this simulation, blood is assumed to be a Newtonian fluid and is modelled using the Navier-Stokes and continuity equations. As the Reynolds number is small, the flow can be treated as laminar. The geometry of these simulations are created using segmented micro-CT images of blocks of placental tissue (1.5x1.5x1.5 mm blocks). Boundary conditions for these simulations include a pressure drop across the block which is informed from our second model. In the second model, we perform simulations at a larger scale by simulating a single placentone, which is a functional subunit of the placenta. This model uses a porous media approach using Darcy's equations whereby we no longer explicitly consider the microstructure of the placenta and instead take a continuum approach where we have a solid phase (the placenta) and a fluid phase (the blood). This model allows us to estimate the pressure drop at different locations in the placentone and capture the resulting variation of shear stress at this larger scale. Exploiting the linearity of our explicit flow simulations, we then combine these two models to make predictions of shear stress for normal term placenta as well as placenta affected by fetal growth restriction, a disease that is associated with abnormal placental development. Initial simulations predict that the placenta surface experiences higher levels of shear stress in FGR compared to normal pregnancies. We plan to use these results to inform future work to understand the effect of this higher shear stress using in vitro microfluidic experiments.

Mathematical methods in continuum mechanics and wave theory, Thursday 12:00-12:25 Room 401-307

Lorentzian homogeneous spaces with indecomposable isotropy

Thomas Leistner[1], *Steven Greenwood*[2]

[1]University of Adelaide, [2]Masaryk University

The results in this talk are motivated by the question to which extent the curvature of a ho-

mogeneous space G/H is determined by algebraic conditions on the isotropy representation of H. While there are many Riemannian homogeneous spaces with irreducible isotropy, the Lorentzian case is very rigid: Zeghib proved that a Lorentzian homogeneous space with irreducible isotropy has constant sectional curvature. This indicates that for indefinite metrics the notion of indecomposability is more relevant. It means that the isotropy representation of H may have invariant subspaces but only those on which the metric is degenerate. Due to a lack of examples, and encouraged by dichotomy for Lorentzian symmetric spaces, we conjecture that a reductive Lorentzian homogeneous space with indecomposable isotropy is a plane wave. In the talk we will present an important step towards this conjecture, namely that a Lorentzian manifold that admits a homogeneous structure (aka an Ambrose–Singer connection) with indecomposable holonomy is a plane wave. The existence of an Ambrose–Singer connection is almost equivalent to reductive homogeneity and its holonomy closely related to the isotropy of the homogeneous space. En route to this result we prove several results about locally symmetric connections and connections with parallel torsion. This is joint work with Steven Greenwood.
Differential geometry and geometric analysis, Tuesday 14:30-14:55 Room 260-005

New unconditional bounds on the reciprocal of the Riemann zeta function

Nicol Leong[1]

[1]UNSW Canberra at ADFA

Without assuming the Riemann hypothesis, upper bounds on the reciprocal of the Riemann zeta function are only valid in a zero-free region. These bounds are crucial when estimating partial sums of the Mobius function μ. Typically, the order of such bounds on $1/\zeta$ are determined by the shape of the zero-free region considered. In this talk, using a method involving the non-negative trigonometric polynomial, we show that obtaining a power savings on such bounds are possible without modifying the zero-free region.
Computational Number Theory and Applications, Monday 14:15-14:25 Room 405-422

The applicability of equal area partitions of the unit sphere

Paul Leopardi[1]

[1]ANU

Wigner has famously written about the “unreasonable effectiveness” of mathematics in the natural sciences. Practitioners of applied mathematics usually take a more pragmatic approach, assessing and comparing different techniques before applying them to the problem at hand. This poster summarises a paper that uses, as a case study, a construction and accompanying software that partition the unit sphere into regions of equal area. The paper assesses the applicability of this construction and software by examining existing works, including papers, dissertations and software.
Computational Mathematics, Wednesday 11:30-11:55 Room 402-231

Helton-Howe formula for singular traces

Galina Levitina[1], *Alexandr Usachev*[2]

[1]Australian National University, [2]Central South University

Let A and B be two self-adjoint operators on a Hilbert space which are almost commuting, that is the commutator of A and B is trace-class. The celebrated Helton-Howe-Carey-Pincus formula establishes a formula for the classical trace for the commutator of two polynomials p and q of A and B via principal function. In this talk we show the Helton-Howe-Carey-Pincus formula for singular traces. This is joint work with A.Usachev.
Functional Analysis and Operator Algebras, Thursday 14:00-14:25 Room 260-055

Optimal Liouville theorems for conformally invariant PDEs

Baozhi Chu[2], *Yanyan Li*[2], **Zongyuan Li**[1]

[1]City University of Hong Kong, [2]Rutgers University

In 1989, the renowned Caffarelli-Gidas-Spruck result provided a classification of all non-negative, entire solutions to the equation $-\Delta u = u^{\frac{n+2}{n-2}}$ — a Liouville theorem. This equation, rooted in conformal geometry via the Yamabe problem, also represents the steady states of energy-critical focusing Schrödinger equations. In this talk, we present an optimal fully nonlinear generalization. Based on joint works with B. Z. Chu and Y. Y. Li (Rutgers).
Deterministic and Probabilistic Aspects of Dispersive Partial Differential Equations, Tuesday 11:30-12:20 Room 260-022

On time-dependent boundary crossing probabilities of diffusion processes as differentiable functionals of the boundary

Vincent Liang [1], *Konstantin Borovkov*[1]

[1]The University of Melbourne

We analyse the sensitivity of the finite time horizon boundary non-crossing probability $F(g)$ of a general time-inhomogeneous diffusion process to perturbations of the boundary g. We prove that, for boundaries $g \in C^2$, this probability is Gâteaux differentiable in directions $h \in H \cup C^2$ and Fréchet-differentiable in directions $h \in H$, where H is the Cameron–Martin space, and derive a compact representation for the derivative of F. Our results allow one to approximate $F(g)$ using boundaries $\bar{g}$ that are close to g and for which the computation of $F(\bar{g})$ is feasible. We also obtain auxiliary results of independent interest in both probability theory and PDE theory. These include: (i) an elegant probabilistic representation for the limit of the derivative with respect to x of the boundary crossing probability when the process starts at point (t, x) in the time-space domain and $x \uparrow g(t)$, and (ii) a Shiryaev–Yor type martingale representation

for the indicator of the boundary non-crossing event for time-dependent boundaries.
Probability and Mathematical Statistics, Monday 16:30-16:40 Room 260-098

Complex bound states of dissipative solitons in three-component reaction-diffusion systems

Andreas Kempa - Liehr[1]

[1]University of Auckland

Dissipative solitons are self-organised particle-like structures, which, for example, are observed in multi-component reaction-diffusion systems of FitzHugh-Nagumo type. Depending on the system parameters, these structures are stationary or propagate with a well-defined velocity. They either exhibit purely repulsive interaction or alternating repulsive and attractive interaction. In this presentation, we are revisiting the perturbation approach for reducing the partial differential equations modelling the dynamics of these particle-like structures to a set of ordinary differential equations covering the dynamics and interaction of dissipative solitons. A particular focus will be the discussion of complex bound states between dissipative solitons and the comparison of PDE and ODE solutions.
New directions in pattern formation, Friday 14:30-14:55 Room 303-B11

CTLNs as a mean field theory for clustered spiking networks

Caitlin Lienkaemper[1]

[1]Boston University

Combinatorial threshold linear networks (CTLNs) model the activity of a network of excitatory neurons against a background of non-specific inhibition. While the simplicity of the CTLN model makes it an ideal setting to study the relationship between a network's structure and its dynamics, the lack of explicit inhibition makes it difficult to relate CTLNs to more biologically detailed models. To remedy this, we derive the CTLN model as a mean field theory of a clustered spiking network which has an explicit population of inhibitory neurons and a cluster of excitatory neurons corresponding to each neuron in the CTLN. We show that attractors in the CTLN model, such as fixed points, limit cycles, and chaotic attractors, also appear in the clustered spiking network.
Computational Methods and Applications of Dynamical Systems, Thursday 12:00-12:25 Room 303-G20

Higher-order Riemannian spline interpolation problems: a unified approach by gradient flows

Chun-chi Lin[1]

[1]National Taiwan Normal University

This paper addresses the problems of spline interpolation on smooth Riemannian manifolds, with or without the inclusion of least-squares fitting. Our unified approach utilizes gradient flows for successively connected curves or networks, providing a novel framework for tackling these challenges. This method notably extends to the variational spline interpolation problem on Lie groups, which is frequently encountered in mechanical optimal control theory. As a result, our work contributes to both geometric control theory and statistical shape data analysis. We rigorously prove the existence of global solutions in Hölder spaces for the gradient flow and demonstrate that the asymptotic limits of these solutions validate the existence of solutions to the variational spline interpolation problem. This constructive proof also offers insights into potential numerical schemes for finding such solutions, reinforcing the practical applicability of our approach.

Mathematics of nonlinear diffusion processes, Thursday 14:00-14:50 Room 260-018

Mutation Invariants of Virtual Alternating Knots

Damian Lin[1], *Hans Boden, Zsuzsanna Dancso, Tilda Wilkinson-Finch*

[1]The University of Sydney

Conway mutation is an important knot operation in which a disk intersecting the knot diagram four times is cut out and rotated or flipped. The d-invariant, or equivalently, the lattices of integer flows of the Tait graphs is a knot invariant that completely distinguishes mutation classes of alternating knots (Greene 2012). Virtual knots are a generalisation of knots whose diagrams live on surfaces of any genus, modulo stabilisation. We generalise Greene's d-invariant (lattice of integer flows) to alternating virtual knots, and provide and example to show that while this virtual d-invariant remains a mutation invariant, it no longer completely distinguishes mutation classes. We touch on another invariant that may be a complete mutation invariant of virtual alternating knots. This talk is based on joint work with Hans Boden, Zsuzsanna Dancso and Tilda Wilkinson-Finch.

Early Career Showcase in Low-Dimensional Topology, Tuesday 11:30-11:55 Room 260-073

On Convergence of Adam for Stochastic Optimization

Yusu Hong, **Junhong Lin**[1]

[1]Zhejiang University

In this paper, we study Adam in non-convex smooth scenarios with potential unbounded gradients and affine variance noise. We consider a general noise model which governs affine variance noise, bounded noise and sub-Gaussian noise. We show that Adam with the right parameter can find a stationary point with a $\mathcal{O}(\text{poly}(\log T)/\sqrt{T})$ rate in high probability under this general noise model where T denotes total number iterations, matching the lower rate of stochastic first-order algorithms up to logarithm factors. We also provide a probabilistic convergence result for Adam under a generalized smooth condition which allows unbounded smoothness parameters and has been illustrated empirically to more accurately capture the smooth property of many practical objective functions.

Recent developments in data science and machine learning, Monday 16:30-16:55 Room 402-220

On tight error bounds for conic optimisation

Scott Lindstrom[1]*, Ying Lin*[2]*, Bruno F. Lourenço*[3]*, Ting-Kei Pong*[2]

[1]Curtin University, [2]The Hong Kong Polytechnic University, [3]The Institute of Statistical Mathematics

Conic-linear programming allows researchers to tackle many important problems. Popular programs such as Mosek, CVX, and Hypatia solve problems with conic-linear methods. Such software packages provide users with so-called “backward error bounds, ” which may not be useful accuracy guarantees. I will describe the framework that we built for obtaining useful “forward” bounds, and explain how we have used it to find such bounds for classes of next generation cones in Mosek and Hypatia. I will also discuss how such bounds also admit convergence rate guarantees for projection methods.

Optimisation, Thursday 14:30-14:55 Room 402-221

Best Subset Selection via Continuous Optimization

Benoit Liquet[1]*, Sarat Moka*[2]*, Samuel Muller*[3]*, Houying Zhu*[3]

[1]University of Pau Et Pays De L'adour, [2]University of New South Wales, [3]Macquarie University

Recent rapid developments in information technology have enabled the collection of high-dimensional complex data, including in engineering, economics, finance, biology, and health sciences. High-dimensional means that the number of features is large and often far larger than

the number of collected data samples (units). In many of these applications, it is desirable to find a small best subset of predictors so that the resulting model has desirable prediction accuracy. In this talk, we present the COMBSS framework, a continuous optimization-based solution that we recently showed to solve the best subset selection problem in linear regression. Then, we highlight how COMBSS can be extended to other models such as the logistic model. Finally, we present how to cast the best subset solution method into principal component analysis and partial least square frameworks.
RECENT DEVELOPMENTS IN DATA SCIENCE AND MACHINE LEARNING, TUESDAY 16:30-16:55 ROOM 402-220

Balanced systems of cell representations for affine Hecke algebras

Eloise Little[1], *Nathan Chapelier-Laget*[2], *Jeremie Guilhot*[3], *James Parkinson*[1]

[1]The Univerisity of Sydney, [2]Université du Littoral côte d'Opale, [3]Universite de Tours

The concept of a balanced system of cell representations for an affine Hecke algebra $\mathcal{H}$ was introduced by Guilhot and Parkinson in 2019, inspired by work of Geck in 2011 for the finite case. Informally, a balanced system is a set of bounded finite-dimensional matrix representations of $\mathcal{H}$ that realise the Kazhdan-Lusztig cells of the underlying affine Weyl group, and where particular restrictions exist between the bounds of the representations. With a balanced system of cell representations one can give an explicit construction of Lusztig's asymptotic algebra. In this talk I will define a balanced system more explicitly, give examples, and touch on recent results regarding boundedness and the construction of a balanced system in affine type A_n. This is joint work with Nathan Chapelier-Laget, Jeremie Guilhot and James Parkinson.
REPRESENTATION THEORY AND TENSOR CATEGORIES, MONDAY 16:30-16:55 ROOM 303-G14

Tree-polynomial representations of RNA secondary structures and their application in understanding R-loop formation

Pengyu Liu[1]

[1]University of Rhode Island

Graph polynomials, such as the Tutte polynomial, are fundamental mathematical tools for analyzing discrete structures. They encode structural information and can be expressed in vector or matrix forms. These polynomials enable the analysis of extensive structures using modern data analytic methods. In this talk, we present tree-polynomial representations of RNA secondary structures, based on a computationally efficient and interpretable polynomial for trees. We apply these new representations of RNA secondary structures to understand the mechanisms of R-loop formation.
TOPOLOGY, GEOMETRY AND COMBINATORICS OF BIOPOLYMERS, THURSDAY 14:30-14:55 ROOM 260-221

Normal approximation of subgraphs counts in the random-connection model

Qingwei Liu[1], *Nicolas Privault*

[1]National University of Singapore

This paper derives normal approximation results for subgraph counts written as multiparameter stochastic integrals in a random-connection model based on a Poisson point process. By combinatorial arguments we express the cumulants of general subgraph counts using sums over connected partition diagrams, after cancellation of terms obtained by Mobius inversion. Using the Statulevicius condition, we deduce convergence rates in the Kolmogorov distance by studying the growth of subgraph count cumulants as the intensity of the underlying Poisson point process tends to infinity. Our analysis covers general subgraphs in the dilute and full random graph regimes, and tree-like subgraphs in the sparse random graph regime.
Probability and Mathematical Statistics, Friday 14:45-14:55 Room 260-098

Optimal Information Disclosure of the Principal-Agent Problem in Infinite Horizon

Ruyi Liu[2], *Zhou Zhou*[1]

[1]The University of Sydney, [2]The Hong Kong Polytechnic University

Information disclosure is crucial in leader-follower games. We examine a discrete-time Principal-Agent problem in an infinite-horizon setting. Inspired by pure information disclosure strategies, we begin by analyzing the followers' utilities and constructing randomized strategies that lie between pure strategies. We then derive the optimal strategies from the leader's perspective. A numerical study is included to illustrate the key findings.
Stochastic Differential Equations, Friday 11:30-11:55 Room 260-016

BNSR invariants and the tropical variety of jump loci

Yongqiang Liu[1]

[1]University of Science and Technology of China

Papadima and Suciu studied the relationship between the Bieri-Neumann-Strebel-Renz (short as BNSR) invariants of a space and its homology jump loci of rank one local systems. Recently, Suciu improved these results using the tropical variety associated to the homology jump loci of complex rank one local systems. In this paper, we extend Suciu's results to any field coefficients and integer coefficients, hence get a better upper bound for the BNSR invariants.
Singularities, Wednesday 10:30-11:20 Room 260-024

The Explicit Hypergeometric-Modularity Method

Ling Long[1], *Michael Allen, Brian Grove, Fang-Ting Tu*

[1]Louisiana State University

The theories of hypergeometric functions and modular forms are highly intertwined. In this talk we describe an explicit "Hypergeometric-Modularity" method for associating a modular form to a given hypergeometric datum. Our method utilizes Ramanujan's theory of elliptic functions to alternative bases, commutative formal group laws, finite field hypergeometric character sums and supercongruences.
Arithmetic Geometry and Number Theory, Wednesday 10:30-10:55 Room 405-430

Hypergeometric Functions and Modular Forms

Ling Long[1], *Michael Allen*[1], *Brian Grove*[1], *Fang-Ting Tu*[1]

[1]Louisiana State University

In this talk, we will use hypergeometric functions to explore a special class of weight-3 modular forms with multiplicative q-coefficients. These modular forms are bi-products of the Explicit Hypergeometric-Modularity Method which was developed based on three closely related aspects of hypergeometric functions: the classical complex aspect, the p-adic aspect initiated by Dwork, and the finite field or Galois aspect pioneered by Greene and Katz.
Special Functions, q-Series and Beyond, Thursday 11:30-12:20 Room 401-312

Pisier's Question: Steinberg Theorem Revisited

Jimeng Lu[1], *Fedor Sukochev*[1], *Dmitriy Zanin*[1]

[1]UNSW

We provide a new proof to Pisier's conjecture that "bounded convolution operators on $L_{p,\infty}(G)$, $0 < p < 2$, are also bounded on $L_p(G)$ if G is a compact Abelian group" in a more general manner. Our approach extends that of Steinberg and uses interpolation theory for the couple (L_0, L_2).
Functional Analysis and Operator Algebras, Wednesday 11:00-11:25 Room 260-055

16-Descent on Elliptic Curves

Victor (Sheng) Lu [1]

[1]University of Canterbury

The method of descent for Diophantine equations involves deriving auxiliary equations which may contain information on the solutions of the original equation. In modern number theory descent is used to find potential rational points of Abelian varieties. For elliptic curves over number fields K, algorithms for explicit p^n-descent for $p = 2$ and $n = 1, 2, 3$ has been developed. We aim to extend it to $n = 4$ case, which would allow us to find better bounds for the group of rational points $E(K)$ when the Tate-Shafarevich group of E/K has nontrivial 2-primary part. In this talk we describe the general theory behind descent, and some of the work we've done so far for 16-descent on elliptic curves over number fields. Please note that this research is still ongoing.

Computational Number Theory and Applications, Wednesday 11:00-11:10 Room 405-422

Convergence Theory for Expansive Markov Chains

Russell Luke[1]

[1]Georg-August-University of Goettingen

We consider the problem of computing the invariant distribution of a Markov process. This is motivated primarily from problems in optimization where the input data, sampled from some unknown distribution, follows some nonconvex model. We develop a framework for analyzing the convergence to invariant measures of random fixed point iterations built from mappings that, while expansive, nevertheless in aggregate concentrate on an invariant distribution of the corresponding Markov operator. Building on techniques that we have established for determining rates of convergence of numerical methods for inconsistent nonconvex feasibility, we lift the relevant regularities to the setting of probability spaces to arrive at a convergence analysis for noncontractive Markov operators. This approach has many other applications, for instance the analysis of distributed randomized algorithms, and, of course, machine learning. We illustrate the approach on the problem of stochastic tomography for determining the electron distribution of a molecule from randomly generated scattering data. This is joint work with Anja Sturm, Neal Hermer, Steffen Schultze and Helmut Grubmüller.

Optimisation, Thursday 11:30-12:20 Room 402-221

Stokes' phenomenon, discretization, and discrete integrability

Christopher Lustri[1]

[1]The University of Sydney

Discrete equations such as the discrete Painleve I equation can be written in terms of an infinite-order differential equation. We will consider a family of equations obtained by truncating this infinite-order differential equation at different orders. In this talk we will answer two questions: (1) How does discretization connect the Stokes' phenomenon in continuous and discrete Painleve I? (2) How does integrability emerge in this family of equations in the discrete limit?
New directions in pattern formation, Tuesday 15:00-15:25 Room 303-B11

Complex Singularities in Analytically-Continued Nonlinear PDE Solutions

Christopher Lustri[1]

[1]The University of Sydney

About a decade ago, there was a spark of interest in studying PDE solutions by analytically continuing the solutions into the complex plane and studying the formation and dynamics of singularities. Interesting results were obtained, but the technical challenge of these methods slowed progress. In recent years, new asymptotic methods have been devised to study these singularities. I will show some recent results in this area on solutions to Burgers and KdV equations, and we can discuss other contexts in which this may be useful.
Mathematical methods in continuum mechanics and wave theory, Friday 14:00-14:25 Room 401-307

Bridging Assumed Knowledge Gaps with Technology: Implementing a University-Wide Mathematics Diagnostic Tool

Fu Ken Ly

[1]The University of Sydney

The pandemic has highlighted the need for innovative, technology-driven solutions to support students in tertiary mathematics education. This project addresses the challenge of assumed knowledge in mathematics—often a barrier for students entering university unprepared—through the implementation of a university-wide mathematics diagnostic tool. Developed using the The University of Sydney's Student Relationship and Engagement System (SRES), the tool enables students to assess their prior knowledge, plan their degree path, and connect with tailored support resources. This presentation outlines the implementation and findings from a pilot rollout, and explores how this digital tool empowers students to engage more actively with their learning. We discuss how this digital tool can help to meet emerging governmental requirements for early, proactive student support, and reflect on how the project can be scaled and expanded to meet the demands of the rapidly evolving educational landscape at the University of Sydney.
Mathematics Education, Thursday 15:00-15:25 Room 260-115

Modelling growth and metabolism of methanogens and other anaerobic microbial communities

Tammy Lynch[1], *Brandon Jones[1]*, *Peter Janssen*, *Bruce van Brunt[1]*

[1]Massey University

Methane from farmed ruminants (cattle, sheep, deer, goats) contributes about 35% of New Zealand's greenhouse gas (GHG) budget, and about 20% of total global GHGs from agriculture. Research is underway in New Zealand and overseas to develop technologies to reduce the amount of methane formed by farmed ruminants, without affecting animal productivity or product quality and with regards to the economic viability of farming enterprises. Mathematical models can be used to explore possible outcomes of animal experiments before these are conducted, allowing a more targeted approach for investigating mitigation technologies. Methane is formed in the rumen, the modified forestomach of ruminants, which is heavily colonised by a complex community of anaerobic microbes (microbes that grow in the absence of oxygen). Anaerobic microbes like methanogens grow under thermodynamic limitation caused by the concentrations of their energy sources and end-products. A threshold exists below which the anaerobic microbes cannot metabolise their energy source (substrate). In this talk we extend a mathematical model (Lynch et al., 2019, J Theor Biol 477: 14-23) developed for methanogens that incorporates this thermodynamic limitation. In the extension the ability of the microbe to modulate its metabolism (by changing the energy required to produce ATP) is included, allowing a decrease in threshold and the ability of the microbe to survive in conditions that would not otherwise be possible. Results of the model are validated against laboratory data on over 100 anaerobes, making it generally applicable to a wide range of microbes with different metabolisms.
Industrial Mathematics, Friday 11:30-11:55 Room 402-211

Generalized Temperley-Lieb algebras and their diagram presentation

Mengfan Lyu[1]

[1]Western Sydney University

The generalised Temperley-Lieb algebra $TL_{r,1,n}$, which is defined as a quotient of the cyclotomic Hecke algebra $H(r,1,n)$ as well as the isomorphic cyclotomic KLR algebra of type A_{n-1}, can be regarded as a generalisation of the Temperley-Lieb algebras of type A and B corresponding to the unitary reflection groups $G(r,1,n)$. In the talk, I will introduce a graded cellular structure for the generalised Temperley-Lieb algebra, which is inherited from the cyclotomic KLR algebra. I will also introduce the diagrammatic descriptions of the generalised Temperley-Lieb algebra $TL_{r,1,n}$ associated with this cellular basis.
Representation Theory and Tensor Categories, Friday 14:30-14:55 Room 303-G14

Nonlocality, integrability and solitons

Wen-Xiu Ma[1]

[1]University of South Florida

We will discuss integrable models that involve involution points. By reducing classical Lax pairs, we generate nonlocal integrable models. Solitons for these models are produced through Darboux transformations or reflectionless Riemann–Hilbert problems in the nonlocal setting.
Discrete and continuous integrable systems: geometry analysis and applications, Thursday 15:00-15:25 Room 260-036

A Generic Scheme for Quadratic Minimisation

Liam MacDonald[1], *Rachael Tappenden*[1], *Rua Murray*[1]

[1]University of Cantebury

A Generic Scheme for quadratic optimization is introduced. The Generic Scheme can be considered a 'multi'-directional search method, with the gradient as one of the directions. The exact step sizes for each direction are found by minimising the gradient under a matrix norm. This scheme also allows for symmetric preconditioning. Several state-of-the-art algorithms including the (preconditioned) Conjugate Gradient method and the Conjugate Residual method are included within this scheme. Linear convergence is established for all algorithms, and stronger results are available for some choices of search directions. Convergence with relaxation is established, and numerical experiments demonstrate the advantage of relaxation in certain cases.
Optimisation, Tuesday 16:30-16:55 Room 402-221

Toric Bertini theorems in arbitrary characteristic

Diane Maclagan[1]

[1]University of Warwick

The classical Bertini theorem on irreducibility when intersecting by hyperplanes is a standard part of the algebraic geometry toolkit. This was generalised recently, in characteristic zero, by Fuchs, Mantova, and Zannier to a toric Bertini theorem for subvarieties of an algebraic torus, with hyperplanes replaced by subtori. I will discuss joint work with Gandini, Hering, Mohammadi, Rajchgot, Wheeler, and Yu in which we give a different proof of this theorem that removes the characteristic assumption. The proof surprisingly hinges on better understanding algebraically closed fields containing the field of rational functions in n variables, which involve polyhedral constructions. An application is a tropical Bertini theorem.
Computations and applications of algebraic geometry and commutative algebra, Wednesday 11:00-11:25 Room 303-B05

Tropical Vector Bundles

Diane Maclagan[1]

[1]University of Warwick

Tropicalization replaces a variety by a combinatorial shadow that preserves some of its invariants. When the variety is a subspace of projective space the tropical variety is determined by a (valuated) matroid. I will review this, and discuss a resulting definition for a tropical vector bundle in the context of tropical scheme theory. This is joint work with Bivas Khan.
Algebraic Combinatorics and Matroids, Thursday 11:30-11:55 Room 303-B09

Identifiability and reparameterisation methods for inverse problems

Oliver Maclaren[1], *Joel Trent*[1], *Matthew Simpson*[2], *Ruanui Nicholson*[1]

[1]University of Auckland, [2]Queensland University of Technology

In many areas of applied mathematical modelling, models contain parameters that cannot be determined from the experimental designs available. Thus, estimation for these models is an ill-posed inverse problem. The lack of uniqueness for these models is called (structural) non-identifiability in the modelling and statistics literature. While classical regularisation methods or related approaches, such as Bayesian inference with informative priors, can formally resolve the lack of uniqueness, practitioners often want to understand which aspects of the model can be determined by the experiments available and which require different types of information. Here, we present our recent work on automatically finding structurally and practically identifiable nonlinear reparameterisations of mathematical models that highlight which aspects of the model are well-estimated from the data available.
Stochastic and Deterministic Inverse Problems, Monday 15:00-15:25 Room 260-223

Workshop: A Combinatorial Game

Dominic Maderazo[1], *Cait Pryse*[1], *Paul Fijn*[1], *Cindy Huang*[1], *Susan James*[1]

[1]The University of Melbourne

We will run an example of a hands-on learner-centred workshop, designed and run for students in primary and secondary schools. Time permitting, we will also discuss the refinements made to the workshop over time that consider the practicalities of running the workshop in a variety of classroom settings.
Engagement with mathematics through communication and outreach, Tuesday 16:00-16:55

Room 260-040

On the evaluation of a class of integrals involving the product of a Bessel function, a trigonometric function and a polynomial term.

John D. Mahony

Integrals with integrands that involve the product of a Bessel function (first kind), a single polynomial term of some prescribed integer power, and a simple trigonometric term, which can be a cosine function or a sinc function, are of interest to mathematicians and engineers alike. For the former who are interested in special functions, such integral types can occur in studies related to Fourier-Bessel series expansions and to associated studies of the finite Hankel transform. For the engineer, such integrals arise in the discipline of antenna theory concerned with the analysis and design of large radiating circular apertures, and integral evaluation has in the past been somewhat troublesome because such integrals were felt to be intractable. However, this is not always the case, and it is possible to develop, prescriptively, an expression/formula for their evaluation in terms of known library functions that can be accommodated on a spreadsheet, without recourse to the usual time-consuming methods of numerical integration. In the process, a variety of trigonometric results, Chebyshev polynomial results and Bessel function results are employed to render the integrals tractable. Such an exercise allows the antenna engineer to extract, more easily, radiation pattern characteristics of interest, such as such as half-power beamwidths, side lobe levels and directivity factors, but the prime focus here is on the development of the integration formulae that allows for this.
Industrial Mathematics, Friday 14:30-14:55 Room 402-211

Weyl substructures, polar kangaroos and uniclass automorphisms of spherical buildings

Hendrik Van Maldeghem[1]

[1]Ghent University

The prototype of interplay between groups and geometries is provided by the theory of buildings. In this talk, which is joint work with James Parkinson, and parts of it also with Yannick Neyt and Daan Rijpert, we show how a building-theoretic condition on an automorphism of a spherical building translates into a general condition on the fixed point structure, and also into a condition on the displacement spectrum of the automorphism in the corresponding (Grassmannian or shadow) geometries. This is a tale about unicorns, kangaroos, ideal subspaces and magic squares.
Groups and Geometry, Friday 14:30-15:20 Room 260-092

Morse Theoretic Gaussian Elimination for Rouquier Complexes

Leonardo Maltoni[1]

[1]Australian National University

Rouquier complexes were introduced to study braid group actions on categories, especially in representation theory. They are also important in algebraic topology as they relate to Khovanov-Rozansky triply graded link homology. These complexes are described in terms of the homotopy category of the Hecke category, and have standard representatives which are very difficult to use in practice. In this talk, after introducing the prerequisites, I will present reduced representatives for positive Rouquier complexes, obtained via a discrete Morse theoretic approach to Gaussian elimination for complexes.

Representation Theory and Tensor Categories, Friday 12:00-12:25 Room 303-G14

Bifurcation analysis of a two-delay model for the Atlantic Meridional Overturning Circulation

Renzo Mancini[1], *Bernd Krauskopf*[1]

[1]The University of Auckland

We perform a bifurcation study of a conceptual model for the Atlantic Meridional Overturning Circulation (AMOC) in the form of a scalar delay differential equation (DDE) with two time delays. The time delays are associated with the negative salinity feedback between the Equator and the North Pole, and the density exchange between the surface and deep water at the Pole. After rescaling, the delays are the only parameters of the model. The presented model is interesting beyond the context of the AMOC as a new type of DDE with two multiplicative delay terms, which is effectively the logistic growth equation with two independent delay times. As such, this DDE can be seen as a generalization of the Hutchinson-Wright equation, which has been introduced in two seminal papers in the rather different contexts of the distribution of primes and population dynamics. We perform a comprehensive bifurcation study of this DDE model as a function of the two delays. In particular, the system exhibits different types of complex oscillatory behavior, which we analyze with the software package DDE-Biftool for Matlab. This enables the identification and characterization of fascinating dynamics, including codimension-two Belyakov and Shilnikov-Hopf global bifurcations in the parameter plane of the two delays, which act as organizing centers for nearby dynamics. In particular, we discover previously unknown limiting periodic oscillations with rational ratios between the delays and the associated period, which we refer to as locking orbits. Moreover, we show where in the parameter space, nontrivial oscillations are stable and, hence, observable in the context of the AMOC. We observe that these stable solutions are organized in a repeating structure involving dynamics on invariant tori and associated bifurcations, which include torus break-up to chaotic behavior.

Differential delay equations and their applications, Tuesday 16:30-16:55 Room 303-B05

Sun's conjecture on the summatory function of $(-2)^{\Omega(n)}$

Riddhi Manna[1]

[1]Unsw Canberra At Adfa

A conjecture of Sun states that the sum of $(-2)^{\Omega(n)}$ taking n up to x, denoted by $W(x)$, can be bounded as $|W(x)| \leq x$ for all $x \geq 3078$. Here $\Omega(n)$ denotes the number of prime factors of n counted with multiplicity. Sun's conjecture was verified by Mossinghoff and Trudgian for $x < 2.5 \cdot 10^4$. Merten's conjecture is of a similar form and this was famously verified for large values of x and then later shown to be false. This makes it possible for Sun's conjecture to also be false for large values. Interestingly, in a recent work Johnston, Leong and Tudzi proved that Sun's conjecture predicts the correct order of approximation. They showed that $|W(x)| \leq O(x)$ with the implied constant being 2260. The problem can be approached using analytic techniques. We consider the summatory function of $(-2)^{\Omega}(n)\log(x/n)$, to introduce a degree of smoothness to the sum and analyze it using techniques of contour integration.
Computational Number Theory and Applications, Monday 14:30-14:40 Room 405-422

Deciding discreteness of groups of 2x2 matrices over local fields

Ari Markowitz[1]

[1]University of Auckland

In this talk we discuss the problem of deciding discreteness of finitely generated subgroups of SL2 over a local field. We present algorithms for R and Qp, as well as an algorithm to decide whether or not a finitely generated subgroup of SL2(K) is discrete and free where K is a non-Archimedean local field.
Groups and Geometry, Tuesday 16:00-16:25 Room 260-092

Past Instability of FLRW Solutions to the Einstein-Euler-Scalar Field Equations

Elliot Marshall[1]

[1]Monash University

The FLRW solution is the simplest cosmological model in general relativity, describing a fluid-filled, spatially homogeneous universe. While there is extensive literature on the dynamics of fluid-filled cosmologies, very little is known, outside of some special cases, about the behaviour of these models near the big bang. In this talk, I will focus on the past dynamics of perturbed FLRW solutions to the Einstein-Euler-scalar field system. In particular, I will discuss recent numerical work with F. Beyer and T. Oliynyk on the past instability of FLRW models with

sub-radiative equations of state.
Recent advances in geometric PDE, Wednesday 11:00-11:10 Room 260-057

Upsilon invariants for lens spaces

Lavender Marshall[1]

[1]Monash University

Knot Floer homology is a rich source of concordance invariants for knots in the 3-sphere. Sano (2019) proved that many of these invariants can be derived from G0-sets, constructed out of grid diagrams. In this talk, we will explain how to extend Sano's G0-sets to lens spaces. In particular, we give a combinatorial description of Ozsvath-Szabo-Stipsicz's Upsilon invariant for knots in lens spaces. We present an algorithm to compute these from twisted toroidal grid diagrams, and a sample calculation of the Upsilon invariants and G0-sets associated to a knot in L(3, 1).
Early Career Showcase in Low-Dimensional Topology, Monday 15:00-15:25 Room 260-073

GNLS: an R Program for Errors-in-Variables Fitting

Simon Marshall[1]

[1]University of Western Australia

The R programming language, together with its numerous packages for specialized applications, has become firmly established as a preferred vehicle for exploratory data analysis and statistical modeling. The built-in `nls()` function available for nonlinear parameter estimation relies on (i) the distinction between regressor and response variables; (ii) the existence of an explicit functional relationship between them, and (iii) absence of errors in the regressors; since these assumptions are not always justified, the present article addresses the need for a more general treatment that avoids them. This formulates the generalized least squares problem as a constrained minimization of the weighted sum of squared residuals, to be solved iteratively for the regressors and parameters. The key inputs are a subprogram evaluating the scalar or vector function to be fitted, a matrix containing the covariances of the regressors at each design point, and an initial estimate of the parameters - all the required partial derivatives are approximated by central differences. The program is suitable for application to models defined by one or more nonlinear, implicit relationships between parameters and regressors at each datum, arising in a diverse range of fields. Application to data reduction problems in physical chemistry and chemical physics is demonstrated.
Optimisation, Thursday 15:00-15:25 Room 402-221

The Wrapped Hyperbolic Secant Distribution and its Binary Mixtures

Simon Marshall[1]

[1]University of Western Australia

Bimodal circular data are commonly analysed by assembling binary mixtures of von Mises distributions, or by use of the Generalized von Mises distribution. While the latter function has the advantage of being of exponential class, the cumulative probability function is not easily calculated for either distribution, since it involves infinite series of modified Bessel functions. In this article, it is shown that the wrapped hyperbolic secant distribution exhibits similar qualitative behavior to the von Mises distribution, but possesses the additional advantage of being analytically integrable. Rapidly converging series representations of the probability density function are derived, leading to particularly simple expressions for the circular moments of arbitrary order, and computationally robust application of the method of moments to the determination of parameters in binary mixtures of such distributions is described. The use of these distributions in representing bimodal wind direction data is demonstrated.

Probability and Mathematical Statistics, Friday 15:15-15:25 Room 260-098

Money, Reputations, and Evolutionary Game Theory

Stephen Marsland[1], *Marcus Frean*[1]

[1]Victoria University of Wellington

Helping strangers at a cost to oneself is a hallmark of many human interactions, but difficult to justify from the viewpoint of natural selection, particularly in anonymous one-shot interactions. The mathematics of evolutionary game theory provide a potential explanation for this via 'indirect reciprocity' (you scratch my back because I scratched somebody else's), but research has largely been restricted to simple binary 'good and bad' situations. This makes the reputation that underlies indirect reciprocity almost memoryless– limited to the previous transaction – which seems particularly limiting for a mechanism that is usually acknowledged to be specific to humans amongst all animals. At the other extreme from a binary reputation is a score: a lifetime record of the number of positive and negative actions (according to a pre-chosen evaluation system known as the social norm) that the agent has chosen. Based on the formulation of population dynamics as a birth-death Markov chain we have the ability to analyse the far richer dynamics of score-based reputations and the interactions they allow, including the case where scores might be managed by mutual consent between the agents themselves without oversight by third parties, and the case where reputations change according to how others act towards you as well as how you act towards them. We demonstrate that it is sufficient to record only status as a cooperator (i.e., using only positive integers to record how many times more an agent with positive status has correctly followed the social norm) to obtain perfect cooperation within a society, that there are many social norms that facilitate this – including several that do not work in the binary case – and that they are extremely robust against noise. We analyse these strategies to identify what makes them successful and identify the components of the social norm that are most critical in allowing cooperation by indirect reciprocity to arise. We also prove that mutual consent by score mediation is possible, and that the strategies that allow

it and are evolutionarily stable belong to one family, which ground the concept of value by incrementing one score at the cost of the other, thus closely resembling the token exchange that underlies money in everyday human transactions. The equilibrium distribution of scores under any of this family of strategies is geometric, meaning that agents with score 0 are inherent to money-like strategies.
Contributed Session A, Tuesday 15:00-15:25 Room 260-016

Hypergeometric Polynomials with Free Probability Tools

Andrei Martínez-Finkelshtein[2]

[1]Baylor University, [2]University of Almeria

Mathematics is a highly interconnected field, and ideas that were initially developed in one context can sometimes find unexpectedly fruitful applications in seemingly unrelated domains. A striking example of this is the recent application of tools from free probability theory to the study of the zeros of polynomials. One such concept is the finite free convolution of polynomials, introduced relatively recently. This concept becomes particularly appealing when applied to hypergeometric polynomials. Remarkably, these polynomials can be represented as a finite free convolution of more elementary building blocks. This representation, combined with the preservation of real zeros and interlacing properties through free convolutions, provides an effective tool for analyzing when all roots of a particular hypergeometric polynomial are real and when they exhibit monotonicity with respect to parameters. Consequently, this approach offers a fresh perspective on the zero properties of hypergeometric polynomials. Furthermore, this representation remains valid even in the asymptotic regime, allowing us to express the limit zero distribution of generalized hypergeometric polynomials as a free convolution of more "elementary" measures. This convolution can be expressed analytically by combining some integral transforms of these measures. In the case of hypergeometric polynomials, some of these transforms take a particularly simple form. These results are demonstrated through applications to some families of multiple (or Hermite-Padé) orthogonal polynomials that can be expressed in terms of generalized hypergeometric functions. This is joint work with R. Morales (Baylor University) and Daniel Perales (Texas A&M University).
Special Functions, q-Series and Beyond, Thursday 14:00-14:25 Room 401-312

Upper bound estimates on the dimension of the global attractor for the 2D NSE on the beta-plane

Vincent Martinez[1]

[1]City University of New York, Hunter College & Graduate Center

In 2011, M.A.H. Al-Jaboori and D. Wirosoetisno proved that the global attractor of the 2D Navier-Stokes equations on the beta-plane collapses to a single zonally-confined point when rotation is sufficiently fast. However, estimates on the dimension of the global attractor for slower rotation rates were not obtained. This talk will present upper bound estimates on the

dimension of the global attractor for a wide range of rotation rates. The key ingredients for obtaining these estimates are the so-called “differentiation-by-parts” technique of Babin, Ilyin, and Titi applied to the linearized system and a careful quantification of the dependence of the long-time average of non-zonal palenstrophy on the Grashof and Rossby number.
Recent advances in mathematical fluid dynamics, Thursday 15:00-15:25 Room 401-311

Flow of the zeros of polynomials under iterated differentiation

Andrei Martinez-Finkelshtein[1], *Evgenii Rakhmanov*[3]

[1]Baylor University, [2]University of Almeria, [3]University of South Florida

Assume we have a sequence of polynomials whose asymptotic zero distribution is known. What can be said about the zeros of their derivatives? Especially if we differentiate each polynomial several times, proportional to their degree? This simple-to-formulate problem has recently attracted the attention of several researchers. Both the problem and its solution methods have exciting connections with free probability, random matrices, approximation theory on the complex plane, and non-linear PDE, such as the inviscid Burgers equation.
Discrete and continuous integrable systems: geometry analysis and applications, Tuesday 16:30-16:55 Room 260-036

TEAM Reflection Cycles: Supporting Instructors to Teach Equity-minded Active Mathematics

Alison Marzocchi[1]

[1]California State University, Fullerton

A growing number of mathematics instructors in the USA are convinced of the benefits of equity-minded active learning and desire to improve their instruction, but do not yet have the knowledge, confidence, or skills to do so. Instructional transformation is difficult and faculty need effective professional development tools and formats to support their improvement. Among numerous other professional development activities, our department offers Reflection Cycles to mathematics instructors who desire to transform their instruction. We offer two formats of Reflection Cycles: researcher-facilitated or peer-facilitated. Researcher-facilitated Reflection Cycles are led by a trained student researcher. Peer-facilitated Reflection Cycles involve pairs of faculty leading Reflection Cycles with each other. In either format, a Reflection Cycle consists of three phases: planning, implementation, and debrief. The planning phase involves the facilitator guiding the instructor to set specific goals for a particular upcoming lesson while striving towards more equity-minded active instruction. The implementation phase involves the facilitator observing the instructor during a regularly scheduled class session, while directing their attention to the goals set by the instructor. The debrief phase involves the facilitator guiding the instructor to reflect on the implementation of their goals and to set new goals for the future. A second Reflection Cycle can then be scheduled to continue working on the same goals or to set new goals. University mathematics courses in the USA have long been considered

gatekeepers, bottlenecks, or even dream-crushers for students pursuing postsecondary degrees. Students from historically marginalized population groups are disproportionally impacted by opportunity gaps in mathematics. Reflection Cycles support faculty to improve their instruction to be more equity-minded and active by following a format that is voluntary, supportive, educative, self-guided, and sustainable. This allows all instructors, regardless of prior knowledge, confidence, or skills, to work gradually and continuously to improve their instruction. They are also low-cost and facilitated in-house. Thus, Reflection Cycles could lead to improvements in instruction that close opportunity gaps and allow more students, particularly those from historically marginalized population groups, to succeed in university mathematics courses.
Contributed Session A, Monday 14:30-14:55 Room 303-B11

Asymptotic behavior of solutions to systems of cubic NLS equations in 1D

Satoshi Masaki[1]

[1]Hokkaido University

In this talk, we consider the asymptotic behavior of solutions to a class of systems of cubic NLS equations in 1D. The cubic nonlinearity is critical in 1D, and the modified scattering result is well-known. Our motivation is to understand the complexity and variety of nonlinear effects in the system case. To this end, we also introduce an argument to classify the systems. It will turn out that the analysis of the corresponding ODE system is crucial. In several cases, we find the explicit asymptotic profile of small solutions in terms of elementary functions and Jacobi elliptic functions.
Harmonic analysis and Hamiltonian PDE, Tuesday 11:30-12:20 Room 260-028

Chow functions for partially ordered sets

Luis Ferroni[1], **Jacob Matherne**[2], *Lorenzo Vecchi*[3]

[1]Institute for Advanced Study, [2]North Carolina State University, [3]KTH Royal Institute of Technology

In this talk, I will associate a "Chow polynomial" to any pair (P, κ) consisting of P a finite, graded, bounded poset and κ a certain element of the incidence algebra $I(P)$ called a P-kernel. For the pair where P is the lattice of flats of a matroid and κ is the characteristic polynomial, we recover the Poincaré polynomial of Feichtner-Yuzvinsky's Chow ring of a matroid (the so-called Chow polynomial of a matroid). I will discuss general properties of these Chow polynomials as well as connections to other settings such as convex polytopes and Coxeter groups. In addition, I will explain some relations between these Chow polynomials and the Kazhdan-Lusztig-Stanley polynomials that can also be constructed from such a pair (P, κ). This is ongoing joint work with Luis Ferroni and Lorenzo Vecchi.
Algebraic Combinatorics and Matroids, Friday 14:00-14:25 Room 303-B09

Some four-genus bounds and unknotting by full twists

Alexandra Kjuchukova, **Gordana Matic[1]**, *Linh Truong*

[1]University of Georgia

Donald and Vafaee constructed a knot slicing obstruction using Furuta's 10/8 theorem and Truong used a refinement of this result by Hopkins-Lin-Shi-Xu, the10/8+4 theorem, to strengthen this slicing obstruction. We in turn construct a lower bound on the four-ball genus of a knot from the 10/8+4 theorem and produce an Arf invariant obstruction to unknotting a knot by a sequence of full twists of specified odd linking numbers.
Early Career Showcase in Low-Dimensional Topology, Tuesday 15:00-15:25 Room 260-073

A geometric perspective on generalized weighted Ehrhart theory

Laurentiu Maxim[1], *Joerg Schuermann[2]*

[1]University of Wisconsin - Madison, [2]University of Muenster

Classical Ehrhart theory for a lattice polytope encodes the relation between the volume of the polytope and the number of lattice points the polytope contains. In this talk, I will discuss a geometric interpretation, via the (equivariant) Hirzebruch-Riemann-Roch formalism, of a generalized weighted Ehrhart theory depending on a homogeneous function on the polytope and with Laurent polynomial weights attached to each of its faces. In the special case when the weights correspond to Stanley's g-function of the polar polytope, we recover in geometric terms a recent combinatorial formula of Beck-Gunnells-Materov. (Based on joint work with Joerg Schuermann.)
Algebraic Combinatorics and Matroids, Thursday 15:00-15:25 Room 303-B09

On information theory in geometric measure theory

Elvira Mayordomo[1]

[1]Universidad de Zaragoza

Effective and resource-bounded dimensions were defined by Lutz in [4] and [3] and have proven to be useful and meaningful for quantitative analysis in the contexts of algorithmic randomness, computational complexity and fractal geometry (see the surveys [1, 5, 2, 10] and all the references in them). The point-to-set principle (PSP) of J. Lutz and N. Lutz [6] fully characterizes Hausdorff and packing dimensions in terms of effective dimensions in the Euclidean space, enabling effective dimensions to be used to answer open questions about fractal geometry, with already an interesting list of geometric measure theory results (see [9, 8] and a long list of more recent results). In this talk I will review the point-to-set principles focusing on its recent extensions to separable spaces [7] and to Finite-State dimensions [11], and presenting open questions as well as further application opportunities.

References

[1] Downey, R.G., Hirschfeldt, D.R.: Algorithmic randomness and complexity. Springer-Verlag (2010)

[2] J. M. Hitchcock, J. H. Lutz, and E. Mayordomo. The fractal geometry of complexity classes. *SIGACT News Complexity Theory Column*, 36:24–38, 2005.

[3] Lutz, J.H.: Dimension in complexity classes. SIAM Journal on Computing **32**(5), 1236–1259 (2003)

[4] Lutz, J.H.: The dimensions of individual strings and sequences. Information and Computation **187**(1), 49–79 (2003)

[5] Lutz, J.H.: Effective fractal dimensions. Mathematical Logic Quarterly **51**(1), 62–72 (2005)

[6] Lutz, J.H., Lutz, N.: Algorithmic information, plane Kakeya sets, and conditional dimension. ACM Transactions on Computation Theory **10** (2018), article 7

[7] Lutz, J.H., Lutz, N., Mayordomo, E.: Dimension and the structure of complexity classes. Theory of Computing Systems **67**, 473—-490 (2023)

[8] Lutz, J.H., Mayordomo, E.: Algorithmic fractal dimensions in geometric measure theory. In: Brattka, V., Hertling, P. (eds.) Handbook of Computability and Complexity in Analysis. Springer-Verlag (2021)

[9] Lutz, J., Lutz, N.: Who asked us? how the theory of computing answers questions about analysis. In: Complexity and Approximation: In Memory of Ker-I Ko. Springer, ding-zhu du and jie wang (eds.) edn. (2020)

[10] E. Mayordomo. Effective fractal dimension in algorithmic information theory. In *New Computational Paradigms: Changing Conceptions of What is Computable*, pages 259–285. Springer-Verlag, 2008.

[11] Mayordomo, E.: A point to set principle for finite-state dimension. Tech. Rep. arXiv:2208.00157, Arxiv (2022)

COMPUTABILITY THEORY AND APPLICATIONS, TUESDAY 11:30-12:50 ROOM 303-B07

Computer-assisted proofs for blenders

Natalia Mcalister[1]

[1]Monash University

The aim of this project is to develop computational techniques to detect blenders. A blender is a hyperbolic set whose unstable manifold, when looking at certain intersections, seems to have a greater dimension than it actually does. This descriptive definition cannot be verified on a computer. The first step is then stating necessary conditions for establishing the existence

of a blender in a computer-friendly way. Then, we develop a method to verify said necessary conditions. In this talk I present an algorithm for verifying the existence of a blender for a skew product over the Henon map. This algorithm could potentially be extended to more challenging examples.
Computational Methods and Applications of Dynamical Systems, Thursday 14:30-14:55 Room 303-G20

A Mathematician Teaches Statistics

Tim McDevitt[1]

[1]Elizabethtown College

Many mathematicians like me are asked to teach elementary statistics courses in spite of having little to no training in the field, and we often have to promulgate implementation advice from textbooks without substantial evidence for those claims in the books. For example, many textbooks say that the sample size must be at least thirty before using the central limit theorem. This talk explores evidence for many of the statistical guidelines encountered in the first two elementary statistics courses including the central limit theorem, the plus-4 rule for confidence intervals for proportions, the robustness of t-tests and lack of robustness of the χ^2 and F-tests, and the loss of power that occurs when using nonparametric tests.
Contributed Session A, Monday 15:00-15:25 Room 303-B11

The harmonic measure distribution function and stopping times of complex Brownian motion

Clayton McDonald[1]

[1]Monash University

1Monash University The harmonic measure distribution function or "h-function" of a domain Ω in C with base point $x \in \Omega$ is defined as the probability Brownian motion started at x exits through Ω at a distance r from x. Given a domain in C, one can determine the h-function of that domain through numerical simulations or complex-analytic techniques, usually involving analytic invariance of Brownian motion. The inverse problem is an interesting open problem: given a suitable function h, does there exist a domain in C such that the h-function of that domain is h. In this talk we extend the problem from domains to stopping-times, and then showcase an algorithm to construct said stopping time. In the case the stopping-time corresponds to a hitting time of some domain we solve the original problem. The stopping-time is defined as the projection of the hitting time of the real line from the half-plane through some constructed analytic function. The algorithm is simple to compute so any h-function can be tested. We have found a large family of h-functions such that the constructed stopping time corresponds to a hitting time for some domain. And for the cases in which it doesn't the problem can be lifted to a Riemann surface such that the stopping-time is a hitting time.
Stochastic Differential Equations, Monday 16:00-16:25 Room 260-016

Rosette harmonic mappings, their generalizations, and deformation to the classical Enneper surface

Jane Mcdougall[1], *Sohair Abdullah, Conor Wellman*

[1]Colorado College

A harmonic mapping f is a complex valued univalent harmonic function defined on a region in the complex plane. Rosette harmonic mappings are generalizations of the polynomial harmonic mappings $z+\overline{z}^{n-1}/(n-1)$ through modifying the canonical decomposition with hypergeometric ${}_2F_1$ factors. These mappings were discovered through a fortuitous application of Clunie and Sheil-Small's famous shear construction. For appropriate parameters, the harmonic mapping 'lifts', through Weierstrass Enneper equations, to the **rosette minimal surfaces**. One particular choice of the parameters leads to a **triply periodic minimal surface** (TPMS). We also describe the continuous deformation of this TPMS into the classical Enneper surface, using a further generalization of the rosette harmonic mappings.

Differential geometry and geometric analysis, Tuesday 14:00-14:25 Room 260-005

Luminescent Solar Concentrators

Stephen McDowall[1]

[1]Western Washington University

A luminescent solar concentrator (LSC) is a sheet of glass or plastic into which has been embedded nanometer luminophores which absorb light over a range of wavelengths and, with probability Φ, re-emit light at red-shifted wavelengths. Most re-emitted light is waveguided by total internal reflection to the edges of the sheet where there are photovoltaic cells to convert captured light to electrical energy. Efficiency of power conversion depends on the quantum yield Φ together with spatially varying material parameters such as: concentration β of luminophores, Rayleigh scattering γ, and attenuation α. In scaling up to practically useful LSCs, scattering is a major obstacle to achieving efficiency in large panels. When prototype LSC's are made there is uncertainty about what exactly has been fabricated. This motivates considering the inverse problem of determining the material parameters from boundary measurements, modeling photon transport within an LSC using a wavelength-dependent transport equation. We will present this model together with a treatment of the inverse problem, and will present progress which has been made toward commercialization of this technology.

Microlocal analysis and inverse problems, Wednesday 11:30-11:55 Room 260-009

Non-realistic black holes, non-hypergeometric equations, and non-accessible invariants

Joseph McGovern[1], *Johanna Knapp*

[1]University of Melbourne

For highly supersymmetric black holes in five dimensions, string theory is known to reproduce the Bekenstein-Hawking area-entropy law. Accomplishing this for less supersymmetric 4d configurations, which bear more resemblance to our universe, remains an important open problem. In the 4d N=2 case, the microstate counts possess captivating relations to the enumerative geometry attached to compact Calabi-Yau threefolds. Powerful formulae due to Feyzbakhsh relate counts of D4D2D0 bound states to Pandharipande-Thomas invariants, which themselves are related to Gopakumar-Vafa (GV) invariants by the MNOP conjecture. GV invariants have as generating series the topological string partition function, and the determination of this to arbitrarily high genus is another major outstanding problem. In this talk, we discuss work that applies the modular bootstrap method of Alexandrov-Feyzbakhsh-Klemm-Pioline-Schimmanek, which exploits modularity properties of the D4D2D0 invariants to compute previously unknowable GV invariants. We do this for non-hypergeometric Calabi-Yau threefolds, which have previously been unexplored. This means that the Picard-Fuchs equation governing the periods is not of generalised hypergeometric type, which produces certain technical difficulties but is no real obstacle. Those same modularity properties mentioned also lead to the computation of infinitely many (but not every) D4D2D0 indices. We are able to provide the first non-hypergeometric examples of the modular generating function for these indices. We also relax assumptions on the simply-connectedness of our Calabi-Yau, so that our computations may provide interesting new data to inform future work.
Mathematical Physics, Tuesday 11:30-11:55 Room 260-221

Microwaving Ore to Detect Moisture Content

Mark McGuinness[1], *Lata Paea*[2], *Sione Paea*[3]

[1]Victoria University of Wellington, [2]University of Auckland, [3]University of the South Pacific

A key uncertainty when delivering bauxite ore to an alumina factory is the moisture content in the shipment. A microwave analyser measures phase shift and attenuation in real time, of microwaves passing through the ore while it is entering the factory on a conveyor belt. These measurements are used to infer the moisture content of the ore, which affects its weight, and directly impacts the price paid per tonne. Our study is motivated by data provided to a Study Group with Industry that was collected from a number of shipments of bauxite ore. A single-layer model based on Maxwell's differential equations for electromagnetic wave propagation in bauxite underlies the regression that the microwave analyser uses to infer moisture content. This model predicts a linear dependence of data on ore height, and fails to explain the highly nonlinear dependence on bauxite height that is seen in attenuation data. We develop and solve a four-layer model that allows reflections of electromagnetic waves at interfaces between ore and air. Our model solution features highly nonlinear attenuation as a function of ore height, providing convincing matches to analyser data. It explains how the interference effects of multiple internal

reflections cause data to be sensitive to setup geometry and ore height. It provides some hope of improving real-time measurement of ore moisture content using microwaves on a conveyor belt, while also sounding a cautionary note about the possibilities of non-invertibility of the data. Preliminary contacts with the company manufacturing the microwave analysers have not yet led to enthusiastic uptake of our modelling results. The machine in Limerick that provided our data in 2017 remains unused on the shipping conveyor belt for now, its results no longer trusted by the bauxite factory.
Industrial Mathematics, Thursday 15:00-15:25 Room 402-211

Modelling of three-component complex conflict with decision-making, host population support and resource redistribution

Sergiy Shelyag[1], **Jody McKerral**, *Yang Shi*

[1]Flinders University

How are decisions made and implemented? Decisions are based on time-dependent interactions with the environment, which is invariably complex, volatile and uncertain, with limited resources to redistribute on demand and compete for. This is applicable to any kind of decision-making, including competitive sports, co-operational and competitive organisational structures, military conflicts. Characterising and modelling decision-making processes and designing model-informed strategies for organisational structures with the aim to achieve favourable results, therefore, would be of interest. In this presentation, I will show a mathematical model of two adversarial populations in the vicinity of a neutral population and will explore the impact of each population pursuing specific decision-making strategies, given limited resources. The model is based on our previous efforts in conflict modelling and makes a bridge between static qualitative models and high-fidelity agent-based stochastic models, which, while quantitative, have reduced explanatory power and require significant computational resources. It employs multiple and multiscale processes to represent the military conflict, local population support and competition and resource redistribution functions. The model is defined by the archetypal *Lanchester*, *Lotka-Volterra* and *Kuramoto-Sakaguchi* components, which characterise adversarial interaction, population and resource dynamics and decision-making, with feedback between each component adding heterogeneity. In the model, the adversaries are capable of drawing and consuming resources from the neutral host population by demanding more production through influencing and enabling the decision-making initiative. The model is studied both analytically and numerically, and I will discuss applicability of the model to a variety of real-life scenarios.
Industrial Mathematics, Tuesday 16:30-16:55 Room 402-211

Maths Craft: An Unexpected Journey

Jeanette McLeod[1]

[1]University of Canterbury

Maths Craft New Zealand is a non-profit outreach initiative founded and run by mathematicians

Jeanette McLeod and Phil Wilson from the University of Canterbury. Maths Craft brings maths to the masses by celebrating the links between mathematics and craft. Our aim is threefold: to show young and old alike the fun, creativity, and beauty in mathematics through the medium of craft, to demonstrate just how much mathematics there is in craft, and to enable people to experience what it means to think like a mathematician. Since our inception in 2016, Maths Craft has reached 17, 000 people through festivals and workshops across Aotearoa New Zealand, and over 20, 000 school students through Maths Craft in a Box, making it New Zealand's largest mathematics outreach programme. We have secured over NZ$1, 000, 000 in grants, sponsorship, and in-kind support; written dozens of freely-available instructional handouts; trained and mentored many volunteers and team members; and run professional development for teachers. We have also incorporated Maths Craft into our university teaching and collaborated with other researchers to investigate the efficacy of our approach, resulting in publications. In this talk we explain who Maths Craft are and what we do, and discuss the nuts and bolts of running a maths outreach programme. We'll also reveal some of our exciting plans for 2025 and beyond.
Engagement with mathematics through communication and outreach, Tuesday 11:30-12:25 Room 260-040

Filtering Weak Keys in Quasi-Cyclic Code-Based Cryptosystems

Emily Mcmillon[1], *Gretchen Matthews*[2]

[1]Rice Unviersity, [2]Virginia Tech

Quasi-cyclic code-based cryptosystems have shown promise for use in post-quantum cryptography. One example is Bit Flipping Key Encapsulation (BIKE), which is based on quasi-cyclic moderate density parity-check (QC-MDPC) codes paired with an iterative decoder. A major issue preventing adoption of this standard is that decoding failures have been demonstrated to lead to an attack that recovers the BIKE private key. The decoder failure rate of these codes is difficult to determine, as their capabilities are governed by the code's graphical representation as opposed to traditional, more well-understood code parameters. In this talk, I will highlight combinatorial graph structures that lead to decoding failure for the iterative decoder used in BIKE and examine existing weak key filtering algorithms in light of these structures.
Computational Number Theory and Applications, Friday 15:00-15:10 Room 405-422

Modularity and Resurgence

Eleanor McSpirit

[1]Vanderbilt University

The study of asymptotics as q approaches roots of unity is central to the theories of mock and quantum modular forms. In a collection of works, Gukov, Pei, Putrov, and Vafa proposed a candidate for a q-series invariant of closed 3-manifolds inspired by physics. Many of these invariants are known to be mock and quantum modular forms, and this modularity has been integral to their study. Resurgent analysis is a natural tool to study this invariant from the

perspective of physics, and is a theory centrally concerned with the relationship of functions to their asymptotic series. This has lead to several questions on the interrelationship of resurgence and modularity. While this has been discussed across the subject, many questions still remain. This talk will discuss ongoing work to make this connection explicit and natural from the perspective of number theory.
SPECIAL FUNCTIONS, q-SERIES AND BEYOND, TUESDAY 14:00-14:50 ROOM 401-312

Electrical Wave Generation and Spatial Organisation in Uterine

Shawn Means[1], *Amy Garrett, Alys Clark, Leo Cheng, Jagir Hussan*

[1]Auckland Bioengineering Institute

Critical to the propagation of the human race, proper function of the uterus hinges on co-ordinated and spatially organised contractions – particularly at term. Unlike in cardiac or gastro-intestinal systems, no pacemaking mechanism is known to exist in the uterus. It remains mysterious how uterine contractile strengths and spatial organisation changes for the organ's dynamically varying roles over the duration of menstrual or, in animals, estral cycles. It is known, however, that intercellular electrical coupling via gap junctions dramatically increases at term. This fact combined with presence of electrically 'passive' cells in the uterine tissue suggests a dynamic intercellular interaction may be the trigger of activity by way of increased coupling between electrically disparate cells. We present results from our two-track effort investigating feasibility of this dynamic with both our theoretical investigation using a lattice-based model of uterine tissue, and experimental studies revealing more on the manner of gap junctional expression than simply their number.
CONTRIBUTED SESSION A, FRIDAY 12:00-12:25 ROOM 303-G15

Computable duality theory

Alexander Melnikov[1]

[1]Victoria University of Wellington

I will go over some recent results establishing direct links between computable structure theory and effective topology.
COMPUTABILITY THEORY AND APPLICATIONS, MONDAY 16:00-16:50 ROOM 303-B07

Numerical Implementation of the Friedrich-Nagy Initial Boundary Value Problem

Areeba Merriam

[1]University of Canterbury

The difference-of-convex (DC) program is a crucial approach to nonconvex optimization problems due to its structure, which encompasses a wide ranges of practical applications. In this paper, we aim to tackle a generalized class of DC programs, where the objective function is formed by summing a possibly nonsmooth nonconvex function and a differentiable nonconvex function with Lipschitz continuous gradient, and then subtracting a nonsmooth continuous convex function. We develop a proximal splitting algorithm that utilizes proximal evaluation for the concave part and Douglas–Rachford splitting for the remaining components. The algorithm guarantees subsequential convergence to a stationary point of the problem model. Under the widely used Kurdyka–Łojasiewicz property, we establish global convergence of the full sequence of iterates and derive convergence rates for both the iterates and the objective function values, without assuming the concave part is differentiable. The performance of the proposed algorithm is tested on signal recovery problems with a nonconvex regularization term and exhibits competitive results compared to notable algorithms in the literature on both synthetic data and real-world data.

Recent advances in geometric PDE, Monday 16:30-16:40 Room 260-057

Efficient Numerical Solution of the Wave Equation as Matrix Multiplication.

Mike Meylan[1]

[1]The University of Newcastle

The linear wave equation is usually solved by calculating the solution in the frequency domain. Such solutions mimic experiments where the system is driven by waves of a single frequency far from the scatterers, for example a long wave tank. However, the wave equation itself takes as input an initial condition and outputs the solution at a later time. The mapping which perform this is a single parameter continuous group and it is this object which is central to the wave equation and scattering theory. I will show that this operator can be approximated numerically as matrix multiplication using the single frequency solutions. The theory is widely applicable and I will illustrate it through different examples from acoustics, hydrodynamics and geophysics.

Mathematical methods in continuum mechanics and wave theory, Wednesday 11:30-11:55 Room 401-307

A super-resolution approach to classification

HRUSHIKESH MHASKAR[1]

[1]Claremont Graduate University (Claremont, CA, US)

The traditional approach in machine learning is to treat classification problem as a problem of function approximation. This creates a gap between the theory, where one requires the target function to be smooth, and the practice, where the class boundaries may be non-smooth, even touching each other. We propose a novel paradigm, where we consider each class k appearing with a probability distribution μ_k, $k = 1, \cdots, K$. The data consists of samples $\{x_j\}$ drawn from an unknown convex combination of these distributions. We then use our localized kernels developed for solving super-resolution signal separation problems to separate the supports of the measures μ_k. With these supports identified accurately, one can then seek the label of one of the points in each of the supports, and extend it to the entire support. In this "cautious active learning" manner, one can solve the problem with a small if not minimal number of labels queried at judiciously chosen points x_j.
Recent developments in data science and machine learning, Tuesday 15:00-15:25 Room 402-220

Radiation Transport Problem in Proton Therapy of Cancer

Dragan Mirkovic[1]

[1]The University of Texas MD Anderson Cancer Center

Proton therapy has emerged as a highly precise form of cancer treatment, offering distinct advantages over conventional radiation therapies by delivering targeted doses of radiation with minimal impact on surrounding healthy tissues. However, accurate dose calculations and treatment planning rely heavily on understanding and solving the radiation transport problem, which governs how protons interact with matter, lose energy, and scatter as they penetrate tissue. In this talk, we will explore the fundamental principles of radiation transport as applied to proton therapy, including the underlying physics of proton interactions, the computational techniques used to model proton trajectories, and the challenges of accurately predicting dose distributions within complex anatomical structures. Emphasis will be placed on Monte Carlo simulations for solving the transport equations, and the role of linear energy transfer (LET) in determining the biological effectiveness of proton beams. Additionally, the importance of accurate dose calculation within the complex and heterogeneous geometries of patients will be discussed. Using examples from our clinical practice, this talk aims to illustrate how advancements in radiation transport modeling are optimizing proton therapy, enhancing our understanding of cancer treatment outcomes, and offering valuable feedback for improving treatment strategies.
Industrial Mathematics, Monday 16:30-16:55 Room 402-211

The integrated model of the production planning and the assignment of warehouse locations to products in an uncertain environment

Amirhossein Mostofi[1], **Maryam Mirzaei[1]**

[1]Auckland University of Technology

Effective warehouse management is essential for enhancing productivity and efficiency in the manufacturing industry. To date, numerous policies have been developed to address warehouse layout design and assignment challenges, each requiring appropriate mathematical models and decision-making tools for successful implementation. However, traditional approaches often treat production and warehouse planning separately, leading to suboptimal outcomes such as inaccurate cost estimates, inefficient space utilization, and increased operational costs. Recent research highlights the economic benefits of jointly optimizing production and warehouse operations. There is also a growing emphasis on integrated models that consider uncertainties like fluctuating demand and capacity constraints. In this paper, we investigate the dedicated storage policy in conjunction with production planning. By taking into account the physical limitations of the warehouse, we propose a new mixed integer programming (MIP) model designed to minimize the total costs of production and warehousing. Additionally, we ensure regular and smooth allocation in the model's solutions by introducing lexicographical constraints developed in this study. To address uncertainties in fixed and variable production costs, production capacity, and demand, we extend the proposed model using the Jimenez Fuzzy framework. We demonstrate the necessity of an integrated approach to production and warehouse planning by pointing out the flaws in separate models, such as incorrect holding cost estimations, inaccurate determination of storage locations, and violations of warehouse space constraints when production planning and warehouse design are handled independently. Case study implementations reveal the determinant rules of capacity constraints and the demand for products on the assignment and production decisions. Based on the case study results, increasing the confidence level in the uncertain parameters of demand and fixed and variable production cost decreases the total costs while decreasing production capacity. Increasing the confidence level parameter increases the total costs. Overall, the proposed integrated model provides more robust solutions compared to models that separately address production planning and warehouse allocation.
Contributed Session A, Tuesday 12:00-12:25 Room 260-036

Girth Alternative for groups acting on CAT(0) cube complex

Arka Banerjee, Daniel Gulbrandsen, **Pratyush Mishra***, Prayagdeep Parija*

[1]Auburn University, [2]Adams State University, [3]Wake Forest University, [4]Virginia Tech

Girth of a finite graph is defined as the length of the shortest non-trivial cycle in it. For a finitely generated group G, girth is defined as the supremum of Cayley graphs of G, where the supremum is taken over all finite set of generators of G. Given a class of groups, it is natural to ask if one can classify each group in the class in terms of finite and infinite girth. Motivated by the celebrated Tits Alternative, Girth Alternative is defined as follows: For a given class C of finitely generated groups, C is said to satisfy the Girth Alternative if for any group G in the class C is either virtually solvable (and hence has finite girth unless isomorphic to Z) or girth

of G is infinite. Motivated by the work of Caprace–Sageev on two versions of Tits Alternative relying on Rank rigidity of CAT(0) cube complex, we obtain a version of Girth Alternative for groups acting geometrically on a finite dimensional CAT(0) cube complex: any such group is either locally finite-by-virtually abelian or it has infinite girth. We produce counterexamples to show that the alternative fails in the general class of groups acting cocompactly on finite dimensional CAT(0) cube complexes by obtaining examples of non-virtually solvable groups which satisfy a law. This is a joint work with A. Banerjee, D. Gulbrandsen, and P. Parija.
Groups and Geometry, Tuesday 15:00-15:25 Room 260-092

2D V-line Tensor Tomography with Some Numerical Simulation

Gaik Ambartsoumian[2], **Rohit Kumar Mishra**[1], *Indrani Zamindar*[1]

[1]Indian Institute of Technology Gandhinagar, [2]University of Texas at Arlington

The reconstruction problem of tensor fields has been studied in many classical works of integral geometry. The underlying problem involves the inversion of integral transforms of unknown tensor fields, including the longitudinal (Doppler) ray transform, mixed ray transform, transverse ray transform, and momentum ray transforms of different orders. We consider a generalization of these transforms, in which the linear integration path is replaced either by V-lines (broken rays) or stars (a finite union of rays emanating from a common vertex). We first focus on the case of vector fields and present several exact closed-form inversion formulas along with some numerical simulations. Then we move to the case of symmetric 2-tensor fields and discuss recent developments in the area.
Microlocal analysis and inverse problems, Tuesday 12:00-12:25 Room 260-009

"Sharing is caring": A mathematical study on bacterial conjugation

Meghna Mistri[1]

[1]University of Auckland

Horizontal gene transfer (HGT) is the process of sharing genes between two bacterial cells without a parent-child relationship. One type of HGT is conjugation, where plasmids (self-replicating, stable circular loops of DNA; a type of mobile genetic element) carrying genes are shared; this process is not intuitive - it does not appear to be beneficial for the donor cell, but in practice, cells prone to sharing gain an evolutionary advantage - leading to a disconnect between theoretical studies and real world observations. In this dissertation, we aim to explain why conjugation provides this evolutionary advantage to "generous" bacteria (i.e. bacteria that are more prone to sharing their plasmids). We consider two hypotheses to explain why conjugation occurs in practice, and how it proves to be beneficial for the donor bacteria; these two hypotheses are the plasmid-compatibility hypothesis and the metabolic niche hypothesis. First, we test these hypotheses separately via agent based model simulations; our results from the implementation of both hypotheses are strongly in favour of the generous population - that is the generous population grows to fill up almost the entire system being simulated. We

then build a compartmental model to further analyze a system of bacteria with the plasmid-chromosome hypothesis; from analysis of the compartmental model, we find that the system becomes stable when the entire population has compatible plasmid-chromosome pairs. Overall, we show that the results from both analyses find that conjugation is beneficial for the donor bacteria, and the hypotheses applied to the system of bacteria give possible reasons for what these benefits are.
Contributed Session A, Tuesday 14:00-14:25 Room 260-016

Distinguished Coefficient Tensors for Second Order Elliptic Differential Operators and Applications to Boundary Value Problems

Irina Mitrea[1]

[1]Temple University

In this talk I will discuss how the choice of coefficient tensor for a second order weakly elliptic constant coefficient differential operator L affects the Fredholm properties of the boundary layer potential operators associated with L considered on domains Ω with compact boundaries. While all these integral operators share many common properties (such as nontangential maximal function estimates, boundedness properties, jump-relations, etc.), some more specialized functional analytic features are heavily dependent on the nature of the coefficient tensor involved. This is joint work with Dorina Mitrea and Marius Mitrea from Baylor University and is part of our recent five volume Springer series Geometric Harmonic Analysis.
Functional analysis and partial differential operators, Monday 16:00-16:50 Room 260-020

On the Neumann Problem for the bi-Laplacian in Infinite Sectors

Irina Mitrea[1]

[1]Temple University

The study of boundary value problems associated with the bi-Laplacian operator plays an important role in the theory of elasticity, specifically in the Kirchhoff-Love theory of thin plates. The goal of this talk is to investigate the solvability of the L^p Neumann problem for the bi-Laplacian, for $p \in (1, \infty)$, along with spectral properties of singular integral operators associated with the boundary value problem, in infinite sectors in two dimensions, using Calderón-Zygmund, Mellin Transform, and Validated Numerics techniques. This is joint work with Jeongsu Kyeong (Syracuse University), Katharine Ott (Bates College) and Warwick Tucker (Monash University).
Computational Methods and Applications of Dynamical Systems, Thursday 11:30-11:55 Room 303-G20

Exponential graph growth via eigenspaces of graphs over finite fields

Dorde Mitrović[1]

[1]University of Auckland

Let Γ be a finite connected graph and G a vertex-transitive group of its automorphisms. The pair (Γ, G) is called locally-L if the group induced by the action of the vertex-stabiliser G_v on the neighbourhood of a vertex v is permutation isomorphic to L. The graph growth of a permutation group L describes the growth of the order of G_v as a function of the order of Γ across locally-L pairs (Γ, G). In this talk, we present new constructions of infinite families of symmetric graphs with "large" eigenspaces over finite fields and we use them to show that the graph growth of certain imprimitive permutation groups is exponential.

Groups, actions and computations, Wednesday 11:00-11:25 Room 260-051

Nonlinear and dispersive waves in a basin: Theory and numerical analysis

Dimitrios Mitsotakis[1]

[1]Victoria University of Wellington

Surface water waves of significant interest such as tsunamis and solitary waves are nonlinear and dispersive waves. Unluckily, the equations derived from first principles and describe the propagation of surface water waves known as Euler's equations are immensely hard to study. For this reason, several approximate systems have been proposed as mathematical alternatives. We show that among the so many systems of PDEs of water wave theory there is only one proved to be well-posed (in Hadamard's sense) in bounded domains with slip-wall boundary conditions. We also show that the particular well-posed system obeys most of the physical laws that acceptable water waves equations must obey, and it is consistent with the Euler equations. For the numerical solution of our system we rely on a Galerkin/Finite element method based on Nitsche's method for which we have proved its convergence. Validation with laboratory data is also presented.

Mathematical methods in continuum mechanics and wave theory, Thursday 14:00-14:50 Room 401-307

A gauge theoretic invariant of embedded surfaces in 4-manifolds and exotic P^2-knots

Jin Miyazawa[1]

[1]Research Institute for Mathematical Sciences (Kyoto University)

When two embeddings of surfaces on a 4-dimensional manifold are given, if they are topologically isotopic but not smoothly isotopic, we call them a pair of exotic surfaces. While there is a great

deal of study of exotic surfaces in 4-manifolds, studies of closed exotic surfaces in S^4 are limited. In particular, the existence of orientable exotic surfaces in S^4 remains unknown to date. There are some examples of non-orientable exotic surfaces in S^4, including the first example given by Finashin-Kreck-Viro in 1988, but all such cases have genus greater than or equal to 5. The difficulty in detecting exotic surfaces in S^4 is to prove that two embeddings of surfaces are not smoothly isotopic. All examples of exotic non-orientable surfaces in S^4 have been detected by proving the 4-manifolds obtained by the double branched covers are exotic. If we attempt to apply this technique to low-genus non-orientable surfaces in S^4, we have to discover exotic small 4-manifolds, which is known to be difficult. We construct an invariant for embedded surfaces in 4-manifolds using Real Seiberg-Witten theory, that is a variant of Seiberg–WItten theory. As an application, we give an infinite family of exotic embeddings into S^4 for the real projective plane.
Early Career Showcase in Low-Dimensional Topology, Tuesday 14:30-14:55 Room 260-073

Physics Informed Deep Neural Networks for Dynamical system identification and Inverse problems

Ali Mohammad-Djafari[1,2], *N. Chu*[1], *R.K. Niven*[3]

[1]CNRS, [2]Shanfeng Company, [3]UNSW

Dynamical systems appears in many mecanical fluid inverse problems, where one of the main issue is the identification and estimation of the parameters of ODE or PDE modeling them. Classical methods of ODE and PDE and inverse problems fails when faced to incomplete data.
Stochastic and Deterministic Inverse Problems, Friday 15:00-15:25 Room 260-040

Efficient Rare-Event Simulation for Random Geometric Graphs via Importance Sampling

Sarat Moka[1]

[1]The University of New South Wales

Random geometric graphs are prevalent in modeling spatially embedded networks across various domains. This paper focuses on random geometric graphs in a d-dimensional subspace of $\mathbb{R}^d$, sometimes known as Gilbert graphs, where nodes are randomly distributed and connected if they are within a certain distance threshold. Accurately estimating rare-events on these graphs is essential but computationally challenging, particularly for large networks. Importance sampling offers a promising solution by concentrating computational efforts on significant graph regions. This paper explores the application of one such importance sampling to estimate graph properties, highlighting its advantages in reducing variance and enhancing accuracy. Through asymptotic analysis and experiments, we demonstrate its effectiveness, contributing to improved analysis of random geometric graphs and showcasing the broader applicability of

importance sampling in complex network analysis.
Probability and Mathematical Statistics, Thursday 15:00-15:25 Room 260-098

Applications of geometric singular perturbations techniques to investigate multiple timescale dynamics: a case study of the active metabolic oscillatory subsystem in pancreatic beta cells.

Prannath Moolchand[1], *Martin Wechselberger*[1]

[1]The University of Sydney

Insulin secretion by pancreatic beta cells in response to blood sugar level is fundamental to vital life functions, and is modulated by the tight bidirectional coupling of electrical and metabolic oscillators. Bertram et. al (2023) have recently presented such an Integrator Oscillator Model, whereby the slower metabolic oscillations are mediated by two mechanisms, namely: glycolytic oscillations, also referred to as the active metabolic oscillators (AMO) and calcium effects on ATP consumption, the passive metabolic oscillators (PMO). Our study focuses on the AMO where we employ dimensional analysis (Jelbart et al., 2022, Kosiuk and Szmolyan, 2011) to define appropriate reference scales and non-dimensionalise the model to identify small parameters and processes evolving on different timescales. We proceed to identify the oscillatory regime of this model and show that such metabolic oscillations can be recast as relaxation oscillations (Jelbart et al., 2022), a more general class of multiple timescale problem involving oscillation cycles comprising fast and slow segments. Using the machinery of geometric singular perturbation theory developed for such relaxation oscillators (Wechselberger, 2020, Kosiuk and Szmolyan, 2011), we aim to rigorously explain the observed metabolic oscillations and their contribution to bursting. In particular, we use the parametrisation method (Lizarraga et al., 2021) to identify slower timescale dynamics with their corresponding invariant manifolds, and blow-up analysis (Kosiuk and Szmolyan, 2011) to understand the geometry of the blown-up space and to reconstruct the singular oscillatory cycle spanning several timescales.

Bertram, R., Marinelli, I., Fletcher, P. A., Satin, L. S., & Sherman, A. S. (2023). Deconstructing the integrated oscillator model for pancreatic β-cells. Mathematical Biosciences, 365, 109085. https://doi.org/10.1016/j.mbs.2023.109085
Jelbart, S., Pages, N., Kirk, V., Sneyd, J., & Wechselberger, M. (2022). Process-Oriented Geometric Singular Perturbation Theory and Calcium Dynamics. SIAM Journal on Applied Dynamical Systems, 21(2), 982–1029. https://doi.org/10.1137/21M1412402 Kosiuk, I., & Szmolyan, P. (2011).
Scaling in Singular Perturbation Problems: Blowing Up a Relaxation Oscillator. SIAM Journal on Applied Dynamical Systems, 10(4), 1307–1343. https://doi.org/10.1137/100814470
Wechselberger, M. (2020). Geometric Singular Perturbation Theory Beyond the Standard Form (Vol. 6). Springer International Publishing. https://doi.org/10.1007/978-3-030-36399-4
Lizarraga, I., Rink, B., & Wechselberger, M. (2021). Multiple Timescales and the Parametrisation Method in Geometric Singular Perturbation Theory. Nonlinearity, 34, 4163-4201. https://doi.org/10.1088/1361-6544/ac04bf

Computational Methods and Applications of Dynamical Systems, Thursday 14:00-14:25 Room 303-G20

Finite simple groups have many classes of p-elements

Luke Morgan[1], *Michael Giudici*[1], *Cheryl E. Praeger*[1]

[1]The University of Western Australia

For an element x of a finite group T, the Aut(T)-class of x is the set $\{x^\sigma \mid \sigma \in \mathrm{Aut}(T)\}$. In recent work, with Michael Giudici and Cheryl Praeger, we showed that the order $|T|$ of a finite nonabelian simple group T is bounded above by a function of the parameter $m(T)$, where $m(T)$ is the maximum, over all primes p, of the number of Aut(T)-classes of elements of T of p-power order. This bound is a substantial generalisation of results of Pyber, and of Héthelyi and Külshammer, and it has implications for relative Brauer groups of finite extensions of global fields.

Groups, actions and computations, Monday 16:30-16:55 Room 260-051

Elasticity mediated yielding of an elasto-viscoplastic fluid in a plane channel flow

Miguel Moyers[1]

[1]University of Canterbury

This study presents a numerical investigation of the unsteady plane channel flows of an elasto-viscoplastic material using the Saramito model, which incorporates both viscoelastic and viscoplastic behavior. Yield stress fluids exhibit a dual nature, behaving as solids below a critical stress threshold and flowing as generalised Newtonian fluids above it. This duality is crucial for numerous industrial applications and remains an area of active research. By examining the unsteady flow dynamics driven by steady and unsteady pressure gradients in a plane channel, this work evaluates the performance of the Saramito model against experimental data from Carbopol gels. The findings highlight the significant role of elasticity in the yielding process and the resulting flow characteristics. Various flow scenarios, including creep tests, unsteady pressure ramps, and large amplitude oscillatory flows, are analyzed to elucidate the complex interplay between elastic and plastic responses. The results demonstrate that the Saramito model effectively captures the transient flow behaviors and hysteresis phenomena observed experimentally, providing insights into the material's yielding and flow mechanisms.

Mathematical methods in continuum mechanics and wave theory, Friday 12:00-12:25 Room 401-307

Applications of W*-categories to noncommutative function theory

Paul Muhly[1]

[1]University of Iowa

In this talk, which is based on joint work with Baruch Solel, I will show how the theory of W^*-categories can help to inform and generalize recent work in non-commutative function theory, an area of mathematics which has shown significant current activity that has been driven in large part by operator theory. Although the roots of noncommutative function theory can be traced back to the 19th century through the works of Wedderburn and Hausdorff, much of the current activity in the subject stems from some pioneering papers of Joseph Taylor in the late 1960s. Taylor's work, in turn, was contemporary with, but apparently independent of, work by Takesaki and Bichteler that was dedicated to the problem of how to reconstruct a C^*-algebra from its *category* of representations. I will strive to answer the pressing question: Which came first, W^*-algebras or W^*-categories?
FUNCTIONAL ANALYSIS AND OPERATOR ALGEBRAS, THURSDAY 14:30-14:55 ROOM 260-055

Regularity preserving perturbations for operator semigroups

Jonathan Mui[1]

[1]University of Wuppertal

Let $(T(t))_{t\geq 0}$ be a C_0-semigroup with generator A on a Banach space X. We study an abstract regularising property of the type $\|T(t)\|_{X\to V} \leq Ct^{-\alpha}$ for all $t \in (0,1]$, where $\alpha > 0$ and V is a subspace of X. Such a property is related to the classical notion of ultracontractivity (for semigroups arising from diffusion equations), and also has found more recent applications in the study of so-called eventually positive semigroups. We investigate unbounded perturbations B of the generator such that the regularising property carries over to the semigroup generated by $A + B$. Some examples and applications will be discussed. This is joint work with Sahiba Arora (University of Twente).
FUNCTIONAL ANALYSIS AND PARTIAL DIFFERENTIAL OPERATORS, MONDAY 14:30-14:55 ROOM 260-020

Optimal relaxed control of stochastic hereditary evolution equations with Levy noise

Debopriya Mukherjee[1], *Utpal Manna*[2]

[1]Indian Institute of Technology Indore (IITI), [2]Indian Institute of Science Education and Research Thiruvananthapuram (IISERTVM)

Existence theory of optimal relaxed control problem for a class of stochastic hereditary evolution equations driven by Levy noise has been studied. We formulate the problem in the martingale sense of Stroock and Varadhan to establish existence of optimal controls. The construction of the solution is based on the classical Faedo–Galerkin approximation, the compactness method and the Jakubowski version of the Skorokhod theorem for nonmetric spaces, and certain compactness properties of the class of Young measures on Suslin metrizable control sets. As application of the abstract theory, Oldroyd and Jeffreys fluids have been studied and existence of optimal relaxed control is established. Existence and uniqueness of a strong solution and uniqueness in

law for the two-dimensional Oldroyd and Jeffreys fluids are also shown.
Stochastic Differential Equations, Thursday 14:00-14:25 Room 260-016

The Kodaira classification of the moduli space of pointed hyperelliptic curves

Scott Mullane[1], *Ignacio Barros*[2]

[1]University of Melbourne, [2]University of Antwerp

The moduli space of pointed hyperelliptic curves is a seemingly simple object with perhaps unexpectedly interesting geometry. I will report on joint work with Ignacio Barros completing the classification of both the Kodaira dimension and the structure of the effective cone of these moduli spaces.
Computations and applications of algebraic geometry and commutative algebra, Wednesday 10:30-10:55 Room 303-B05

Relations in Topological Dynamics

Anima Nagar[1]

[1]Indian Institute of Technology Delhi

Relations always play an important role in the study of topological dynamics. Proximal, distal and almost periodic relations are well studied in literature. We further this direction and analogously study the strongly proximal and weakly distal relations. This gives a new class of flows - the weakly distal flows. We observe that the well known Morse-Thue substitution flows and Chacon transformations are weakly distal. This is a joint work with Joseph Auslander.
Ergodic Theory and Dynamical Systems, Thursday 15:00-15:25 Room 303-G23

On Graded Twisted Steinberg Algebras

Lynnel Naingue[1,2]

[1]Mindanao State University - Iligan Institute of Technology, [1]Victoria University of Wellington

In this talk, we determine when large classes of algebras can be realized as twisted Steinberg algebras, which are built from topological groupoids. We generalize recent results in this area by introducing the notion of a graded algebraic Cartan pair. This was done for C*-algebras in 2019 by Brown, Fuller, Pitts and Reznikoff, which motivates our study. Their arguments are highly analytic and do not apply in our setting so we needed to develop new purely algebraic techniques. In this study, we show that there is a correspondence between the graded algebraic Cartan pair and the graded twisted Steinberg algebras. This is a joint work with Dr. Lisa Orloff

Clark and Dr. Jocelyn P. Vilela.
Contributed Session B, Wednesday 11:30-11:55 Room 260-215

Classification of global dynamics around multi-solitons for the nonlinear Klein-Gordon equation

Kenji Nakanishi

[1]RIMS, Kyoto University

This is joint work with Gong Chen (GATech). We study the nonlinear Klein-Gordon equation with the focusing cubic power in three space dimensions, which has the unstable ground state and the solitons generated by the Lorentz transform. We consider superposition of separated solitons and classify global behavior of all solutions in a small neighborhood by using center-stable manifolds of asymptotic multi-solitons. The main difficulty lies in the interactions among the unstable modes with various exponential growth and the radiation.
Harmonic analysis and Hamiltonian PDE, Monday 14:00-14:50 Room 260-028

Category O for Lie superalgebras

Daniel Nakano[1], *Chun-Ju Lai, Arik Wilbert*

[1]University of Georgia

In this talk, the speaker will define a general Category $\mathcal{O}$ for any quasi-simple Lie superalgebra. Our construction encompasses (i) the parabolic Category $\mathcal{O}$ for complex semisimple Lie algebras, and (ii) the known constructions of Category $\mathcal{O}$ for specific examples of classical Lie superalgebras. In particular, the speaker will develop a parabolic Category $\mathcal{O}$ for classical Lie superalgebras. Connections between the categorical cohomology and the relative Lie superalgebra cohomology will be firmly established. These results will be used to show that the Category $\mathcal{O}$ is standardly stratified. The definition of standardly stratified used in this context is generalized from original definition of Cline, Parshall, and Scott. The structure of the categorical cohomology ring will be shown to be finitely generated. Furthermore, it will be shown that the complexity of modules in Category $\mathcal{O}$ is finite with an explicit upper bound given by the dimension of the subspace of the odd degree elements in the given Lie superalgebra.
Representation Theory and Tensor Categories, Monday 14:00-14:25 Room 303-G14

Construction of unitary representations of braid groups

Haru Negami[1]

[1]Chibu University

The question of whether any unitary representation of braid groups can be constructed via the Long-Moody construction [1] remains unresolved [2]. In this talk, we first introduce the Katz-Long-Moody construction, an extension of the Long-Moody construction [3]. Then, we demonstrate that middle convolution of the KZ-type equation is associated with the Katz-Long-Moody construction. We further show that the Katz-Long-Moody construction preserves the unitarity of representations and provide insights into the relationship between the Long-Moody construction and unitarity.

[1] Long, D. D. (1994). Constructing representations of braid groups. *Communications in Analysis and Geometry*, 2(2), 217–238.

[2] Birman, J. S., Brendle, T. E. (2005). Braids: a survey. *In Handbook of knot theory* 19-103. item Hiroe, K., Negami, H. (2023). Long-Moody construction of braid representations and Katz middle convolution. *arXiv preprint arXiv:2303.05770*.

Contributed Session B, Thursday 15:00-15:25 Room 405-430

Near-optimal universality for bounded-degree hypergraphs

Rajko Nenadov[1]

[1]University of Auckland

Given a family of hypergraphs H, we say that a hypergraph G is H-universal if it contains every F from H as a subgraph. For positive integers D and r, we construct an r-uniform hypergraph with $O(n^{r-1/D}\log^{2/D}(n))$ edges which is universal for the family of all r-uniform hypergraphs with n vertices and maximum degree at most D. This almost matches the lower bound $n^{r-1/D}$ on the number of edges in such a universal graph. The construction of G is deterministic, whereas showing that G is universal is probabilistic. The overall strategy follows the one used by Alon and Capalbo in the graph case, with two key new ingredients being a decomposition result for hypergraphs of bounded density and a tail bound for random branching walks on expanders.

Contributed Session B, Wednesday 10:30-10:55 Room 260-215

Finite symmetric and exterior algebras in tensor categories

Joseph Newton[1]

[1]The University of Sydney

In characteristic zero, every symmetric tensor category of moderate growth fibres over super vector spaces. The parity of an object in such a category can be determined by its symmetric and exterior powers, with even and odd objects having non-vanishing symmetric and exterior powers respectively. However, in characteristic $p > 0$ there are examples of objects whose symmetric and exterior powers both vanish. We classify all symmetric tensor categories generated by an object whose maximal non-zero powers sum to p. These are described in terms of Verlinde categories of algebraic groups, and along the way we formalise a useful decomposition of such Verlinde categories. This gives evidence towards a conjecture that all finitely generated semisimple symmetric tensor categories of moderate growth can be obtained from Verlinde categories. Joint work with Kevin Coulembier and Pavel Etingof.
Representation Theory and Tensor Categories, Wednesday 11:00-11:25 Room 303-G14

On Hopf algebras of dimension p^2

Siu-Hung Ng[1]

[1]Louisiana State University

In 1971, Taft discovered a family of noncommutative, noncommuative Hopf algebras of dimension n^2 over an algebraically closed field k of characteristic 0. The Taft algebras were later shown to be all the noncommutative, noncommuative Hopf algebras over k of dimension p^2 for any prime p. A similar contruction of the Taft algebras in charactersitic p was discovered by Radford in 1977. It is an open problem whether the Radford algebra is the unique noncommutative, noncommuative Hopf algebras of dimension p^2 in characteristic p. In this talk, we explore this question via extensions of p-dimensional Hopf algebras. The Radford algebra is shown to be a unique nontrivial self-dual extension. This talk is based on a joint work with Xingting Wang.
50 years of Communications in Algebra, Monday 15:00-15:25 Room 303-G15

Phase Resetting in the Yamada Model of a Q-Switched Laser

Jacob Ngaha[1, 2], *Neil G. R. Broderick*[2, 3], *Bernd Krauskopf*[1, 2]

[1]Department of Mathematics, The University of Auckland, [2]The Dodd-Walls Centre for Photonic and Quantum Technologies, [3]Department of Physics, The University of Auckland

Phase resetting is a technique used to investigate how the phase of an oscillating system is altered, or “reset”, due to an external perturbation. A perturbation results in the phase of an oscillating system being advanced or delayed relative to that of the unperturbed system. The resulting phase shift is often portrayed in the form of a phase-transition curve (PTC), showing the relationship between the point at which the perturbation is applied, θ_{old}, and the shifted phase, θ_{new}, where each phase specifies a point on the underlying stable periodic orbit. In this work we investigate the phase resetting of a self pulsing laser, also known as a *Q-switched* laser featuring a gain and a saturable absorber section. We study a specific model due to Yamada consisting of a set of three coupled ordinary differential equations for the gain G, the absorption

Q, and the laser intensity I. The question we address here is how the regular self-pulsating behaviour of this Q-switched device is affected by perturbations, given as external impulses in intensity or gain. We take a dynamical systems approach and employ recently developed methods based on the numerical continuation of boundary value problems in the MATLAB based software COCO. We present an analysis of computed PTCs for different perturbation amplitudes and directions to demonstrate how the different invariant objects in the three-dimensional phase space affect the reset phase. We also present the first computation of a two-dimensional isochron surface, consisting of all points that have the same eventual phase.
Computational Methods and Applications of Dynamical Systems, Tuesday 14:30-14:55 Room 303-G20

Lp Approximation Rates for Location-Scale Mixture Densities and Implications to Adaptive Least-Squares Estimation

Hien Nguyen[1, 2], *TrungTin Nguyen*[3], *Xin Guo*[3], *Jacob Westerhout*[3]

[1]La Trobe University, [2]Kyushu University, [3]University of Queensland

The approximation and estimation of probability densities on Euclidean spaces constitute an important class of statistical problems. Among the solutions is the use of location-scale mixtures of a fixed density as a basis for conducting approximations. In previous work, we established denseness results that provide qualitative approximation guarantees for such mixture classes in L_p spaces. In this paper, we build on those results by providing approximation rates in L_p spaces for p between 1 and infinity (exclusive), which depend only on the dimension of the supporting space, p, and the smoothness of the target function. We then use these new results to present novel estimation rates for adaptive least-squares mixture estimators.
Recent developments in data science and machine learning, Monday 14:30-14:55 Room 402-220

Second-order dynamical systems with fixed-time convergence

Lien Nguyen[1], *Xinghuo Yu, Andrew Eberhard*

[1]RMIT University

In this talk, we introduce novel second-order dynamical system to find a fixed point of Lipschitz operators within a fixed time. We then employ the proposed dynamical systems to solve generalized monotone inclusion problems and nonsmooth additive composite optimization problems. The effectiveness of the proposed fixed-time convergent dynamical systems is shown through numerical simulations.
Optimisation, Tuesday 11:30-11:55 Room 402-221

On joint inversion in the Bayesian framework: is ignorance always bliss?

Ruanui (Ru) Nicholson[1], *Oliver Maclaren*[1], *Matti Niskanen*[1], *Jari Kaipio*

[1]University of Auckland

We consider large-scale joint inverse problems in the Bayesian framework. In particular, we consider inference of two (or more) spatially distributed physical parameters based on measured data. Such problems are also referred to as multi-physics inverse problems and/or model fusion inverse problems. In this work we assume Gaussian marginal prior distributions, and thus the key task is the construction of a suitable joint prior. We provide the construction of such a joint prior which also allows for the correlation between the two parameters to be estimated based on a hierarchical decomposition. We illustrate the applicability of the approach on several example problems motivated by geophysical settings. This is joint work with Oliver Maclaren, Matti Niskanen and Jari Kaipio.

Stochastic and Deterministic Inverse Problems, Friday 12:00-12:25 Room 260-040

Profinite groups, effective dimension, and randomness

Andre Nies[1]

[1]School of Computer Science

Computable profinite groups are equipped with a computable probability measure. A computable inverse system for the group leads to an (ultra)metric and hence to notions of dimension. These properties make computable profinite groups a natural area for applying the tools of algorithmic randomness and effective dimension. We calibrate "almost everywhere" theorems using algorithmic test notions, and reconsider a 1997 question of Barnea and Shalev in light of effective dimension: whether any f.g. pro-p group with a finite range of values for the dimension of closed subgroups must be a Lie group on a p-adic manifold.

Computability Theory and Applications, Wednesday 11:00-11:50 Room 303-B07

The trivial units property and the unique product property for torsion free groups

Andre Nies[1]

[1]University of Auckland

A torsion free group G satisfies the unique product property if for each pair A, B of finite nonempty subsets some product in AB can be written uniquely. The group G satisfies the trivial units property over a domain R if the group algebra $R[G]$ only has the trivial units, the ones of the form rg, where r is a unit in R and g is in G. Fixing a domain, the unique product property implies the trivial units property; the converse implication is not known. Gardam

in 2021 showed that $\mathbb{F}_2[P]$ (where $\mathbb{F}_2$ is the two-element field) fails the trivial unit property for the Hantzsche-Wendt group $P = \langle a, b \mid b^{-1}a^2b = a^{-2}, a^{-1}b^2a = b^{-2}\rangle$. We will discuss the computational methods involving SAT solvers that Gardam used. Extending them we found all 18 nontrivial units supported on the ball of radius 4 (the minimum possible value) in the Cayley graph of P. We consider the Fibonacci groups $F(n, n-1)$ where $n \geq 4$ is even. We show that each such group has a solvable word problem, and suggest $F(6, 5)$ as a candidate counterexample for the 0-divisors conjecture over $\mathbb{F}_2$. We use SAT solvers to show that $F(4, 3)$ fails the unique product property, and discuss work in progress that might lead to a proof that it satisfes the trivial units property over $\mathbb{F}_2$. Joint work with Heiko Dietrich, Melissa Lee, and Marc Vinyals.
Groups, actions and computations, Thursday 15:00-15:25 Room 260-051

Conway-Gordon type theorems and its applications

Ryo Nikkuni[1]

[1]Tokyo Woman's Christian University

The famous Conway–Gordon theorems say that for every spatial complete graph on 6 vertices, the sum of the linking numbers over all of the constituent 2-component links is congruent to 1 modulo 2, and for every spatial complete graph on 7 vertices, the sum of the Arf invariants over all of the Hamiltonian knots is also congruent to 1 modulo 2. In general, we collectively refer to a relational expressions for knot/link invariants binding the behavior of knots/links in a spatial graph that leads to some intrinsic nontrivialities of the graph as a Conway–Gordon type theorem. In this talk, we will explain some particularly noteworthy results on the application of the Conway-Gordon type theorems to (recti)linear spatial graphs.
Structural aspects of matroids and graphs, Tuesday 14:00-14:25 Room 303-B09

Indecomposable killing tensors on symmetric spaces

Yuri Nikolayevsky[1]

[1]La Trobe University

I will present some recent results on the structure of the algebra of Killing tensors on Riemannian symmetric spaces. The fundamental question is whether any Killing tensor field on a Riemannian symmetric space is a polynomial in (a symmetric product of) Killing vector fields. For spaces of constant curvature, the answer is in the positive (as has been known for quite some time). The same is true for the complex projective space (Eastwood, 2023). Surprisingly, for other rank one symmetric spaces (quaternionic projective space and Cayley projective plane), the answer is almost always in the negative (Matveev-Nikolayevsky, 2024). This is a joint project with V.Matveev (University of Jena, Germany).
Differential geometry and geometric analysis, Thursday 14:30-14:55 Room 260-005

Sums involving reciprocals of orbit points In the binary dynamical system

Rodney Nillsen[1]

[1]University of Wollongong

In 1930, G. H. Hardy and J. E. Littlewood derived results concerning rates of divergence of certain series involving cosecants. In more recent terminology, one of their results can be interpreted in terms of the behaviour of orbits in a dynamical system that is a rotation on the unit circle. Now, the expansion of numbers in the unit interval $[0, 1)$ to the base 2 can be associated with a different dynamical system – the binary system. This talk will consider orbit behaviour in the binary system that corresponds, in part, to the behaviour that was observed by Hardy and Littlewood in a different context. A binary rational in $[0, 1)$ is a rational number of the form $k/2^n$, for some $0 \leq k < 2^n$. Given a number in $[0, 1)$ that is not a binary rational, its sequence of binary digits may be arranged as an infinite sequence of consecutive, non-empty, finite blocks, each block consisting of all zeros or all ones. Upper and lower estimates are described for the averages of the sums of powers of the reciprocals of points in the orbit of the number. These estimates are in terms of the lengths of the associated blocks. If $\ell_1, \ell_2, \ldots$ and $m_0, m_1, m_2, \ldots$ are the lengths of the consecutive blocks of zeros and ones respectively, the following condition is necessary and sufficient for the 'equivalence' of the upper and lower estimates: there is $K > 0$ such that for all $j \geq 2$,

$$\max \left\{ \ell_j \left(\sum_{u=1}^{j-1} \ell_u + \sum_{u=0}^{j-1} m_u \right)^{-1}, \quad m_j \left(\sum_{u=1}^{j} \ell_u + \sum_{u=0}^{j-1} m_u \right)^{-1} \right\} \leq K.$$

Almost all numbers in $[0, 1)$ satisfy this condition, including all base 2 simply normal numbers. If a number in $[0, 1)$ is not a binary rational and does not satisfy the condition, then it is a Liouville number, and there is an uncountable set of such numbers. As Liouville numbers are transcendental, all algebraic numbers that are not binary rationals satisfy the above condition. Further results may also be mentioned.

Ergodic Theory and Dynamical Systems, Friday 14:30-14:55 Room 303-G23

Riesz capacity via hitting distribution for stable processes

John Nolan[1]

[1]American University

A method is described for computing alpha-capacity of sets in d-dimensions through the use of simulated continuous time process with isometric stable increments. A method we call Walk-In-Out-Balls is described to simulate points from the equilibrium measure of a set. These points are then used to estimate the Riesz capacity of the set.

Stochastic Differential Equations, Wednesday 11:00-11:25 Room 260-016

Surface Diffusion: Some new results and approaches

Amy Novick-Cohen[1]

[1]Technion - IIT

First we briefly review a variety of geometries where surface diffusion is meaningful in the context of the stabiity of thin solid state films. Then we discuss joint work with E.A. Carlen and L. Peres Hari, regarding an approach to rigorously establishing a connection between surface diffusion and the deep quench obstacle problem with a suitable degenerate mobility. The study begins by rigorously establishing a connection between certain steady states of the respective systems, and then outlines an approach for connecting the respective evolutions via suitable minimizing motion descriptions.

Mathematics of nonlinear diffusion processes, Monday 14:00-14:50 Room 260-018

Homogenization for the nonlinear Schrödinger equation with sprinkled nonlinearity

Maria Ntekoume[1], *Benjamin Harrop-Griffiths*[2]

[1]Concordia University, [2]Georgetown University

The nonlinear Schrödinger equation with sprinkled nonlinearity was introduced recently as a model for the propagation of waves with strong self-interaction at defects of the medium distributed according to a homogeneous Poisson point process. In this talk we will present a homogenization result for this model. If time permits, we will also discuss how the solutions fluctuate around the homogenized limit.

Harmonic analysis and Hamiltonian PDE, Wednesday 11:30-11:55 Room 260-028

Challenging problems from group theory

Eamonn O'Brien[1]

[1]University of Auckland

The construction of polynomial time algorithms to solve various problems in algorithmic group theory often reduces to known "hard problems" in computational number theory. We consider two such key problems for linear groups defined over finite fields.

1. Determine the order of an element of $\mathrm{GL}(d, \mathrm{GF}(q))$.
2. Given $\langle X \rangle \cong \mathrm{SL}(2, \mathrm{GF}(q))$, construct a unipotent element as a word in X.

These currently rely on oracles to solve factorisation and discrete log problems.

Computational Number Theory and Applications, Tuesday 16:00-16:25 Room 405-422

A mathematician meets computer graphics

Hiroyuki Ochiai[1]

[1]Institute of Mathematics For Industry, Kyushu University

This presentation discusses the intersection of mathematics and computer graphics within a CREST project supported by JSPS (Japan Society for the Promotion of Science) from 2011 to 2016, and its continuation. The project was led by Ken Anjyo from OLM Digital, a leading animation, CG, and VFX studio. Our activities included producing a video, publishing a book, organizing international conferences, and conducting experimental tutorial meetings, with a focus on human resource development based at the Institute of Mathematics for Industry (IMI) at Kyushu University.
Industrial Mathematics, Tuesday 16:00-16:25 Room 402-211

A gradient flow for the ideal energy under a length constraint

Shinya Okabe[1]

[1]Tohoku University

The ideal energy is defined by the squared integral of the derivative of the curvature of curves and can be regarded as the Dirichlet energy of curvature. There have been several studies on the L^2-gradient flow for the ideal energy under the total length constraint. The known results prove that the flow has a unique global-in-time solution and that the solution converges to an equilibrium as time goes to infinity, provided that the initial curve has a small energy and a non-zero rotation number. In this talk, we consider a gradient flow for the ideal energy under the local length constraint, and prove the global-in-time solvability and the convergence to an equilibrium without any assumption on the energy and rotation number of the initial curve.
Mathematics of nonlinear diffusion processes, Tuesday 16:00-16:50 Room 260-018

Recent Progress on the Willmore Energy of Four Dimensional Submanifolds

Peter Olanipekun[1]

[1]University of Auckland

The Willmore energy of (two-dimensional) surfaces in $\mathbb{R}^n$ has long been studied due to its rich geometric and variational properties. In higher dimensions, the Willmore energy generalises in a non-trivial way, extending to submanifolds where the interplay between curvature and topology becomes increasingly intricate. In particular, for four-dimensional submanifolds, this generalisation yields a sixth order nonlinear elliptic geometric partial differential equation, making the analysis of the energy far more challenging. In this talk, I will briefly review the classical Willmore energy and its generalisation to higher dimensions. I will then discuss recent developments

and results related to the critical points of the four dimensional Willmore energy.
Recent advances in geometric PDE, Friday 14:30-14:55 Room 260-057

Ricci Curvature on Graphs

Xavier Ramos Olive[1]

[1]College of the Holy Cross

In the last two decades, several non-equivalent versions of Ricci curvature on graphs have emerged. These notions are often inspired by the definition of the Ricci curvature on smooth manifolds, or else they can be used to prove theorems that have analogous versions in the smooth manifold setting. We will introduce some of these notions, focusing our attention on the Lin-Lu-Yau Ricci curvature and its relationship to the eigenvalues of the Graph Laplacian. In particular, we will discuss the well-established Lichnerowicz estimate and the absence of an Obata rigidity result, as well as some new integral curvature notions for graphs.
Recent advances in geometric PDE, Tuesday 14:30-14:55 Room 260-057

Stable and unstable behaviour in relativistic fluids on cosmological spacetimes

Todd Oliynyk[1]

[1]Monash University

Relativistic fluids with linear equations of state $p = K\rho$ are among the most important and widely used matter models in cosmology. The parameter K that appears in the linear equation of state is the square of the fluid sound speed and for physical reasons is restricted to lie in the range $0 \leq K \leq 1$. In recent years, the stability of spatially homogeneous families of cosmological solutions to the relativistic Euler equations have been intensively studied and much progress has been made. The most well analysed family of spatially homogeneous solutions are the Friedmann-Lemaître-Robertson-Walker (FLRW) fluid filled cosmologies with a positive cosmological constant, which are distinguished by being spatially isotropic and undergoing accelerated expansion. This family of solutions has been shown to be nonlinearly stable to the future (expanding direction) for sound speeds $0 \leq K \leq 1/3$, and in the first part of the talk, I will review these stability results. In the second part of the talk, I will present recent results regarding the future nonlinear stability of FLRW fluid cosmologies with non-accelerated expansion for sounds speeds $0 \leq K < 1/3$, and the future nonlinear stability of a family of spatially homogeneous, but non-isotropic, solutions to relativistic Euler equations for $1/3 < K < 1$. Additionally, I will discuss a recent result that rigorously establishes the future instability of the FLRW family of solutions to the relativistic Euler equations for sound speeds $1/3 < K < 1$. This instability is characterized by the blow-up of the fractional density gradient at timelike infinity, a behaviour that was first conjectured by Rendall in 2004. If time permits, I will conclude the talk by discussing similar phenomena that occur towards the past (contracting direction).
Recent advances in geometric PDE, Thursday 14:30-15:20 Room 260-057

q-analogues of multiple zeta functions: Partitions detect prime numbers

Ken Ono[1]

[1]University of Virginia

We study the ring of q-series generated by MacMahon's classical partition q-series and their generalizations. As a consequence, we show that integer partitions, the fundamental building blocks in additive number theory, detect prime numbers in an unexpected way. For example, an integer $n \geq 2$ is prime if and only if $(3n^3-13n^2+18n-8)M_1(n)+(12n^2-120n+212)M_2(n)-960M_3(n) = 0$, where the $M_a(n)$ are MacMahon's well-studied partition functions. More generally, for "MacMahonesque" partition functions $M_{\vec{a}}(n)$, we prove that there are infinitely many such prime detecting equations with constant coefficients.

Special Functions, q-Series and Beyond, Tuesday 11:30-12:20 Room 401-312

Local systems for periodic data

Adam Onus[1], *Primoz Skraba*[1], *Amit Patel*[2]

[1]Queen Mary University of London, [2]Colorado State University

Periodic point clouds naturally arise when modeling large homogeneous structures like crystals. They are naturally attributed with a map to the d-dimensional torus given by the quotient of translational symmetries, however there are many surprisingly subtle problems one encounters when studying their (persistent) homology. On one hand, the quotient space of a periodic data set loses information since it is a finite representation of an infinite object. On the other hand, because the quotient space exists in an ambient space whose homotopy type is that of the d-dimensional torus, they often introduce spurious "toroidal cycles" which do not represent the topology of the overlying periodic data set. The classification of toroidal cycles is a fundamental obstruction in creating a (persistent) homology theory of periodic data sets, and has been studied to some extent by Onus and Robins (2021), Onus and Skraba (2022), and Edelsbrunner and Heiss (2024). We present a new approach based on the relatively recent development of bisheaves. This, is a useful tool to study periodic data sets, as it allows us to unify several different approaches to study such spaces and completely characterize toroidal cycles. The theory of bisheaves and with them, persistent local systems was recently introduced by MacPherson and Patel (2021) as a method to study data with an attributed map to a manifold through the fibres of this map. The theory allows one to study the data locally, while also naturally being able to appeal to local systems of (co)sheaves to study the global behaviour of this data. We introduce the first (persistent) homology theory for periodic data sets in Euclidean space through the use of (persistent) bisheaves and persistent local systems. By providing a complete description of toroidal classes, it provides an algorithm for determining the homology of finite windows of the periodic spaces. Furthermore, we provide the algorithms for computing not only bisheaves but also for computing the persistent local systems from them in a process called isobisheafification. We show how this, in addition to providing a unified mathematical framework, is explicitly algorithmic and is implementable.

Applied and Computational Topology, Friday 11:30-11:55 Room 260-223

Blenders, attractors, and their carpet property

Hinke M Osinga[1], *Sanaz Amani*[1], *Dana C'Julio*[1], *Bernd Krauskopf*[1]

[1]University of Auckland

Recent theoretical work on partially hyperbolic systems by Bonatti, Diaz, and others has shown that chaotic dynamics may occur C^1-robustly in diffeomorphisms of dimension at least three. This result has been proven via the related concept of a blender, which is a hyperbolic set with the characterising feature that its invariant manifolds behave as geometric objects of a dimension that is larger than expected from the dimensions of the manifolds themselves. We present a case study of a family of three-dimensional Hénon-like maps that has a blender for particular parameter values at which the invariant set is transitive hyperbolic. We introduce a tool to verify numerically whether a given invariant set actually is a blender or not. More specifically, we employ advanced computational techniques for the numerical approximation of the one-dimensional global unstable manifold of this hyperbolic set in a compactified phase space. By computing the unstable manifolds of well-chosen fixed or periodic points, we can check and illustrate a form of denseness, which we call the carpet property. We then vary a parameter and verify numerically that the carpet property persists even when the transitive hyperbolic set becomes an attractor.
Ergodic Theory and Dynamical Systems, Tuesday 16:30-16:55 Room 303-G23

Generalised persistent homology transforms over affine Grassmannians

Adi Onus[2], **Nina Otter**[1], *Renata Turkeš*[1]

[1]DataShape, Inria-Saclay, [2]Queen Mary University of London

In this talk I will introduce generalised persistent homology transforms; these are integral transforms that allow one to study a shape through the lens of PH with respect to any filtration function. I will then present a particular example, given by considering sublevel set filtrations with respect to distances from flats in affine Grassmannians. I will discuss how these transforms generalise known examples, how they are sufficient descriptors of shapes, and finally present their computational advantages over the classical persistent homology transform introduced by Turner-Mukherjee-Boyer. This is joint work with Adi Onus and Renata Turkeš.
Applied and Computational Topology, Friday 12:00-12:25 Room 260-223

Bounding the chromatic number of t-perfect graphs

Maria Chudnovsky[1], *Linda Cook*[2], *James Davies*[3], **Sang-il Oum**[4], *Jane Tan*[5]

[1]Princeton University, [2]University of Amsterdam, [3]University of Cambridge, [4]Institute for Basic Science, [5]University of Oxford

Perfect graphs can be described as the graphs whose stable set polytopes are defined by their non-negativity and clique inequalities (including edge inequalities). In 1975, Chvátal defined an analogous class called t-perfect graphs, which are the graphs whose stable set polytopes are defined by their non-negativity, edge inequalities, and odd circuit inequalities. We show that t-perfect graphs are 150000-colourable. This is the first finite bound on the chromatic number of t-perfect graphs, and answers a question of Shepherd from 1995.
STRUCTURAL ASPECTS OF MATROIDS AND GRAPHS, WEDNESDAY 11:00-11:25 ROOM 303-B11

Instantaneous continuous loss of regularity for the SQG equation

Diego Cordoba[1], *Luis Martinez-Zoroa*[1], **Wojciech Ozanski[1]**

[1]Florida State University

We will discuss a recent result concerned with the surface quasi-geostrophic equation (SQG) with low-regularity initial data. Namely, given $s \in (3/2, 2)$ and $\varepsilon > 0$, we will describe a construction of a compactly supported initial data θ_0 such that $\|\theta_0\|_{H^s} \leq \varepsilon$ and there exist $T > 0$, $c > 0$ and a local-in-time solution θ of the SQG equation that loses Sobolev regularity continuously in time. To be precise, for each $t \in [0, T]$, $\theta(\cdot, t) \in H^{s/(1+ct)}$ and $\theta(\cdot, t) \notin H^\beta$ for any $\beta > s/(1 + ct)$. Moreover θ is compactly supported in space, continuous and differentiable on $\mathbb{R}^2 \times [0, T]$, and is unique among all solutions with initial condition θ_0 which belong to $C([0, T]; H^{1+\alpha})$ for any $\alpha > 0$.
RECENT ADVANCES IN MATHEMATICAL FLUID DYNAMICS, FRIDAY 15:00-15:25 ROOM 401-311

Information Architecture (IA): Multidimensional scaling and K-means analysis for small and large card sorting datasets

Sione Paea[1], *Gabiriele Bulivou*[1]

[1]The University of The South Pacific (usp)

One of the well-known clustering techniques for analysing large datasets is the K-means algorithm. However, that algorithm has yet to be widely applied to analysing card sorting datasets to measure the similarity between cards and result displays using multidimensional scaling (MDS). MDS is a well-known exploratory data analysis family of techniques that produce one display on which inter-object similarity relationships are preserved. It is used to visualise and analyse card sorting data and aims to develop an in-depth and effective optimal information architecture (IA) and navigation structure for interactive card sorting datasets. This paper uses K-means to analyse the datasets (small and large) in various dimensional data points for different initialisation methods. The results were compared using 6 matrices: Participant's agreement score (PAS), Category validity score (CVS), Dunn Index (DI), Davies-Bouldin's Index (DBI), Calinski-Harabasz Index (CHI), and Silhouette score (SIL). The study involved current staff, postgraduate students, and third-year face-to-face students. A total of 112 participants were involved, and 50 cards representing items from the regional university's Moodle site were used. The proposed algorithm is applied to a real-world open card sorting dataset, and, unlike existing

solutions in the literature, it can be used with any number of participants and cards. Specifically, the proposed algorithm can expose hidden patterns and relationships amongst cards and identify complexities.
Optimisation, Tuesday 14:30-14:55 Room 402-221

Coalescent point process of branching trees in a varying environment

Sandra Palau[1], *Airam Blancas*[2]

[1]UNAM, [2]ITAM

Consider an arbitrary large population at the present time, originated at an unspecified arbitrary large time in the past, where individuals within the same generation independently reproduce forward in time, sharing a common offspring distribution that may vary across generations. The genealogy of the current generation, traced backward in time, is uniquely determined by the coalescent point process $(A_i, i \geq 0)$ where A_i is the coalescent time between individuals i and $i+1$. In general, this process lacks the Markov property. We define a vector valued Markov process that can reconstruct the genealogy, with finite information for every i.
Probability and Mathematical Statistics, Tuesday 14:00-14:25 Room 260-098

On explicit bounds for the Selberg class functions

Neea Palojärvi[1], *Aleksander Simonič*[1]

[1]University of New South Wales, Canberra

The Selberg class consists of functions sharing similar properties to the Riemann zeta function. The Riemann zeta function is one example of the functions in this class. The estimates for logarithms of Selberg class functions and their logarithmic derivatives are connected to, for example, primes in arithmetic progressions. In this talk, I will discuss about effective and explicit upper bounds for logarithms and logarithmic derivatives of the Selberg class functions when $\Re(s) > 1/2$. In the case of logarithms, I will discuss also about lower bounds for the Selberg class functions. All results are under the Generalized Riemann hypothesis. In some of the results, we additionally assume some additional hypothesis including a polynomial Euler product representation, the strong λ-conjecture or assumptions related to the Selberg's (normality) conjecture. The talk is based on a joint work with Aleksander Simonič (University of New South Wales, Canberra).
Computational Number Theory and Applications, Monday 14:45-14:55 Room 405-422

On misconceptions in the Math Kangaroo Finland

Neea Palojärvi[1], *Anne-Maria Ernvall-Hytönen*[2], *Mika Koskenoja*[2]

[1]University of New South Wales (Canberra), [2]University of Helsinki

The Math Kangaroo is one of the largest international mathematics competitions in the world (Association Kangourou sans Frontières, 2022a). In Finland, it gathers about 15000 participants aged from eight to eighteen. The exams are based on multiple-choice questions and they are offered for all schools free of charge (Association Kangourou sans Frontières, 2022b; Kangaroo Finland, 2021). In this talk, we discuss the fourth to ninth graders' (ages 10-16) misconceptions in the Math Kangaroo Finland 2011, 2015 and 2019. By misconception, we mean conceptual misunderstanding. If we understand better how misconceptions are related to each other, we may be able to find different factors that affect students' learning and hence improve it (see Bransford et al., 2000). We recognized the possible misconceptions by solving the problems and trying to find ways to obtain common wrong answers. If at least two out of the three authors agreed on the misconception, it was classified as such. Out of the 24 misconceptions we found, 12 of them were related to geometry. The underlining structure among those 12 misconceptions seems mostly be not to figure shapes and objects correctly. According to Özerem (2012), the recommended solution is to use more time for visualising the objects in teaching and emphasize the similarities and differences of the objects more.

References:

Association Kangourou sans Frontières. (2022a). Association website. Retrieved April 5, 2023, from http://www.aksf.org Association Kangourou sans Frontières. (2022b). Statistics: Finland. Retrieved April 5, 2023, from http://www.aksf.org/statistics.xhtml#FI

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). How people learn: Brain, mind, experience, and school. National Academy Press.

Kangaroo Finland, M. (2021a). International Maths Contest Kangaroo. Retrieved March 25, 2022, from https://kengurukilpailu.fi Özerem, A. (2012). Misconceptions in geometry and suggested solutions for seventh grade students. Procedia - Social & Behavioral Sciences, 55(5), 720–729.

Mathematics Education, Thursday 12:00-12:10 Room 260-115

Large Deviation Principle for Stochastic Nematic Liquid Crystals Driven By Multiplicative Gaussian Noise

Akash Ashirbad Panda[1], *Subhra Sankar Dhar*[2], *Brijesh Jha*[1]

[1]Indian Institute of Technology Bhubaneswar, [2]Indian Institute of Technology Kanpur

We study a stochastic two-dimensional nematic liquid crystal model with multiplicative Gaussian noise. We prove the Wentzell-Freidlin type large deviation principle for the small noise asymptotic of solutions using weak convergence method.

Stochastic Differential Equations, Thursday 15:00-15:25 Room 260-016

Hook-length formulas for skew shapes via complex integrals and vertex models

Greta Panova[1], *Leonid Petrov*[2]

[1]University of Southern California, [2]University of Virginia

The number of standard Young tableaux of a skew shape λ/μ can be computed as a sum over excited diagrams inside λ. Excited diagrams are in bijection with certain lozenge tilings, with flagged semistandard tableaux and also nonintersecting lattice paths inside λ. We give two new proofs of a multivariate generalization of this formula, which allow us to extend the setup beyond standard Young tableaux and the underlying Schur symmetric polynomials. The first proof uses multiple contour integrals. The second one interprets excited diagrams as configurations of a six-vertex model at a free fermion point, and derives the formula for the number of standard Young tableaux of a skew shape from the Yang-Baxter equation.
Special Functions, q-Series and Beyond, Friday 11:30-12:20 Room 401-312

Slowly, then all at once: Uncovering the dynamics of a catastrophe

Davide Papapicco[1]

[1]University of Auckland

Many natural and human complex systems evolve on a slow timescale and are stable with respect to external perturbations. However, these systems can experience sudden rapid departures from their nat- ural equilibrium, known as tipping events, which often bring catastrophic, unrecoverable repercussions. Extreme paleoclimate events, ecosystems' collapse and economic crises are some examples of dynamical systems evolving slowly around an equilibrium until a tipping point causes a fast critical transition out- side the basin of attraction and onto a new, unhealthy state. Given the disruption of natural equilibria and the potential unrecoverability of certain states past the critical transitions, forewarning of these tipping points has been the subject of extensive research for the past 30 years. Characterisation of these events and their early-warning signals starts with a dynamical interpretation of these different regimes and further develops into the realm of stochastic processes and transitional states. Numerous precursors have been hypothesized and statistical measures have been derived as leading indicators of tipping events for simplified and low-dimensional dynamical systems. Despite these efforts several fundamental issues still plague the practical application of early-warning signals in natural timeseries, with their lack of consistency across a broad spectrum of real-world tipping points posing a major shortcoming in their reliability. The purpose of this talk is twofold. In the first part we will address the challenges fac- ing the generalisation of frameworks of tipping events to spatially-extended (high-dimensional) models. Subsequentially we will show how a novel, prototypical approach based on the finite-states probabilistic interpretation of critical transitions can potentially address the fallacies of previously proposed, model- based indicators.
Contributed Session A, Thursday 12:00-12:25 Room 303-B11

On the speed of coming down from infinity for branching processes with pairwise interactions

Juan Carlos Pardo[1], *Gabriel Berzunza*[2]

[1]Centro de Investigacion en Matematicas, [2]University of Liverpool

In this talk, we investigate the phenomenon of coming-down from infinity for (sub)critical cooperative branching processes with pairwise interactions under suitable conditions. A process in this class behaves as a pure branching process with the difference that competition and cooperation events between pairs of individuals are also allowed. In particular, we are interested in the speed of BPI-processes when their initial population is very large, as well as in their second order fluctuations.
Probability and Mathematical Statistics, Tuesday 14:30-14:55 Room 260-098

Euler characteristic-like invariants, positivity questions, and matroids

Soohyun Park[1]

[1]Hebrew University of Jerusalem

We will discuss connections between Euler characteristic-like invariants and positivity properties in algebraic combinatorics. A well-known example of this interaction is the log concavity of characteristic polynomials of matroids. The positivity questions we will focus on (which lie between unimodality and real-rootedness) are other positivity questions on reciprocal/palindromic polynomials that also arise from Euler characteristic-like invariants. In particular, we note that Chow rings of matroids yield examples of (recursive) algebraic properties and key combinatorial patterns observed in the general setting. We will explore how structural properties from geometric combinatorics interact with these patterns and explicit expressions for this invariant.
Algebraic Combinatorics and Matroids, Monday 14:30-14:55 Room 303-B09

Classification and structure of homoclinic explosions in a four-dimensional Lorenz-like system

Juan Patiño-Echeverría[1], *Bernd Krauskopf*[1], *Hinke M Osinga*[1]

[1]University of Auckland

If we vary the Rayleigh number ρ in the well-known Lorenz equations, a pair of homoclinic orbits to the origin exists at a codimension-one global bifurcation for $\rho = \rho_r \approx 13.9565$. This bifurcation, also called the primary *homoclinic explosion point*, is known to create an infinite number of saddle periodic orbits. It marks the beginning of the so-called preturbulent regime, where one finds a hyperbolic set that contains infinitely many saddle periodic orbits, and there are orbits with arbitrarily long transients. However, $\rho = \rho_r$ is not the only homoclinic explosion

point that exists in the Lorenz equations; many others of a more complex nature exist for larger values of ρ. In this talk, we explain how to compute bifurcations associated with the secondary homoclinic explosion points in a four-dimensional Lorenz-like vector field and follow the curves of codimension-one bifurcation in a two-parameter plane. We find that the primary homoclinic explosion point of the Lorenz system acts as an organising point in this two-parameter plane. Its unfolding gives rise to infinite cascades of curves of Shilnikov-type global connections in the four-dimensional system, leading to a chaotic regime. We classify these connections, which are formed by the unstable manifold of the origin, and identify how they organise the emergence of complicated dynamics in the system.
Computational Methods and Applications of Dynamical Systems, Tuesday 16:30-16:55 Room 303-G20

Approximation in triangulated categories

Bregje Pauwels[1]

[1]Macquarie University

Given a module over a ring, it is standard to replace it by a projective resolution, and it is classical that doing so can be very useful. In other words, every object in the derived category of a ring has a sequence of 'simpler' objects converging to it. In general, a triangulated category is called approximable if this type of 'approximation by simpler objects' is possible. The notion of metrics and approximability in triangulated categories (due to Amnon Neeman) is fairly new and not very well understood yet. But the early evidence is that the new techniques, while at first sight purely categorical, are very powerful. In this talk, I will discuss some applications of this new technique and explain why the derived category of a tame stack with finite diagonal is approximable. Some tensor categories may appear.
Representation Theory and Tensor Categories, Thursday 14:30-14:55 Room 303-G14

Kolmogorov-Arnold theorem and its applications

Vinesha Peiris[1]

[1]Centre For Optimisation And Decision Science, Curtin University

Kolmogorov-Arnold representation theorem (KA theorem) states that every multivariate function can be represented by compositions and summations of univariate functions. Even though the KA theorem has been very well known since 1957, nobody is fully aware of how this function representation works. Therefore, this has been an unsolved problem for many decades. However, some modified versions of this theorem have similar structures as neural networks which are the building blocks of artificial intelligence, but these interpretations have been highly arguable for several years. In this talk, we walk through the history of the KA theorem, its relation to neural networks and recent developments in this area. We will focus on the latest advancement involving rational functions, approximation and optimisation techniques, highlighting their ap-

plications where dimension reduction is necessary.
Optimisation, Tuesday 15:00-15:25 Room 402-221

Bounding the Interleaving Distance of Geometric Graphs with a Loss Function

Sarah Percival[1], *Erin Chambers, Elizabeth Munch, Bei Wang*

[1]University of New Mexiico

Data consisting of a graph with a function to $\mathbb{R}^d$ arise in many applications, encompassing structures such as Mapper graphs, Reeb graphs, geometric graphs, and 3D skeletons. As such, the ability to compare and cluster such objects is required in a data analysis pipeline, leading to a need for distances or metrics on these objects. In this work, we study the interleaving distance on discretizations of these objects, where functor representations of data can be compared by finding pairs of natural transformations between them. However, in many cases, particularly those of the set-valued functor variety, computation of the interleaving distance is NP-hard. For this reason, we take inspiration from the work of Robinson (2020) to find quality measures for families of maps that do not rise to the level of a natural transformation, called assignments. We then endow the functor images with the extra structure of a metric space and define a loss function which measures how far a pair of assignments are from making the required diagrams of an interleaving commute. Finally we show that the computation of the loss function is polynomial in several use cases of interest. This is joint work with Erin Chambers, Elizabeth Munch, and Bei Wang.
Applied and Computational Topology, Tuesday 11:30-11:55 Room 260-223

Ordinary Isogeny Graphs with Level Structure

Derek Perrin[1], *José Felipe Voloch*[1]

[1]University of Canterbury

We study ℓ-isogeny graphs of ordinary elliptic curves defined over $\mathbb{F}_q$ with an added level structure. Given an integer N coprime to p and ℓ, we look at the graphs obtained by adding $\Gamma_0(N)$, $\Gamma_1(N)$, and $\Gamma(N)$ level structures to volcanoes. Given an order $\mathcal{O}$ in an imaginary quadratic field K, we look at the action of generalised ideal class groups of $\mathcal{O}$ on the set of elliptic curves whose endomorphism rings are $\mathcal{O}$ along with a given level structure. We show how the structure of the craters of these graphs is determined by the choice of parameters.
Computational Number Theory and Applications, Wednesday 11:15-11:25 Room 405-422

Semialgebraic Geometry - Modifying Thom's Lemma

Mark Perrin[1]

[1]Usyd

One of the major tools used in the study of semialgebraic geometry is the cylindrical algebraic decomposition (c.a.d.), that is a partition of $\mathbb{R}^n$ into 'cells'. Given a finite family of polynomials in n variables, a c.a.d. of $\mathbb{R}^n$ can be constructed algorithmically such that each polynomial is sign-invariant on the cells of the decomposition, and thus any semialgebraic subset can be expressed as a union of cells, on each of which the underlying family of polynomials have constant sign. The process of constructing such a c.a.d. starts with a sequence of n projections, followed by a sequence of n liftings. Thom's Lemma (and its generalisation to several variables) provides a condition that guarantees that we can recover the topology of the original set and, moreover, that the closure of each cell C is a union of cells whose description is obtained in a simple way from the sign conditions that describe C itself. To apply Thom's Lemma, one must 'complete the family' of polynomials by taking all nonzero derivatives of the members of the polynomials in the family. We explore a modification of the conditions to Thom's Lemma which aims to reduce the size of the resulting family of polynomials, and we provide an algorithmic implementation of it in c.a.d. construction.
Singularities, Thursday 11:30-12:20 Room 260-024

On the Euclideanity of Number Fields

Jordan Pertile[1]

[1]UNSW Canberra At ADFA

In 1977, Lenstra gave a criterion for determining whether the ring of algebraic integers R of a number field K is Euclidean. This criterion connects the number of exceptional units in R, the discriminant of K, and packing theory. A result by Serre on the lower bound for the discriminant shows that, assuming the General Riemann Hypothesis, Lenstra's criterion holds only for finitely many n. We determine when the criterion breaks down by obtaining new explicit bounds on the discriminant. This is joint work with Valeriia Starichkova.
Arithmetic Geometry and Number Theory, Tuesday 15:15-15:25 Room 405-430

New vanishing results for Kaehler manifolds

Peter Petersen[1]

[1]Ucla

This is joint work with Kyle Broder, Jan Nienhaus, James Stanfield, and Matthias Wink. We present curvature conditions for Kaehler manifolds that guarantee that the rational cohomology is that of complex projective space. The conditions are related to work of Calabi-Vesentini and

are more general than those presented by Ogiue-Tachibana. We will give an overview of the relevant background, explain the main results and also indicate the techniques employed to prove them. Specifically we control Betti numbers and offer curvature conditions that are sufficiently general that they allow for the quadrics (oriented Grassmannian of 2-planes in dimension n+2) to be included. The curvature conditions come from considering the curvature tensor as a Hermitian operator on symmetric 2-tensors.
Recent advances in geometric PDE, Thursday 11:30-12:20 Room 260-057

Hodge Numbers for Kaehler-Einstein Manifolds

Peter Petersen[1]

[1]Ucla

Petersen-Wink found new conditions on the Kaehler curvature operator that control Hodge number of Kaehler manifolds. Those conditions are sufficiently general that they are not invariant under the Ricci flow. The talk will mention those results as well as new results on how the curvature conditions can be relaxed even further when the the metric is also Einstein. This is joint work with K. Broder, J. Nienhaus, J. Stanfield, and M. Wink.
Differential geometry and geometric analysis, Friday 11:30-11:55 Room 260-005

Codes associated with generalised polygons

Sebastian Petit[1]

[1]University of Canterbury

Generalised polygons play an important role in incidence geometry, building theory and graph theory. A (weak) generalised n-gon can be defined as a point-line geometry such that the incidence graph has diameter n and girth $2n$. We want to consider the code over a field $\mathbb{F}$ generated by the columns (or rows) of the incidence matrix of some generalised $2n$-gon Γ. This follows up the article *Codes from Generalised Polygons* by B. Bagchi and N.S.N Sastry. They managed to prove a minimum weight for this code if the generalised polygon is *regular*. In this presentation, we will take a look at how their results can be extended for non-regular generalised polygons such as the dual Split Cayley hexagons. This is based on research under the supervision of Geertrui Van de Voorde.
Contributed Session B, Thursday 14:00-14:25 Room 405-430

Rare events for a collision model over a lattice

Maxence Phalempin[1]

[1]University of New South Wales

This talk presents a model of $\mathbb{Z}^d$ lattice whose each site is driven by the dynamic of an expanding map perturbed by a collision interaction from neighbouring sites. Such model is related to physical interacting particle systems over microscopic dynamics. In this talk I study the first collision rate at a particular site of this infinite dimensional system and prove that the number of collision at this site for that same dynamic up to some time converges in distribution to a compound Poisson process. Such result lays on the computation of the extremal index through the spectral properties of a perturbed transfer operator.
Ergodic Theory and Dynamical Systems, Monday 16:00-16:25 Room 303-G23

A proximal splitting algorithm for generalized DC programming with applications in signal recovery

Tan Nhat Pham[1]

[1]Federation University Australia

The difference-of-convex (DC) program is a crucial approach to nonconvex optimization problems due to its structure, which encompasses a wide ranges of practical applications. In this paper, we aim to tackle a generalized class of DC programs, where the objective function is formed by summing a possibly nonsmooth nonconvex function and a differentiable nonconvex function with Lipschitz continuous gradient, and then subtracting a nonsmooth continuous convex function. We develop a proximal splitting algorithm that utilizes proximal evaluation for the concave part and Douglas–Rachford splitting for the remaining components. The algorithm guarantees subsequential convergence to a stationary point of the problem model. Under the widely used Kurdyka–Łojasiewicz property, we establish global convergence of the full sequence of iterates and derive convergence rates for both the iterates and the objective function values, without assuming the concave part is differentiable. The performance of the proposed algorithm is tested on signal recovery problems with a nonconvex regularization term and exhibits competitive results compared to notable algorithms in the literature on both synthetic data and real-world data.
Optimisation, Monday 16:30-16:55 Room 402-221

The Equivariant Fried Conjecture for Suspension Flow

Peter Hochs[1], **Chris Pirie**[1]

[1]Radboud University Nijmegen

Given a dynamical system on a compact manifold, one can associate a certain zeta function called the Ruelle dynamical zeta function. It can be viewed as a weighted count of the number of periodic orbits in the system. It was conjectured by Fried that this zeta function has a meromorphic extension to the entire complex plane, is analytic near 0, and its value at 0 is equal to analytic torsion (also known as Ray-Singer torsion). Analytic torsion is a secondary topological invariant of the manifold, proving more powerful when other invariants such as cohomology fail. While in general Fried's conjecture has been proven false, it has been shown to hold in a large class of examples. Recent work of Hochs and Saratchandran defined equivariant versions of both analytic torsion and the Ruelle zeta function in the case of proper actions by locally compact groups with compact quotients. In this talk, we present an equivariant version of Fried's conjecture and show that it is true in the specific case of a compact group acting on the suspension flow of an isometry. This is joint work with Peter Hochs.
Index Theory in Geometry and Mathematical Physics, Tuesday 14:30-14:55 Room 260-022

The Multichannel Blind Deconvolution Problem in Parallel MRI

Gerlind Plonka[1], *Yannick Riebe*[1], *Benjamin Kocurov*[1]

[1]University of Goettingen

One of the biggest innovations in magnetic resonance imaging (MRI) within the last years was the concept of parallel MRI. In this setting, the use of multiple receiver coils allows the reconstruction of high-resolution images from undersampled Fourier data such that the acquisition time can be substantially reduced. Mathematically, the parallel MRI reconstruction problem can be seen as a multi-channel blind deconvolution problem, where the coil sensitivity functions and the magnetization image have to be recovered simultaneously from the acquired data. In this talk, we will give a short survey on existing reconstruction methods in parallel MRI so far. Further, we propose a new algorithm, called MOCCA, to recover the coil sensitvities and the magnetization image from incomplete Fourier measurements simultaneously. Our approach is based on suitable parameter models for the sensitivities. The derived MOCCA algorithm provides perfect reconstruction results if the model assumptions are satisfied. Moreover, it has a low computational complexity and fits real MRI data sufficiently well such that it is applicable in practice. The results presented in this talk have been obtained jointly with Yannick Riebe and Benjamin Kocurov.
Recent developments in data science and machine learning, Tuesday 14:00-14:25 Room 402-220

Computing the Trunk of Links: Methods and Applications in Linking Probability

Jeremy Eng, **Puttipong Pongtanapaisan**[1], *Rob Scharein, Chris Soteros*

[1]Arizona State University

In the works of Beaton, Ishihara, Atapour, Eng, Vazquez, Shimokawa, and Soteros, the authors

demonstrate that a measure of geometric complexity called the trunk of links is useful in studying linking probability, as the trunk dictates whether a link is embeddable in a lattice tube. In this talk, I will present techniques for computing the trunk and discuss the implications of trunk values on different modes of linking.
Topology, geometry and combinatorics of biopolymers, Friday 14:30-14:55 Room 260-221

Exotic behaviour near heteroclinic networks

Claire Postlethwaite[1]

[1]The University of Auckland

A heteroclinic network in a dynamical system is a set of equilibrium solutions and connecting orbits between them. Heteroclinic networks can be thought of as an embedding of a directed graph into the phase space of the dynamical system, where vertices correspond to equilibria and directed edges to heteroclinic trajectories. The dynamics near a heteroclinic network is characterized by intermittent behaviour: solutions spend a long period of time close to one equilibrium before rapidly switching to another. The manner in which the transitions between equilibria occur can be incredibly rich: trajectories may visit all the equilibria in the network, or only a subset of them; the order in which equilibria are visited may be regular, or apparently chaotic. In spatially extended systems (modelled by partial differential equations), solutions near heteroclinic networks can arise as travelling or spiral waves. In this talk I will present some results demonstrating this exotic behaviour near heteroclinic networks, and discuss some of the ways in which we are able to analyse this behaviour.
Ergodic Theory and Dynamical Systems, Monday 14:30-14:55 Room 303-G23

Local and global well-posedness for the Maxwell-Bloch equations with inhomogeneous broadening

Barbara Prinari, *Gino Biondini, Zechuan Zhang*

[1]University at Buffalo

The Maxwell-Bloch system of equations with inhomogeneous broadening is studied, and the local and global well-posedness of the corresponding initial-boundary value problem is established by taking advantage of the integrability of the system and making use of the corresponding inverse scattering transform. A key ingredient in the analysis is the L^2-Sobolev bijectivity of the direct and inverse scattering transform established by Xin Zhou for the focusing Zakharov-Shabat problem.
Harmonic analysis and Hamiltonian PDE, Tuesday 15:00-15:25 Room 260-028

Discrete solitons for the defocusing Ablowitz-Ladik equation with an arbitrarily large background

Barbara Prinari[1]

[1]University at Buffalo

In this talk we discuss the inverse scattering transform (IST) and soliton solutions of the defocusing Ablowitz-Ladik equation with arbitrarily large nonzero background. In [1], discrete analogs of the celebrated Kuznetsov–Ma (KM), Akhmediev, Tajiri-Watanabe and Peregrine solutions were obtained, which mimic the corresponding solutions of the focusing AL equation. Here we also address in detail the conditions on the background and on the spectral parameters that guarantee the KM solution to be non-singular on the lattice for all times, and present a novel KM-type breather solution which is also regular on the lattice under the same conditions [2].

[1] A.K. Ortiz and B. Prinari, "Inverse scattering transform for the defocusing Ablowitz-Ladik equation with arbitrarily large background", Stud. App. Math., 143, 337-448 (2019)

[2] E. Boadi, E.G. Charalampidis, P. G. Kevrekidis, N. Ossi and B. Prinari, "On the discrete Kutznetsov–Ma solutions for the defocusingAblowitz- Ladik equation with large background amplitude", in preparation (2024)

Discrete and continuous integrable systems: geometry analysis and applications, Friday 11:30-12:20 Room 260-036

Taking Research from Academia to Broader Audiences

Cait Pryse[1], *Paul Fijn*[1], *Dominic Maderazo*[1], *Susan James*[1], *Cindy Huang*[1]

[1]The University of Melbourne

What are effective ways to take research and re-purpose it for a variety of contexts and audiences? We will discuss our design process of taking cutting-edge research from academics within our School and how we adapted them to a variety of outreach programs and communication formats. We will discuss developing workshops for school-aged children based on current research; designing open-ended questions for self-directed research projects; and engaging the wider public through publications and presentations aimed at adult audiences. Research questions enable students to express their creativity and novel approaches to solving problems, and workshops provide opportunities for students to collaborate and communicate mathematics. We will also discuss an example of creating a puzzle based on research and using this to more broadly engage the general public in the mathematics underlying the problem posed as a puzzle. This provides an avenue for both creating more interest in mathematics and statistics, and opportunities to highlight your own specific research area.

Engagement with mathematics through communication and outreach, Monday 14:30-14:55 Room 260-040

Trees, fixed points, and the Cremona group

Piotr Przytycki[1]

[1]Mcgill University

An action of a group on a space is called decent if every finitely generated subgroup all of whose elements have fixed-points has a global fixed-point. An example is the automorphism group of a tree or a finite product of trees. I will give a sufficient condition for a group acting on a restricted infinite product of trees to be decent. This allows to prove that every finitely generated subgroup of the Cremona group of P^2 all of whose elements are algebraic is bounded. Joint work with Anne Lonjou and Christian Urech.
Groups and Geometry, Tuesday 14:00-14:50 Room 260-092

Counting lines in a symmetric quintic threefold surface under the action of the group of permutations S_5

Luis David Garcia Puente[1], *Iverson Wang*

[1]Colorado College

A symmetric quintic threefold is a 3-dimensional surface of degree 5 in 4-dimensional complex projective space. These surfaces are important examples in algebraic and differential geometry since non-singular quintic threefolds are Calabi-Yau manifolds. It is a classic result that a generic quintic threefold contians exactly 2875 distinct lines. On the other hand, example such as the Fermat quintic threefold contain infinitely many lines. When a quintic threefold is symmetric, one can count the orbits under the action of the group of pemutations S_5. Prior to our work, Thomas Brazelton had shown that the 27 lines on the Fermat cubic lie on three S_4-orbits of sizes 12, 12, and 3. In this talk, we will give a brief introduction to the broad area of equivariant enumerative geometry. We will then show how to compute the S_5-orbits and the corresponding isotropy subgroups for the 2875 lines on a particular symmetric quintic threefold. We will finish our talk with some facts and conjectures about the lines on symmetric quintic threefolds.
50 years of Communications in Algebra, Monday 16:00-16:25 Room 303-G15

Einstein metrics on homogeneous superspaces

Yang Zhang, Mark Gould, Jorgen Rasmussen, **Artem Pulemotov**[1]

[1]The University of Queensland

The notion of a supermanifold generalises the concept of a manifold in classical geometry by exploiting the idea of supersymmetry from theoretical physics. Supermanifolds have become an integral part of quantum field theory and arisen in other areas. We will explain how analogues of Einstein metrics can be produced on supermanifolds and how the super setting challenges

the intuition provided by the classical theory. Our focus will be on constructions involving homogeneous superspaces, which one may think of as supermanifolds with symmetries.
Differential geometry and geometric analysis, Wednesday 10:30-10:55 Room 260-005

Sounding Lie groups

Denis Collins, **Artem Pulemotov**

[1]The University of Queensland

I will discuss my collaboration with the University of Queensland School of Music, which has led to the creation of a new piece for chamber ensemble and the production of four lecture-recitals for general audiences in Brisbane and regional Queensland. The talk will touch upon the challenges of initiating a collaboration, working across disciplinary lines, securing funding and producing outcomes in an unfamiliar field.
Engagement with mathematics through communication and outreach, Thursday 15:00-15:25 Room 260-009

Geometry and combinatorics of 3-manifold triangulations

Jessica Purcell[1]

[1]Monash University

Every 3-manifold can be obtained by gluing tetrahedra, by classical work of Moise. When the manifold admits a hyperbolic structure, the tetrahedra can often be taken to be convex with respect to the hyperbolic metric. Such a triangulation is called a geometric triangulation. It is conjectured that every cusped hyperbolic 3-manifold admits an ideal geometric triangulation. However, Choi showed that there is a 3-dimensional hyperbolic cone manifold without an ideal geometric triangulation. The closed hyperbolic 3-manifold Vol3 has no known (spun) ideal geometric triangulation. In this talk, we discuss these results and present evidence that Vol3 cannot have an ideal geometric triangulation. This is joint work with David Futer and Saul Schleimer.
Groups and Geometry, Monday 16:00-16:50 Room 260-092

Solitons of the mean curvature flow

Juncheol Pyo[1]

[1]Pusan National University

Translating solitons and self shrinkers are solitons of the mean curvature flow. They are not

only blow-up models of singularities of MCF but minimal surfaces in Riemannian manifolds. In this talk, we compare some properties of minimal surfaces and solitons of MCF with respect to Bernstein type theorem, properness, and free boundary surfaces in a ball. More precisely, we prove that the rigidity results when a graphical translator moves in a non-vertical direction. Secondly, we introduce some sufficient conditions for properness of translating solitons. Finally, we prove that any graphical self-shrinker with free boundary in a ball is a flat disk passing through the center of the ball. These are joint work with Daehwan Kim, Sangwoo Park, Yuan Shyong Ooi, and John Ma.
Mathematics of nonlinear diffusion processes, Wednesday 10:30-11:20 Room 260-018

A discrete de Rham scheme for the exterior calculus Einstein's equations

Jia Jia Qian[1]

[1]Monash University

There are many challenges to overcome when trying to numerically simulate Einstein's equations. In this talk we propose a discrete de Rham scheme for a recent 3+1 exterior calculus formulation of Einstein's equations, of which little is known about the theoretical properties so far. The method preserves exactly the constraints linked to the tetrad of the metric, but not necessarily the Hamiltonian constraint that should come as a result of the twice contracted Bianchi identities. Numerical results are discussed.
Computational Mathematics, Tuesday 15:00-15:25 Room 402-231

Isomorphism problems for some algebraic structures: algorithms, complexity, and cryptography

Youming Qiao[1]

[1]University of Technology Sydney

In this talk we examine testing isomorphism of some algebraic structures, including tensors, groups, polynomials, algebras, from the perspectives of algorithms, complexity, and cryptography. A focus will be on some recent algorithmic advances on these problems (partly motivated by cryptoanalysis), including worst-case, average-case, and heuristic algorithms. We will also report results on enumeration of p-groups of Frattini class 2, which improve Higman's bound in the 1960's and answer some questions raised by Blackburn, Neumann, and Venkataraman. Based on joint works with J. A. Grochow, G. Ivanyos, E. Mendoza, X. Sun, C. Zhang, Y. Li, P. A. Brooksbank, J. B. Wilson, A. Natarayan, G. Tang, M. Bläser, and A. Rogovskyy.
Groups, actions and computations, Thursday 11:30-12:25 Room 260-051

Characteristic elements modulo p in noncommutative Iwasawa theory

Chao Qin[1]

[1]Harbin Engineering University

In this talk, we begin reviewing the non-commutative Iwasawa theory as developed by Coates, Fukaya, Kato, Sujatha and Venjakob which is concerned with attaching suitable characteristic element to modules of arithmetic interest. By their construction, these characteristic elements are realized as element in an appropriate localized K_1 group. We then introduce a notion of taking modulo p of these characteristic elements and discuss some of its properties. This is an ongoing work with Meng-Fai Lim.
Computational Number Theory and Applications, Wednesday 11:30-11:40 Room 405-422

Infinite-dimensional statistical distances for functional data analysis

Minh Ha Quang[1]

[1]RIKEN Center For Advanced Intelligence Project

In this talk, we present an overview of recent results on infinite-dimensional statistical distances between covariance operators and stochastic processes in the setting of functional data analysis. Our focus will be on distances and divergences arising from information geometry and optimal transport, including the Wasserstein distance and its entropic regularization. We discuss the challenges faced in dealing with the infinite-dimensional setting and show in particular that, by using regularization, the infinite-dimensional distances and related quantities can be consistently and efficiently estimated from their finite-dimensional counterparts. The resulting numerical algorithms will be illustrated by applications in functional data analysis.
Recent developments in data science and machine learning, Wednesday 10:30-10:55 Room 402-220

The ladder method

John Quigg[1], *Matthew Gillespie, Steve Kaliszewski, Dana Williams*

[1]Arizona State University

We present a new method of establishing a bijective correspondence - in fact, a lattice isomorphism - between invariant ideals of C*-algebras and their crossed products by a fixed locally compact group. It was already known that such a correspondence exists whenever the group is amenable; our results hold for any locally compact group under a natural form of coaction invariance. Time permitting, we also introduce a similar result for ideals of Fell bundles over groupoids. Joint work with Matthew Gillespie, S. Kaliszewski, and Dana P. Williams.
Functional Analysis and Operator Algebras, Friday 12:00-12:25 Room 260-055

Resonance in Partial Tipping Due to Timescale Variation of Chaotic Forcing

Courtney Quinn[1], *Hassan Alkhayuon*[2]

[1]University of Tasmania, [2]University College Cork

Many physical systems are forced by external factors which are subject to chaotic variation. A particular example is in applications to weather and climate where chaotic behaviour is prevalent across timescales. If the system in question has multiple attracting solutions under the bounds of variation, then partial tipping can be observed. This is where, initialising from the base attractor, only a subset of realisations undergo a transition to an alternative attractor. We explore this phenomenon in a low-order model of ice-age dynamics. The model exhibits bistability between two equilibria in one bistable region of the parameter space, and between an equilibrium and a periodic orbit in another bistable region. When allowing for chaotic variation of the parameters within these bistable regions, the solution can undergo either reversible or irreversible tipping between attractors. We find that the timescale of the chaotic variation induces resonance-like behaviour in that there exists an optimal timescale for tipping as well as a minimum timescale for the occurrence of tipping. We also explore the crossing of the stable manifold of the time-varying saddle equilibrium through the use of finite-time Lyapunov exponents.

Computational Methods and Applications of Dynamical Systems, Monday 16:00-16:30
Room 303-G20

Understanding complex oscillations in a model of intracellular calcium dynamics

Behnaz Rahmani[1], *Samuel Jelbart*[2], *Vivien Kirk*[1], *James Sneyd*[1]

[1]The University of Auckland, [2]University of Vienna

Oscillations of free intracellular calcium concentration are thought to be important in the control of a wide variety of physiological phenomena, and there is long-standing interest in understanding these oscillations via the investigation of suitable mathematical models. Many mathematical models of calcium dynamics exhibit variables or terms that evolve on vastly different time scales, leading to temporally complex oscillations. This talk describes efforts to use geometric singular perturbation theory and numerical bifurcation analysis to explain complex oscillations observed in a model of hepatocytes (liver cells).

Computational Methods and Applications of Dynamical Systems, Monday 14:30-14:55
Room 303-G20

A geometric approach to the Ma–Trudinger–Wang estimates

Cale Rankin[1]

[1]Monash University

Optimal transport is a driving force of 21st century analysis and in its most basic form asks for a map between probability measures which minimizes a particular transport cost. For a long time the regularity of the optimal transport map for general transport costs was a fundamental open problem. While this question had been answered in particular cases by Delanoë, Caffarelli, and Urbas (separately) via apriori estimates for Monge–Ampère equations, it remained unknown how to deal with general costs. The extension of these estimates and the regularity of the optimal transport maps was proved in a groundbreaking work by Ma, Trudinger, and Wang who introduced a mysterious fourth order condition on the cost. Kim and McCann realised this condition amounts to a curvature condition in a particular pseudo-Riemannian geometry and, with Warren, realised after a conformal rescaling the graph of optimal transport maps are maximal surfaces in this geometry. In this talk we show how the original MTW estimates may be realized via estimates for maximal surfaces in pseudo-Riemannian geometry. This is joint work with Brendle, Léger, and McCann

Recent advances in geometric PDE, Friday 14:00-14:25 Room 260-057

Profinite rigidity

Alan Reid[1]

[1]Rice University

In this talk we discuss profinite rigidity of groups arising in low-dimensional geometry and topology.

Groups and Geometry, Thursday 11:30-12:20 Room 260-092

Strongly dense representations of surface groups

Alan Reid[1]

[1]Rice University

Following Breuillard, Green, Guralnick and Tao, we say that a subgroup G of $\mathrm{SL}(n,\mathbb{R})$ is strongly dense if any pair of non-commuting elements of G generates a Zariski dense subgroup of $\mathrm{SL}(n,\mathbb{R})$. This talk will describe constructions of faithful representations of surface groups that have strongly dense image. There will be both theoretical and computational constructions.

Groups, actions and computations, Friday 12:00-12:25 Room 260-051

Non-existence of upper volume bounds for classes of links on incompressible surfaces

Corbin Reid[1]

[1]Monash University

The volume of a hyperbolic 3-manifold can be a powerful invariant, but it is often difficult to determine given only a combinatorial description of a 3-manifold, such as a link diagram. We consider volumes of two families of links that have been the focus of recent results on geometry, namely weakly generalised alternating (WGA) links and fully augmented links (FAL). Both have known lower bounds on hyperbolic volume in terms of their diagram combinatorics - the analogous properties of twist number and number of crossing circles, respectively - but less is known about upper bounds. In fact, Kalfagianni and Purcell recently found a family of WGA knots on a compressible surface for which there can be no upper bounds on volume. Their proof relied heavily on the existence of a compression disc in the complement. They asked if upper bounds exist for WGA knots on incompressible surfaces. In this talk, we show the answer is no: we relate their results to FAL on surfaces and find large families of WGA and FALs on incompressible surfaces with no upper bound on volume in terms of twist number.
Early Career Showcase in Low-Dimensional Topology, Thursday 12:00-12:25 Room 260-073

L^p-cohomology of Lie groups

Bertrand Remy[1]

[1]Ens Lyon

L^p-cohomology is a notion which has the advantage of providing a continuous family of numerical quasi-isometry invariants. Intuitions from standard algebraic topology and techniques from homological algebra are still relevant, even though the ultimate goal is to study the large scale geometry of suitable metric spaces. Among interesting such spaces are non-compact Lie groups and their associated geometries. The questions are quite different according to whether one studies semisimple or solvable groups. We will discuss the two situations, mostly under the viewpoint of critical exponent and quasi-isometric rigidity phenomena. This is a joint work with Marc Bourdon.
Groups and Geometry, Wednesday 10:30-11:20 Room 260-092

Some Combinatorial Cartan subalgebras

Sarah Reznikoff[1], *Rachael Norton, Sarah Wright*

[1]Virginia Tech, [2]St Olaf College

Cartan subalgebras in C^*-algebras were introduced and studied extensively by Renault in the early 1980s. The utility of these subalgebras is revealed by Renault's theorem stating that the presence of a Cartan is equivalant to the algebra having a dynamical representation via a groupoid. We present a concrete description of the Cartan subalgebras arising from the work of Duwenig-Gillaspy-Norton-Reznikoff-Wright.
FUNCTIONAL ANALYSIS AND OPERATOR ALGEBRAS, MONDAY 16:30-16:55 ROOM 260-055

Irreducible weight $\mathfrak{sl}_3$-modules with infinite multiplicities

David Ridout[1]

[1]University of Melbourne

Motivated by the quest to understand the correct notion of a non-finite non-semisimple modular tensor category, which is in turn motivated by a consistency condition for logarithmic conformal field theories, we study the category of finitely generated weight modules over the simple affine vertex operator algebras associated with $\mathfrak{sl}_3$. In many cases, the "standard modules" of this category require us to consider (generically) irreducible families of (possibly new?) weight $\mathfrak{sl}_3$-modules in which every weight space has infinite dimension. These families include, but are more general than, another well-studied family of such modules, constructed using Gelfand-Tsetlin combinatorics by Futorny and collaborators. [Joint work with Chris Raymond.]
REPRESENTATION THEORY AND TENSOR CATEGORIES, TUESDAY 14:00-14:25 ROOM 303-G14

Diophantine approximation in integer bases

Gerardo Gonzalez Robert[1], *Mumtaz Hussain*[1], *Nikita Shulga*[1], *Zhengliang Zhang*[2]

[1]La Trobe University, [2]Chongqing Normal University

Classical Diophantine approximation studies how close we can get to real numbers by rational numbers. A variant of this problem is to restrict the set of approximating rationals. In this talk, after fixing a natural number b¿1, I will consider approximation to a given irrational number by the partial sums of its base b expansion. To understand the problem better, I will introduce a new approximation exponent similar to the exponents studied by Amou-Bugeaud and Bugeaud-Liao. I will compare the new exponent with the old ones. I will conclude the talk by stating an open problem (in the spirit of Furstenberg) motivated by our findings.
ERGODIC THEORY AND DYNAMICAL SYSTEMS, THURSDAY 14:00-14:25 ROOM 303-G23

Advancing the MERGE Gully Erosion Model to inform gully remediation in protection of the Great Barrier Reef

Melanie Roberts[1]

[1]Australian Rivers Institute - Griffith University

Effective gully remediation is essential for safeguarding the Great Barrier Reef from sediment runoff, a key contributor to reef degradation. This presentation will introduce recent developments in the MERGE (Modelling Erosion Resistance for Gully Erosion) model, which supports strategies to mitigate sediment discharge. We will discuss the current state of the model, emphasising enhancements in simulating mitigation and remediation practices focussed on channel-like gullies. Additionally, future developments aimed at refining predictive capabilities and incorporating more complex environmental factors will be explored. This work underpins informed decision-making in gully remediation, contributing to the long-term preservation of this critical ecosystem.
Industrial Mathematics, Tuesday 11:45-11:55 Room 402-211

The Extended Persistent Homology Transform for Manifolds with Boundary

Vanessa Robins[1], *Katharine Turner, James Morgan*

[1]The Australian National University

The Persistent Homology Transform (PHT) is a topological transform introduced by Turner, Mukherjee and Boyer in 2014. Its input is a shape embedded in Euclidean space; then to each unit vector the transform assigns the persistence module of the height function over that shape with respect to that direction. The PHT is injective on piecewise-linear subsets of Euclidean space, and it has been demonstrably useful in diverse applications as it provides a landmark-free method for quantifying the distance between shapes. One shortcoming is that shapes with different essential homology (i.e., Betti numbers) have an infinite distance between them. The theory of extended persistence for Morse functions on a manifold was developed by Cohen-Steiner, Edelsbrunner and Harer in 2009 to quantify the support of the essential homology classes. By using extended persistence modules of height functions over a shape, we obtain the extended persistent homology transform (XPHT) which provides a finite distance between shapes even when they have different Betti numbers. It may seem that the XPHT requires significant additional computational effort, but recent work by Katharine Turner and myself shows that when A is a compact manifold with boundary X, embedded in Euclidean space, the XPHT of A can be derived from the PHT of X, and a signature for each local minimum. James Morgan has implemented the required algorithms for 2-dimensional binary images as an R-package. This talk will provide an outline of our results and illustrate their application to shape clustering, and symmetry quantification. These applications were studied by our former students Jency Jiang, Thomas Burnett and Nicholas Bermingham.
Applied and Computational Topology, Tuesday 15:00-15:25 Room 260-223

Topological data analysis of self-assembled point patterns formed in molecular dynamics simulation

Vanessa Robins[1]

[1]The Australian National University

We study the time evolution, convergence, and final self-assembled state in molecular dynamics simulations of particles interacting through a pair-wise potential with three local minima. The pair potential has two parameters and its phase diagram was established by Engel et al (Nature Materials, 2015) to contain icosahedral quasicrystals, various crystalline phases, and a disordered phase. The persistent homology of alpha-shape filtrations reveals the formation and dissipation of specific particle constellations in the MD trajectories, and shows that the persistence diagrams are sensitive to the nucleation and convergence to a final structure. In particular, we identify the presence of pentagonal bi-pyramid arrangements in icosahedral quasicrystals, and show that their geometry is stabilised by the relative locations of the three local minima in the interaction potential. This identifies the underlying geometric reason for the observation by Engel et al (2015) that a three-well potential is required for quasicrystal formation in single-particle systems. This work is published in Pedersen MC, Robins V, Mortensen K, Kirkensgaard JJK. 2020 Evolution of local motifs and topological proximity in self-assembled quasi-crystalline phases. Proc. R. Soc. A 476: 20200170.

New directions in pattern formation, Friday 11:30-11:55 Room 303-B11

On q-Painlevé VI transcendents, connection problems and Segre surfaces

Pieter Roffelsen[1]

[1]The University of Sydney

Under a q-analog of the Riemann-Hilbert correspondence, q-Painlevé VI transcendents are related to points on a six-dimensional family of affine Segre surfaces. I will explain how geometric aspects of the affine surfaces translate to analytic aspects of the transcendents under this correspondence and how it further yields the solution to the general connection problem of q-Painlevé VI.

Special Functions, q-Series and Beyond, Tuesday 16:30-16:55 Room 401-312

Adaptive regularization of rough linear functionals for nonconforming FEM

Ignacio Muga[2], **Sergio Rojas**[1], *Kristoffer Vander Zee*[3], *Patrick Vega*[4]

[1]Monash University, [2]Pontificia Universidad Catolica de Valparaiso, [3]University of Nottingham, [4]Universidad de Santiago de Chile

Rough linear functionals, such as Dirac Delta distributions, often appear on the right-hand side

of variational formulations of PDEs. As they live in negative Sobolev spaces, they dramatically affect adaptive finite element procedures to approximate the solution of a given PDE. Furthermore, in the case of nonconforming (or broken) test spaces, rough functionals could not even belong to the dual of such a test space. To overcome this drawback, we propose an alternative that, in the first step, computes a projection of the rough functional over piecewise polynomial spaces up to a desired precision in a negative norm sense, using either conforming or nonconforming test spaces. The projection is then used as the right-hand side of a regularized PDE problem for which adaptive nonconforming methodologies are perfectly well-defined and converge. An error analysis of the proposed methodology will be shown, together with numerical experiments.
Computational Mathematics, Friday 11:30-11:55 Room 402-231

Exploring Calcium oscillation patterns in T-lymphocytes using ordinary differential equations

Paco Castaneda Ruan[1], *VIvien Kirk*[1], *James Sneyd*[1], *Mohamed Trebak*[2, 3], *J Cory Benson*[2, 3]

[1]The University of Auckland, [2]University of Pittsburgh School of Medicine, [3]The Pennsylvania State University College of Medicine

Across the spectrum of cell types, the concentration of intracellular calcium controls a wide array of cellular functions. Calcium signals, usually in the form of oscillations, play a paramount role in correct cellular activity. Lymphocytes, a type of white blood cell, are fundamental to the function of the immune system. These cells have recently been shown to exhibit two fundamentally different types of oscillation, depending on the influx of extracellular calcium. In this talk, we will present a model of ordinary differential equations constructed to replicate the oscillations of calcium seen in experiments on T-lymphocytes, then explore the multiple types of oscillations exhibited by the model. The aim of this work is to help understand the physiological mechanisms that underlie the different oscillatory patterns observed in these cells.
Contributed Session A, Wednesday 11:00-11:25 Room 260-040

Aposterior error analysis of robust virtual element methods for stress-assisted diffusion problems

Andres E Rubiano[1], *Ricardo Ruiz Baier*[1], *Franco Dassi*[2], *Rekha Khot*[3]

[1]Monash University, [2]Università degli Studi di Milano-Bicocca, [3]National Institute for Research in Computer Science and Control

In this paper we develop and analyse upper and lower a posteriori error estimates for the virtual element discretisation of a nonlinear diffusion - elasticity coupled problem. The equations model stress-assisted diffusion and are of relevance for example in electromechanics of soft tissues and simplified models for lithium ion batteries. The error estimates are based on appropriately weighted norms that make the analysis robust with respect to model parameters. The a poste-

riori error estimators are of residual type (including also stabilisation terms) and their analysis requires modified projection and interpolation operators. The reliability bounds for the decoupled elasticity equations in mixed form follows from a parameter-robust global inf-sup condition and properties of the modified projections, interpolations, and stabilisations. For the nonlinear diffusion in mixed form we require in addition a Helmholtz decomposition and additional regularity of the boundary data. We provide several numerical experiments to demonstrate the sharpness of the error estimates in 2D and 3D problems.
Computational Mathematics, Monday 15:00-15:25 Room 402-231

Bound quiver algebras that are Morita-equivalent to the one-boundary Temperley-Lieb algebras

Yvan Saint-aubin[1]

[1]Universite de Montreal

Bound quiver algebras are in a sense the simplest (non-semisimple) algebras: their simple modules are one-dimensional, and indecomposable projective and injective ones can be read from their quiver presentation. Finding a path algebra that captures the representation theory of another given algebra is however very difficult. The family of one-boundary Temperley–Lieb algebras TLb_n has played a crucial in the description of some lattice statistical-physics models. It has a rich representation theory and is related to several important ones in both mathematics and physics: the affine Temperley–Lieb, the cyclotomic affine Hecke and the KLR algebras. Using Elias–Soergel–Williamson diagrammatic calculus we obtain bounded quiver algebras that are Morita-equivalent to the blocks of the algebras TLb_n. This is work in progress with Alexis Leroux-Lapierre and Théo Pinet. The relations on the bound quiver were also checked independently by Philippe Petit using KLR diagrammatics.
Mathematical Physics, Monday 15:00-15:25 Room 260-221

How to pack a bunch of Kyber ciphertexts?

Amin Sakzad[1], *Shuiyin Liu*[2]

[1]Monash University, [2]Holmes Institute

To reduce communication overhead in Integer/Ring/Module Learning with Errors (I/R/M-LWE) based key encapsulation mechanisms (KEMs), various coding schemes have been developed, such as lattice codes for FrodoKEM and BCH codes for CRYSTALS-Kyber. These schemes typically assume that the decryption noise entries are independent, which can lead to an underestimated decryption failure rate (DFR). This work presents a new design for Kyber KEMs that does not rely on this independence assumption. By using ciphertext packing and lattice packing, the proposed scheme, Coded P_ℓ-Kyber, achieves a significant reduction in communication overhead while ensuring a low DFR. Specifically, with $\ell = 24$ and a Leech lattice encoder, the scheme reduces communication overhead by 90% and achieves a DFR of less than

2^{-254}.
Computational Number Theory and Applications, Friday 15:15-15:25 Room 405-422

Hypergeometric motives and invertible K3 surface pencils

Adriana Salerno[1]

[1]National Science Foundation

In work with Doran, Kelly, Sperber, Voight, and Whitcher, we obtained an explicit description of hypergeometric motives associated to five one-parameter deformations of K3 quartic hypersurfaces in projective space. These pencils fit naturally into a broader class of invertible K3 quartic pencils. In this talk, we describe hypergeometric decompositions associated with such pencils, including geometric and arithmetic aspects.
Arithmetic Geometry and Number Theory, Wednesday 11:00-11:25 Room 405-430

Dissipative 2D MHD equations with L^1 vorticity and current

Marco Sammartino[1], *Vincenzo Sciacca, Maria Schonbek*

[1]University of Palermo

We consider the two-dimensional magneto-hydrodynamic (MHD) equations describing the evolution of a dissipative incompressible electrically conducting fluid, with velocity u, moving through a magnetic vector field B. The interaction between the fluid and the magnetic field is described by the coupling between the Navier-Stokes and Maxwell's equations. We shall consider these equations in the vorticity-current 2D formulation and investigate the well-posedness problem in the critical space L^1. We shall prove the solution's local in-time existence and regularity for initial fluid vorticity and initial magnetic current in L^1. We shall also discuss some instances when one can extend the solution globally in time.
Recent advances in mathematical fluid dynamics, Thursday 12:00-12:25 Room 401-311

Unlocking Curiosity and Building Resilience: Engaging Students in Biocalculus with Inquiry-Based AI Tools for Effective Hybrid Learning

Widodo Samyono[1]

[1]Jarvis Christian University

The recent shift to online teaching due to the COVID-19 pandemic has accelerated the integration of technology in education, presenting both challenges and opportunities. This presentation explores the innovative use of inquiry-based AI tools to enhance student engagement and learning outcomes in a Biocalculus course. By leveraging AI platforms such as Copilot, Gemini, and ChatGPT, alongside traditional symbolic manipulation software like Wolfram Alpha, students are empowered to tackle complex biological problems through mathematical modeling. The course is structured as a hybrid learning environment, combining synchronous in-person discussions with asynchronous online activities. This approach not only fosters flexibility but also promotes active learning and resilience among students. Assessment methods include traditional exams and project-based tasks, allowing for a comprehensive evaluation of students' problem-solving skills and understanding. Notably, several students have demonstrated remarkable success through this approach. For instance, one student utilized AI tools to model the spread of a viral infection, leading to a deeper understanding of epidemiological concepts and earning top marks in their project. Another student applied AI-driven analysis to enzyme kinetics, resulting in a publication-worthy research paper. Students faced and overcame significant challenges, such as adapting to new AI tools and integrating them with traditional mathematical methods. One student initially struggled with the complexity of AI-driven modeling but, through perseverance and support, successfully developed a robust model of population dynamics. Another student overcame difficulties in interpreting AI-generated data, ultimately mastering the skill and applying it to a groundbreaking project on cellular growth. Preliminary data indicates a significant improvement in student performance, with average exam scores increasing by 15% and project completion rates rising by 20% compared to previous semesters. These improvements highlight the efficacy of integrating AI tools in enhancing student learning outcomes.

Mathematics Education, Tuesday 16:00-16:50 Room 260-115

Analysing the impact of streaming in New Zealand primary schools through multilevel models using TIMSS data

Tanya Saxena[1], *Tanya Evans*[1], *Stephanie Budgett*[1]

[1]University of Auckland

The academic discourse on ability grouping in New Zealand highlights a contentious and multifaceted debate within the education sector. Ability grouping involves segregating students within classrooms based on perceived academic capabilities. The reliance amongst teachers on ability grouping has been fuelled by the Numeracy Development Project (Ministry of Education, 2008), a country-wide professional development program introduced between 2000 and 2009, which advocated for using ability-based classroom grouping (Anthony et al., 2018). Over the past two decades, research has highlighted the negative effects of sorting students into ability groups (Hunter et al., 2020). While the supposed benefits of this system are debated, the drawbacks are evident. These include reinforcing educational inequalities through a restricted curriculum at lower-group levels, damaging students' self-confidence. Students in lower-ability groups often receive less challenging instruction, hindering their academic growth and widening the achievement gap (Hattie, 2009). Some studies have highlighted that ability grouping can negatively affect students' self-esteem and limit their academic potential, especially among marginalised groups like Māori and Pacific Island students (Pomeroy et al., 2024). Teachers also face challenges in addressing diverse educational needs within the same classroom and ensuring all students stay engaged and challenged. The aforementioned arguments go against the nationally rolled-out Numeracy Professional Development project and call for more research on the impacts of ability grouping. Hence, this presentation reports on the analyses of TIMSS data from 2011 to 2019, focusing on teacher-reported items related to grouping practices. Multilevel modelling examined both population-level fixed effects and cluster-based random effects. References:

Anthony, G., Hunter, R., & Hunter, J. (2018). Challenging teachers' perceptions of student capability through professional development: A telling case. Professional Development in Education, 44(5), 650-662.

Hattie, J. (2009). Visible learning: A synthesis of over 800 meta-analyses relating to achievement. Routledge.

Hunter, J., Hunter, R., & Anthony, G. (2020). Shifting towards equity: Challenging teacher views about student capability in mathematics. Mathematics Education Research Journal, 32(1), 37-55. Ministry of Education. (2008). Numeracy Professional Development Projects 2008, Book 3: Getting started. Learning Media.

Pomeroy, D., Azarmandi, M., Ratima, M. T., Tolbert, S., Jones, K. L., Riki, N., & Karaka-Clarke, T. H. (2024). Shame, entitlement, and the systemic racism of mathematics "ability" grouping in Aotearoa New Zealand. Educational Studies in Mathematics, 116(3), 463-478.

Mathematics Education, Wednesday 11:30-11:55 Room 260-115

Noncommutative Martingales in Continuous Time

Thomas Scheckter[1]

[1]Unsw

In this talk we will discuss the difficulties encountered in trying to study noncommutative martingales in the continuous time setting, After a brief review of existing approaches, and the technical troubles in trying to deal with such processes, we will discuss an approach for the hyperfinite type II_1 factor, allowing us to explore càdlàg processes, stopping times, stopped processes, and semimartingales. The focus will remain largely on the construction and properties of such processes, rather than the associated stochastic integration theory.

Functional Analysis and Operator Algebras, Thursday 15:00-15:25 Room 260-055

Braid groups, elliptic curves, and resolving the quartic

Peter Huxford, **Jeroen Schillewaert**[1]

[1]University of Auckland

We show that, up to a natural equivalence relation, the only non-trivial, non-identity holomorphic maps between unordered configuration spaces, where the target are triples or quadruples, are the resolving quartic map, a map constructed from the inflection points of elliptic curves in a family, and their composition. This completes the classification of holomorphic maps between configuration spaces where the target has at most as many points as the source, extending results of Lin, Chen and Salter, and partially resolves a conjecture of Farb. We also classify the holomorphic families of elliptic curves over configuration spaces. To do this we classify homomorphisms between braid groups with few strands and the modular group, then apply powerful

results from complex analysis and Teichmüller theory. Furthermore, we prove a conjecture of Castel about the equivalence classes of endomorphisms of the braid group with three strands.
Early Career Showcase in Low-Dimensional Topology, Friday 11:30-11:55 Room 260-073

Rook equivalence and a multisum extension of the Sears ${}_4\phi_3$ transformation

Samrith Ram[1], **Michael Schlosser**[1]

[1]University of Vienna

We identify a class of boards which are mutually rook equivalent and obtain, by convolution, expressions for certain rook numbers in terms of multisums whose summands are closed form products. Computing the same rook number in a different way gives a transformation of sums. This not only nicely extends to the q-case, in the setting of the q-rook theory of Garsia and Remmel, but even to a uniparametric extension of the latter, called $(a;q)$-rook theory, which was more recently introduced by the speaker and Meesue Yoo. Working in the $(a;q)$-theory, the just mentioned multisum transformation reduces in one of the simplest cases to Sears' transformation of balanced terminating basic hypergeometric ${}_4\phi_3$ series (which is different from any of the transformations of basic Karlsson–Minton type series obtained by James Haglund in his work on q-rook theory). This is joint work with Samrith Ram (IIIT Delhi).
Special Functions, q-Series and Beyond, Monday 15:00-15:25 Room 401-312

On Bochner Kähler manifolds

Gerd Schmalz[1], *David Sykes, Martin Kolář*

[1]University of New England

Bochner Kähler manifolds are Kähler manifolds with vanishing Bochner curvature. Although Bochner curvature can be considered as the Kähler analog of Weyl curvature in Riemannian geometry Bochner flatness is quite different from conformal flatness. We use the correspondence between Kähler manifolds and Sasakian manifolds to give a complete local description of Bochner Kähler manifolds and provide a host of explicit examples.
Differential geometry and geometric analysis, Tuesday 15:00-15:25 Room 260-005

The kernel of the Gysin homomorphism for positive characteristic

Claudia Schoemann[1]

[1]Laboratoire GAATI, Université de la Polynésie française

Let S be a smooth projective connected surface over an algebraically closed field k embedded into a projective space $\mathbb{P}^d$ and let C be a smooth projective curve embedded into S. Let $CH_0(S)_{\deg=0}$ and $CH_0(C)_{\deg=0}$ be the Chow groups of zero-cycles of degree 0 on S and C, respectively. Following the approach of Bannerjee and Guletskii we prove that the kernel of the Gysin homomorphism from $CH_0(C)_{\deg=0}$ to $CH_0(S)_{\deg=0}$ induced by the embedding is a countable union of translates of an abelian subvariety A inside the Jacobian J of the curve C. We also prove that there is a countable open subset U_0 contained in the set $U \subset (\mathbb{P}^d)^*$ parametrizing the smooth curves such that $A = 0$ or $A = B$ for all curves parametrized by U_0, where B is the abelian subvariety of J corresponding to the vanishing cohomology $H^1(C, k')_{\mathrm{van}}$ of C. The subset U_0 being countable open allows to apply the irreducibility of the monodromy representation on $H^1(C, k')_{\mathrm{van}}$ (for the étale cohomology and for the singular cohomology for complex algebraic varieties). We describe the Gysin kernel for the points in $U \setminus U_0$ via the local and global monodromy representations. The approach is to construct a stratification $\{U_i\}_{i\in I}$ of U by countable open subsets with I an at most countable, partially ordered set, for each of which the monodromy argument applies. We then apply a convergence argument for the stratification $\{U_i\}_{i\in I}$ such that the monodromy argument applies for U seen as the set-theoretic directed union $U = \underset{\vec{i}}{\cup} U_i$. This is joint work with Rina Paucar (IMCA/UNI, Lima in Peru).

Arithmetic Geometry and Number Theory, Friday 14:30-14:55 Room 405-430

Existential Closure of Subshifts

Antonio Nakid Cordero[2], **Isabella Scott**[1]

[1]Te Herenga Waka—Victoria University of Wellington, [2]University of Wisconsin–Madison

Subshifts are a combinatorial class of dynamical systems which show up naturally in a variety of mathematical contexts. Work in the early 2000s of Hochman, Jeandel, McCarthy, and others uncovered deep connections with computability theory. Jeandel–Vanier proposed a dictionary between subshifts and groups, and proved that many classical results of computable group theory have natural analogues in subshifts. Jeandel conjectured that — in analogue with classical results of Macintyre and Ziegler — the computable subshifts over a finite alphabet are exactly those which embed in every existentially closed subshift. In this talk I will review the background on subshifts and existential closure, and describe progress on this conjecture and on related questions concerning this dictionary. This is joint work with Antonio Nakid Cordero.

Computability Theory and Applications, Friday 11:30-11:55 Room 303-B07

The Abstract Boundary (a-boundary) for Space-Time and its Applications

Susan Scott[2]

[1]The Australian National University, [2]Australian Research Council Centre of Excellence for Gravitational Wave Discovery (OzGrav)

Finding a suitable boundary construction for the space-times of General Relativity has proven to be a challenging problem. Since the 1960s several important boundaries have been devised.

In this talk I will present the Abstract Boundary (a-boundary) construction of Susan Scott and Peter Szekeres. I will discuss its flexibility and its amenability to providing a suitable boundary for solutions of the Einstein field equation. The a-boundary is free of the topological problems which apply to the earlier proposed boundary constructions. I will also discuss how the a-boundary can be applied in the longstanding quest to complete the famous singularity theorems of Penrose and Hawking.
Recent advances in geometric PDE, Monday 15:00-15:25 Room 260-057

A McCord theorem for Cech closure spaces

Nicholas Scoville[1], *Nikola Milicevic*[2]

[1]Ursinus College, [2]Penn State University

In this talk, we verify analogues of classical results for higher homotopy groups and singular homology groups of (Čech) closure spaces. Closure spaces are a generalization of topological spaces that also include graphs and directed graphs and are thus a bridge that connects classical algebraic topology with the more applied side of topology, such as digital topology. Our main result is the construction of a weak homotopy equivalence between the geometric realizations of (directed) Vietoris-Rips complexes and their underlying (directed) graphs. This implies that singular homology groups of finite graphs can be efficiently calculated from finite combinatorial structures, despite their associated chain groups being infinite dimensional. This work is similar to the work McCord did for finite topological spaces, but in the context of closure spaces. This is joint work with Nikola Milicevic.
Applied and Computational Topology, Friday 15:00-15:25 Room 260-223

Lifting the dual immaculate functions to the polynomial ring

Sarah Mason[1], **Dominic Searles**[2]

[1]Wake Forest University, [2]University of Otago

The dual immaculate functions form a basis of the ring of quasisymmetric functions analogous to the famous Schur basis of symmetric functions. We introduce a polynomial ring analogue of the dual immaculate functions, and establish positive combinatorial formulas for the expansions of elements of this basis into the fundamental slide and quasi-key bases of polynomials. These formulas extend connections between the dual immaculate, fundamental, and Young quasisymmetric Schur bases of quasisymmetric functions to the polynomial ring.
Algebraic Combinatorics and Matroids, Monday 16:00-16:25 Room 303-B09

0-Hecke–Clifford supermodules from diagrams

Dominic Searles[1]

[1]University of Otago

We introduce a method for constructing supermodules of 0-Hecke–Clifford algebras from fillings of box diagrams. We use this to answer a question of Jing and Li regarding a representation-theoretic interpretation of a basis of the peak algebra, find a new connection between quasisymmetric Schur functions and Schur Q-functions, and provide a common framework for known interpretations of families of quasisymmetric functions as quasisymmetric characteristics of 0-Hecke modules.

Representation Theory and Tensor Categories, Friday 14:00-14:25 Room 303-G14

Finitely presented simple groups that act on the circle, but not in a piecewise linear way

Ryan Seelig[1]

[1]UNSW

In a monumental effort spanning decades, the finite simple groups were completely classified. On the other hand, no such classification is known for infinite discrete simple groups, and the state of the art consists of constructing examples that satisfy interesting properties. The first examples of finitely presented (infinite discrete) simple groups were found in 1965 by Richard Thompson. One of these groups, known today as Thompson's group T, consists of certain piecewise linear homeomorphisms of the circle, and many contemporary examples of finitely presented simple groups that act on the circle can be viewed as "Thompson-like" groups. In 2019, Lodha constructed the first example of a finitely presented simple group that acts on the circle, however in contrast to T and others, admits no piecewise linear action on the circle. In this talk we construct infinitely many new groups witnessing these phenomena. Our examples arise as forest-skein groups, which are a class of "Thompson-like" groups introduced by Brothier in 2022. Forest-skein groups differ from other "Thompson-like" groups in that they are defined diagrammatically and not dynamically — their elements consist of coloured tree pairs, taken up to skein relations that are reminiscent of Vaughan Jones' planar algebra. This is joint work with Arnaud Brothier.

Groups and Geometry, Monday 15:00-15:25 Room 260-092

PT-symmetric oscillators with one-center point interactions

Iveta Semorádová[1, 2]

[1]Czech Technical University In Prague, [2]Cardiff University

We investigate the spectrum of 1D Schrödinger operators with complex potentials perturbed with δ and δ' interactions centered at the origin, with real coupling constants α and β. Special attention is given to imaginary odd polynomial potentials, which exhibit very different spectral properties when defined $L^2(\mathbb{R}_+)$ or $L^2(\mathbb{R}_-)$, compared to when defined on $L^2(\mathbb{R})$. For $\alpha, \beta \neq 0$, these models nicely demonstrate the instability of the spectrum of non-self-adjoint operators. The imaginary Airy operator, unperturbed having an empty spectrum, has countably many complex eigenvalues once perturbed. The problems with higher-order imaginary odd polynomial potentials such as imaginary cubic oscillator, unperturbed possessing countably many real eigenvalues, have only finitely many real eigenvalues and countably many complex eigenvalues after perturbation, as the PT symmetric phase transition occurs. We also discuss the existence and asymptotic behaviour of the real eigenvalue present for $\alpha < 0$ and $\beta < 0$ for a wide class of complex potentials. References: [1] J. Behrndt, I. Semorádová, P. Siegl, The imaginary Airy operator with one-center δ interaction, to appear in Pure and Applied Functional Analysis [2] M. Marletta, I. Semorádová, PT-symmetric oscillators with one-center point interactions. ArXiv 2410.????

Functional analysis and partial differential operators, Monday 15:00-15:25 Room 260-020

Some orbits of a two-vertex stabilizer in a Grassmann graph and a generalization of the Askey-Wilson relations

Ian Seong[1]

[1]University of Wisconsin-Madison

Let V denote a finite-dimensional vector space over a finite field. The corresponding projective geometry P is the poset consisting of the subspaces of V, with partial order by inclusion. A Grassmann graph Γ associated with P is known to be distance-regular. Pick distinct vertices x, y of Γ that are not adjacent and at distance less than the diameter of Γ. In this talk we discuss the stabilizer $Stab(x, y)$ in $GL(V)$. We show that there are five orbits of $Stab(x, y)$ in the local graph of x. We construct some matrices A, A^* that have rows and columns indexed by P. These matrices are generalizations of the adjacency matrix and the dual adjacency matrix for Γ. We use the five orbits of $Stab(x, y)$ to show that A, A^* satisfy some relations that generalize the Askey-Wilson relations.

Algebraic Combinatorics and Matroids, Friday 14:30-14:55 Room 303-B09

Supergroups and finite groups in positive characteristic

Vera Serganova[1]

[1]UC Berkeley

In this talk I will discuss similarities and differences between modular representation theory of finite groups and algebraic supergroups over C with reductive underlying groups. We try to generalize defect theory and Green correspondence to supergroups. At the moment we have

precise results in defect 1 case and some conjectures and open questions in general. Time permits I will also review support theory and rank variety in the supercase. This is a joint work with I. Entova-Aizenbud and A. Sherman.
Representation Theory and Tensor Categories, Monday 15:00-15:25 Room 303-G14

Complexity of presenting cohesive powers

Paul Shafer[1]

[1]University of Leeds

A *cohesive power* of a computable structure is an effective analog of an ultrapower where a cohesive set plays the role of an ultrafilter. Here we investigate the complexity of presenting structures that arise as cohesive powers. Every cohesive power of a computable structure via a Δ_2 cohesive set has a Δ_3 presentation. We show that the maximum complexity in this situation is achieved by exhibiting a computable graph G where every presentation of every cohesive power of G computes $0''$. This work is joint with David Gonzalez.
Computability Theory and Applications, Wednesday 10:30-10:55 Room 303-B07

Dynamics of actions of automorphisms of a Lie group on certain compact spaces and applications to lattices

Riddhi Shah[1]

[1]Jawaharlal Nehru University

A homeomorphism T of a topological space X is said to be distal if the closure of any double orbit $\{(T^n(x), T^n(y)) \mid n \in \mathbb{Z}\}$ does not intersect the diagonal in $X \times X$, unless $x = y$. Distal maps were introduced by Hilbert to study non-ergodic maps. We consider actions of automorphisms T of a connected Lie group G on the compact space of closed subgroups of G endowed with the Chabauty topology. For a large class of G, we characterise those T which act distally on compact subspaces containing abelian subgroups, cyclic subgroups or one-parameter subgroups of G. For any lattice Γ in G, we show that only finite order automorphisms of Γ act distally on the compact space of cyclic subgroups of Γ. We also get a structure theorem for lattices in Lie groups. The proofs of the main results use the structure of Lie groups, their automorphism groups and lattices, Borel density theorem, Selberg's lemma and properties of distal automorphisms. If time permits, we show that no automorphism of a nontrivial G (resp. an infinite lattice Γ) acts expansively on the space of abelian (resp. cyclic) subgroups. The results obtained are from three joint papers: with Alok Kumar Yadav, with Rajdip Palit & Manoj B. Prajapati and with Debamita Chatterjee, respectively.
Ergodic Theory and Dynamical Systems, Tuesday 15:00-15:25 Room 303-G23

The Status of Mathematics in the South Pacific

Bibhya Sharma[1], *Vineet Singh*[2], *Yukta Chand*[3]

[1]The University of the South Pacific, [2] The University of the South Pacific, [3] The University of the South Pacific

Mathematics remains a scientific area that plays an indispensable role in innovations, data-driven solutions, and almost everything including artificial intelligence (AI). Mathematics is recognised as fundamental for critical thinking and problem-solving skills, which are essential for individual success, but also societal advancement and sustainable economies. The South Pacific region continues to explore methodologies that foster mathematical reasoning as an essential skill for various life tasks and professions. Numeracy and mathematical knowledge have been an issue for in the South Pacific for various reasons, such as underqualified teachers, poor facilities and the lack of sufficient contextualized learning resources. While a few initiatives aim to improve mathematics education in the South Pacific, it is important to know the current status in order to improve and achieve better results. This research will utilise qualitative and quantitative data collection methods to determine the status of mathematics in three South Pacific countries, Fiji, Samoa and Vanuatu and will provide recommendations where possible to improve the status of mathematics.

Mathematics Education, Tuesday 14:45-14:55 Room 260-115

Measuring Student Readiness for Remote Learning in Times of Emergencies and Crisis.

Sushita Sharma[1], *Pritika Reddy, Vishneel Sen*

[1]The University of The South Pacific

This paper is a study based on 16 high schools in Vanuatu which looks at student learning experiences in Mathematics during times of emergencies and crises; prompted by the advent of COVID 19. The main aim of the research was to understand how ready students were in adapting to online learning. A structured questionnaire was used to collect data on student attitudes and perceptions towards online learning, while also looking at gender and rural/urban location of students. The findings show that there is a general trend of poor attitude and perception of online learning due to challenges related to lack of digital literacy and confidence in using various online platforms amongst most students, availability of technology related resources, and internet access. The study reveals that a concerted effort is needed in terms of better infrastructure, support systems and engaging materials for effective teaching / learning in an online mode, as well as acknowledging Pacific styles of learning where students learn better in informal settings and groups.

Mathematics Education, Friday 15:00-15:25 Room 260-115

Delay-differential equations for glucose-insulin regulation system modelling

Sergiy Shelyag[1], *Anatoli Ivanov, Maia Angelova*

[1]Flinders University

Glucose-insulin regulation system is vital for maintaining the blood sugar level within the healthy range. Disruptions in this system lead to a variety of metabolic disorders, including diabetes. Therefore, understanding the details of how the glucose-insulin regulation system works is essential for development of therapies and strategies for prevention of these disorders. Systems of non-linear delay-differential equations have been used to model glucose-insulin regulation system, which necessarily includes intrinsic delays, associated with glucose transportation and insulin secretion and action. In my presentation, I will review applications of delay-differential equations in modelling of glucose-insulin regulation system and focus on one of such models characterised by a single delay. I will demonstrate existence of stable and unstable equilibria of the system and show globally stable and slowly oscillating solutions corresponding to these equilibria. The analytical results will be further supported by numerical solutions.
Differential delay equations and their applications, Tuesday 12:00-12:25 Room 303-B05

The complexity of the epimorphism problem with virtually abelian targets

Jerry Shen[1]

[1]University of Technology, Sydney

Friedl and Löh showed that the epimorphism problem for certain subclasses of virtually abelian targets is decidable. In this talk I will show that the epimorphism problem from finitely presented groups to virtually abelian groups of the same subclasses is in NP, and outline a method to show finite non-nilpotent dihedral group targets are NP-hard.
Groups, actions and computations, Wednesday 11:30-11:55 Room 260-051

Learning Operators with Stochastic Gradient Descent in General Hilbert Spaces

Lei Shi[1]

[1]Fudan University

This talk investigates leveraging stochastic gradient descent (SGD) to learn operators between general Hilbert spaces. We propose weak and strong regularity conditions for the target operator to depict its intrinsic structure and complexity. Under these conditions, we establish upper bounds for convergence rates of the SGD algorithm and conduct a minimax lower bound analysis, further illustrating that our convergence analysis and regularity conditions quantitatively characterize the tractability of solving operator learning problems using the SGD algorithm. It

is crucial to highlight that our convergence analysis is still valid for nonlinear operator learning. We show that the SGD estimator will converge to the best linear approximation of the nonlinear target operator. Moreover, applying our analysis to operator learning problems based on vector-valued and real-valued reproducing kernel Hilbert spaces yields new convergence results, thereby refining the conclusions of existing literature.
RECENT DEVELOPMENTS IN DATA SCIENCE AND MACHINE LEARNING, FRIDAY 12:00-12:25 ROOM 402-220

New symmetries of the discrete Painlevé equations from geometric deautonomization of QRT maps

Yang Shi[1], *Anton Dzhamay*

[1]Flinders

In this talk, using the normalizer theory of Coxeter groups given in (Howlett, 80) and (Brink and Howlett, 99) we consider the symmetries of the examples of discrete Painlevé equations that can be obtained from a given QRT map using the technique of geometric deautonomization. We show how subgroups of extended affine Weyl types arise as normalizers of the ADE type groups in the discrete Painlevé setting, which in general can not be realised as reflection groups in the original space of parameters of the discrete Painlevé equations, but as quasi-reflections, giving rise to the quasi-translational elements obtained from projective reductions of discrete Painlevé equations.
DISCRETE AND CONTINUOUS INTEGRABLE SYSTEMS: GEOMETRY ANALYSIS AND APPLICATIONS, THURSDAY 14:30-14:55 ROOM 260-036

Spatial graphs confined to tube regions in the simple cubic lattice

Koya Shimokawa[1], *Kai Ishihara*[2]

[1]Ochanomizu University, [2]Hiroshima University

We consider trivalent spatial graphs confined to tube regions in the simple cubic lattice. In particular, we characterize theta curves and handcuff graphs in the 2×1-tube region.
TOPOLOGY, GEOMETRY AND COMBINATORICS OF BIOPOLYMERS, FRIDAY 11:30-11:55 ROOM 260-221

Comparative Analysis of Local Minima Prevention Algorithms: LbCS-RRT, Ant Colony Optimization in Continuous Domain (ACOR), and StepAhead Firefly Algorithm (SAFA)

Vivek Shiuram[1], *Avinesh Pradas*[1], *Kaylash Chaudary*[1], *Bibhya Sharma*[1]

[1]The University of The South Pacific

This paper presents a comparative analysis of three path finding algorithms: Lyapunov-based Control Scheme with Rapidly-exploring Random Tree (LbCS-RRT), Ant Colony Optimization in Continuous Domain (ACOR), and StepAhead Firefly Algorithm (SAFA)—focusing on their efficacy in overcoming the local minima problem inherent in pathfinding tasks. Systematically evaluating the performance of these algorithms, in order to determine which method provides the most robust solution to avoid local minima, thereby improving the overall efficiency and reliability of pathfinding in high complexity environments. This research provides a detailed description of the three algorithms—LbCSRRT, ACOR, and SAFA. Simulations will be run on Wolfram Mathematica, with a total of 30 simulations conducted using a point mass model of the robot. The results of these simulations will be analyzed to determine which algorithm most effectively overcomes the local minima problem and provides the most efficient pathfinding solutions. The results of the simulations reveal that the hybrid LbCS-RRT algorithm significantly outperforms both SAFA and ACOR in overcoming local minima issues. The new hybrid algorithm consistently demonstrated superior performance in complex environments, effectively avoiding the clustering of landmarks in locally optimum regions that plagued the other algorithms. In contrast, both SAFA and ACOR had high failure rates and encountered local minima more frequently, which impeded their ability to complete the pathfinding task. Overall, the LbCS-RRT algorithm proved to be more reliable and adaptable in navigating challenging pathfinding scenarios.

Optimisation, Wednesday 11:30-11:55 Room 402-221

Explicit constructions for chaotic attractors of piecewise-linear maps

David Simpson[1], *Paul Glendinning*[2]

[1]Massey University, [2]University of Manchester

Invariant expanding cones have long been used as a tool for establishing the presence of chaos in a rigorous manner, but it is perhaps under-appreciated that such cones work brilliantly for piecewise-linear maps. Immediately they show chaos is robust in families of piecewise-linear maps because the derivative of each map takes finitely many values. They can be constructed explicitly and in some cases so simply that parameter combinations at which the construction fails correspond exactly to bifurcations where a chaotic attractor is destroyed. More complex constructions based on higher iterates can be done computationally, and this leads to computer-assisted proofs of chaos. The cones also show chaos is robust to smooth perturbations in the pieces of the map and we use this to show that power converters used widely in electronics can operate chaotically over intervals of parameter values immediately beyond border-collision bifurcations.

Ergodic Theory and Dynamical Systems, Wednesday 11:00-11:25 Room 303-G23

A Posteriori Error Analysis of Hybrid High-Order Methods for the Elliptic Obstacle Problem

Ritesh Singla[1], *Kamana Porwal*[1]

[1]Indian Institute of Technology Delhi

In this talk, *a posteriori* error analysis of the elliptic obstacle problem is addressed using hybrid high-order methods. The elliptic obstacle problem is a nonlinear model that describes the vertical movement of an object restricted to lie above a barrier (obstacle) while subjected to a vertical force (with suitable boundary conditions). The method involve cell unknowns represented by degree-r polynomials and face unknowns represented by degree-s polynomials, where $r = 0$ and s is either 0 or 1. The discrete obstacle constraints are specifically applied to the cell unknowns. The analysis hinges on the construction of a suitable Lagrange multiplier, a residual functional and a linear averaging map. The reliability and the efficiency of the proposed *a posteriori* error estimator is discussed, and the study is concluded by numerical experiments supporting the theoretical results.
Computational Mathematics, Friday 14:00-14:25 Room 402-231

Structural Characterization of Planar-Rips Complexes and Their Graph Equivalents

Vinay Sipani[1]

[1]Indian Institute of Technology Madras

Given a metric space (X, d), the Vietoris-Rips complex of X at a scale of $\delta > 0$ is a simplicial complex whose simplices are the finite subsets of X with diameter less than δ. In this talk, I will present my recent work showing that the only n-dimensional pseudomanifolds and weak-pseuduomanifolds ($n \geq 2$), and two-dimensional closed simplicial complexes that can be realized as Vietoris-Rips complex of some planar point set, are precisely the iterated wedge of cross-polytopal spheres. Additionally, I will demonstrate a natural isomorphism between the category of planar-Rips complexes and the category of intersection graphs called disk graphs, highlighting the significance of topological and algebraic approaches. I will also introduce the notion of obstructions to planar-Rips complexes, laying the groundwork for identifying forbidden planar-Rips structures.
Applied and Computational Topology, Friday 14:00-14:25 Room 260-223

Orthogonal Yangians and Evaluation Homomorphisms

Gavrilo Šipka[1]

[1]University of Queensland

To each classical Lie algebra $\mathfrak{g}$, there exists an infinite-dimensional Hopf algebra known as the (extended) Yangian of $\mathfrak{g}$. In type A, there exists an evaluation homomorphism from the (extended) Yangian to the corresponding universal enveloping algebra. As a consequence, finite-dimensional irreducible representations can be described in a relatively efficient manner through the representation theory of the underlying Lie algebra. However, if one considers classical Lie algebras outside of type A, apart from a few exceptions, an evaluation homomorphism does not exist from the (extended) Yangian to the corresponding universal enveloping algebra. Due to the low-rank classical isomorphisms, the exceptions in which an evaluation homomorphisms does exist for an (extended) Yangian includes those where the underlying Lie algebra is $\mathfrak{so}_3$, $\mathfrak{so}_4$ or $\mathfrak{so}_6$. In these cases, the corresponding evaluation homomorphisms are more complicated than their type A counterpart. This talk intends to examine these evaluation homomorphisms and discuss the representation theory of the corresponding (extended) Yangians from that perspective.
Representation Theory and Tensor Categories, Tuesday 14:30-14:55 Room 303-G14

Peak functions, pattern avoidance, and positivity.

Matthew Slattery-Holmes[1]

[1]University of Otago

Given a set of permutations Π, let $\mathfrak{S}_n(\Pi)$ denote the elements of the symmetric group $\mathfrak{S}_n$ that avoid every element of Π. Hamaker, Pawlowski, and Sagan defined a function $R_n(\Pi)$ to be the sum of peak functions indexed by the peak sets of permutations in $\mathfrak{S}_n(\Pi)$. We investigate combinatorial properties of these functions, including when their expansion in terms of Schur Q-functions has positive coefficients, and how they relate to other combinatorial objects.
Algebraic Combinatorics and Matroids, Monday 16:30-16:55 Room 303-B09

Hodge theory for modular matroids

Gregory G. Smith[1]

[1]Queen's University

Using elementary techniques, we prove that the graded Möbius algebra of a modular matroid satisfies Poincaré duality, the hard Lefschetz property, and the Hodge–Riemann relations. As a consequence, we discover that modularity characterizes the matroids for which the graded Möbius algebra is canonically isomorphic to its intersection homology module. This talk is

based on joint work with Mats Boij, Bill Huang, and June Huh.
Algebraic Combinatorics and Matroids, Monday 14:00-14:25 Room 303-B09

Cohomology of toric vector bundles

Gregory Smith[1]

[1]Queen's University

A toric vector bundle is a vector bundle on a toric variety equipped with a torus action that is compatible with canonical action on the underlying variety. Klyachko proves that toric vector bundles are classified by finite-dimensional vector spaces with a suitable family of filtrations. Building on this equivalence of categories, we construct a complex of modules over the Cox ring which simultaneously encodes the cohomology of a toric vector bundle and many of its twists by line bundles. Beyond the improved computational efficiency, this approach leads to new insights into virtual resolutions and vanishing theorems. This talk is based on joint work with Michael Perlman.

Computations and applications of algebraic geometry and commutative algebra, Wednesday 11:30-11:55 Room 303-B05

Data assimilation for networks of coupled oscillators: Inferring unknown model parameters from partial observations

Lauren Smith[1], *Georg Gottwald*[2]

[1]University of Auckland, [2]The University of Sydney

Inferring the state and unknown parameters of a network of coupled oscillators, such as neurons in the brain, is of utmost importance. This task is made harder when only partial and noisy observations are available, which is a typical scenario in realistic high-dimensional systems. The general task of inference falls under data assimilation, and a commonly used assimilation method is the Ensemble Kalman Filter. Employing network-specific localization of the forecast covariance, an Ensemble Kalman Filter with state space augmentation is shown to yield highly accurate estimates of both the oscillator phases and unknown model parameters in the case where only a subset of oscillator phases are observed. In contrast, standard data assimilation methods yield poor results. We demonstrate the effectiveness of our approach for Kuramoto oscillators and for networks of theta neurons, using a variety of network topologies.

Computational Methods and Applications of Dynamical Systems, Friday 11:30-11:55 Room 303-G20

When Bike Lanes Are Not Enough: An Application of Network Analysis to Low Stress Cycling Infrastructure in Aotearoa New Zealand Cities

Melissa Louise Smith[1]

[1]University of Waikato

The need for sustainable transportation is paramount. Utilitarian cycling has the potential to improve health outcomes, reduce environmental degradation and greenhouse gas emissions, increase labour productivity, and reduce traffic congestion. For these reasons are more, many cities across Aotearoa New Zealand have committed to increasing utilitarian cycling, however, most have struggled to do so, with only 2% of people commuting to work by bicycle across the country. Surveys have identified, among others, a lack of satisfactory and safe infrastructure as a barrier. The Level of Traffic Stress (LTS) Framework is a recently developed cycling network classification scheme that is growing in popularity in the field of transportation planning due to its relatively simple data requirements, its intuitive description of cycling networks, and its potential to increase the uptake of cycling through application in policy and planning. This paper explores the LTS Framework in the context of Aotearoa New Zealand. Specifically, graph theory is applied to analyse the structure of networks resulting from considering only low stress segments (the 'low stress' network). Graph measures are calculated to evaluate and compare network connectivity, a factor known to be correlated to cycling uptake. It is found that for six of the seven studied cities, the majority of the links are sufficiently low stress to be suited to the majority of people, and in all seven cities, such low stress links are poorly connected, forming so-called "islands of low stress connectivity". Modelling further reveals a relationship between a greater provision of low stress cycling infrastructure and the number of people cycling to work. The methodology and modelling provides policy makers, planners, and local governments with the ability to evaluate the whole of their cycling networks and understand where to install low stress cycling infrastructure to best improve connectivity and therefore ridership.
Industrial Mathematics, Tuesday 12:15-12:25 Room 402-211

Finite element method for a micromagnetic model at elevated temperatures

Agus Soenjaya[1]

[1]University of New South Wales

The Landau–Lifshitz–Bloch (LLB) equation is a vector-valued quasilinear PDE, which is commonly used in the theory of micromagnetism to model the effects of magnetic field on a ferromagnetic material at elevated temperatures. In this talk, I will discuss the LLB equation with spin-torques resulting from applied current. Well-posedness of the problem is derived and a fully-discrete numerical method to solve the problem is proposed. This scheme is energy-dissipative in the absence of current. Assuming certain regularity of the exact solution, an optimal order of convergence to the solution is obtained for the scheme. This is corroborated by several numerical simulations.
Computational Mathematics, Tuesday 12:00-12:25 Room 402-231

Multiple Stopping Problems

Georgy Sofronov[1], *Krzysztof Szajowski*[2]

[1]Macquarie University, [2]Wroclaw University of Science and Technology

In many applications data are sequentially observed over time, and it is necessary to make decisions based on already obtained information while future observations are not known yet. Formally speaking, we observe a sequence of random variables and have to decide when we must stop, given that there is no recall allowed, that is, a random variable once rejected cannot be chosen later on. Our decision to stop depends on the observations already made, but does not depend on the future which is not yet known. In this talk, we will give an overview of discrete-time problems when at least two stops are required.
Probability and Mathematical Statistics, Friday 11:30-11:55 Room 260-098

Bridging the gap between continuous and discrete inverse problems

Erkki Somersalo[1], *Daniela Calvetti*

[1]Case Western Reserve University, [2]Case Western Reserve University

In many important imaging applications, the forward map arises from a partial differential or integral equation. When the problem is discretized for the computational treatment, a modeling error is introduced, and since theproblems are typically ill-posed, the modeling error, behaving like a highly correlated error, may have a]detrimental effect on the computed solutions, even if it is known that by refining the discretization, the modeling error should converge to zero. In this talk, we discuss a modeling approach in which the model discretization is understood as part of the inverse problem. While uniform refinement of the discretization is always possible, such approach nay become computationally unfeasible. In the proposed approach the refinement is mainly done near the singularities of the unknown, and the model update is done iteratively. The discretization is described in terms of an appropriate metric, and he coupling of the unknown and the metric is done by using hierarchical Bayesian prior models. Applications and computed examples are discussed in this talk.
Microlocal analysis and inverse problems, Friday 14:30-14:55 Room 260-009

The Critical Point Degree of a Bloch Variety

Frank Sottile[1], *Matthew Faust*[2], *Jonah Robinson*[1]

[1]Texas A&M University, [2]Michigan State University

Given an operator on a $\mathbb{Z}^d$-periodic graph, its Bloch variety encodes its spectrum with respect to the unitary characters of $\mathbb{Z}^d$. Finer questions about the spectrum involve understanding the critical points of the projection to $\mathbb{R}$. Previous work with Faust gave a bound for the number of complex critical points in terms of the volume of the Newton polytope of the dispersion polynomial. This talk will present background and then describe refined bounds on the number of critical points that are combinatorial in nature and involve an analysis of asymptotic behavior of the Bloch variety. This is joint work with Faust and Robinson.

Computations and applications of algebraic geometry and commutative algebra, Friday 14:00-14:25 Room 303-B05

Assessing moment convergence using polynomial Stein kernels

Narayan Srinivasan[1], *Matthew Sutton*[2], *Christopher Drovandi*[1], **Leah South**[1]

[1]Queensland University of Technology, [2]University of Queensland

This talk will propose an efficient method for measuring the discrepancy between a set of samples and a desired posterior distribution for Bayesian inference. Standard methods for assessing sample quality like the effective sample size do not apply in the broader context of scalable Monte Carlo methods. Instead, the gold standard is to use the kernel Stein discrepancy (KSD, [1]) which is itself not scalable given its quadratic cost in the number of samples. The KSD and its faster extensions also typically suffer from the curse-of-dimensionality and can require extensive tuning. To address these limitations, we develop the polynomial-Stein discrepancy and an associated goodness-of-fit test [2]. While the new test is not fully convergence-determining, we prove that it detects problems with the first k moments in the Bernstein-von-Mises limit. We empirically show that the test has higher power than its competitors for various applications, and at a lower computational cost. Finally, we demonstrate that the discrepancy can assist users to select hyper-parameters more efficiently than competitors.

[1] Gorham, J., & Mackey, L. (2017, July). Measuring sample quality with kernels. In International Conference on Machine Learning (pp. 1292-1301). PMLR.

[2] Srinivasan, N., Sutton, M., Drovandi, C., & South, L. F. (to be arxived soon). The polynomial Stein-based discrepancy.

Probability and Mathematical Statistics, Thursday 14:00-14:25 Room 260-098

What contributions can interpretive description make as a research methodology in the field of mathematics education?

Kerri Spooner[1]

[1]AUT

Interpretive description methodology can provide a theoretically flexible way to address complex experiential questions while also generating implications for applied practice (Thorne, 2008). Unlike other qualitative methodologies, such as grounded theory, phenomenology, and ethnography, which can be primarily focused on theorising, interpretive description seeks to understand participants' experiences to advance and inform practice. This presentation will show case the first-time use of interpretive description as a methodology within mathematics education research. A study utilised interpretive description methodology (Thorne, 2008) to explore how students' experience of learning mathematical modelling may differ from learning mathematics and how this might impact teaching practices. The research question established is: What can we learn from tertiary student experiences to inform the future teaching of mathematical modelling? Twenty students participated in this study. The researcher used an interpretative description approach to discover shared patterns, themes, and variations in participants' experiences and viewpoints that reside under the surface of the data and used these to inform teaching practice (Hunt, 2009). The study's findings demonstrated that all pupils learning to mathematically model were pushed beyond their comfort zones. Students had their boundaries pushed resulting in either progressing forward individually or being moved forward by the lecturer, resources, or their peers. The ability to create practitioner implications from the data is an important aspect of an interpretative description methodology (Thorne, 2008). This distinguishes Intrepretive Description from other qualitative approaches, making it an effective tool for mathematics education research. A crucial educational implication of the findings is for lecturers to foster a culture in which students perceive struggle and creativity in mathematics as favourable attributes.

Contributed Session A, Monday 16:30-16:55 Room 405-430

Sampling triangulations of manifolds using Monte Carlo methods

Jonathan Spreer[1], *Eduardo Altmann*[1]

[1]The University of Sydney

In this talk, I will present a Monte Carlo method for efficiently finding, counting, and sampling abstract triangulations of a given surface or three-dimensional space S. The method is based on iteratively applying local modifications, such as edge flips, to S to randomly move through its space of triangulations. Asymptotically, the method guarantees that samples of triangulations are drawn at random from a chosen probability distribution. To demonstrate the utility of this approach, I will experimentally observe that the growth rate for the number of isomorphism types of 1-vertex triangulations of the 3-dimensional sphere is singly exponential in the number of their tetrahedra. This gives new insights into a high-profile question from low-dimensional topology.

Early Career Showcase in Low-Dimensional Topology, Thursday 14:00-14:25 Room 260-073

Noncommutative geometry over dg-algebras

Prashanth Sridhar[1]

[1]Auburn University

Pioneering work of Artin-Zhang extends important aspects of projective geometry to the noncommutative (nc) setting. In particular, the derived category of such a nc scheme shares many

features with the derived category of a classical one. In this talk, I'll discuss extensions of some classical and modern results in the theory of nc projective geometry to nc spaces associated to dg-algebras. This is joint work with Michael K. Brown.
Computations and applications of algebraic geometry and commutative algebra, Friday 12:00-12:25 Room 303-B05

Respecting CM on elliptic curves: sesquilinear pairings, elliptic nets, biextensions

Katherine E. Stange[1]

[1]University of Colorado Boulder

The points of an elliptic curve form an abelian group, i.e., a $\mathbb{Z}$-module. But when the curve has complex multiplication by an imaginary quadratic order R, they also form an R-module. Many familiar structures in this context respect a $\mathbb{Z}$-module structure: divisors, Weil reciprocity, the Weil and Tate pairings, and elliptic nets. By generalizing these notions to respect an R-module structure, we can capture the R-module structure of the elliptic curve. For example, we can define R-sesquilinear (conjugate linear) versions of the Weil and Tate pairings. These can be recovered from an R-module version of the Poincaré biextension which can be described in terms of generalized elliptic nets.
Computational Number Theory and Applications, Thursday 14:00-14:50 Room 405-422

Recent results on Lorentzian scattering rigidity

Plamen Stefanov[1]

[1]Purdue University

We will review the recent progress on the scattering rigidity problem for Lorentzian metrics. It is a more challenging problem than its Riemannian version (which is hard enough) with much fewer results. One of the reasons is that its linearization, the tensorial light ray transform, is not elliptic even considering the gauge. We will present results for recovery of stationary metrics up to a gauge, by the lightlike scattering relation; of the boundary jet and analytic metrics; and recovery of metrics using timelike geodesics. The latter result is based on work by the student Sebastian Munoz-Thon.
Microlocal analysis and inverse problems, Tuesday 14:00-14:50 Room 260-009

Highly localized horseshoe ripplons and solitons in positive dispersion media

Zhao Zhang[2], *Qi Guo*[2], **Yury Stepanyants**[1]

[1]University of Southern Queensland, [2]Guangdong Provincial Key Laboratory of Nanophotonic, Functional Materials and Devices, South China Normal University

We present a review of various ripplon solutions to the Kadomtsev–Petviashvili equation with positive dispersion (KP1 equation). Ripplons are two-dimensional wave formations with an oscillatory structure in space and a decaying character in time; they are similar to lumps (two-dimensional solitons) but they are non-stationary. We show that there are mappings that allow one to transform the horseshoe solitons and curved lump chains of the KP1 equation into circular solitons of the cylindrical Korteweg–de Vries (cKdV) equation and two-dimensional solitons of the cylindrical Kadomtsev–Petviashvili (cKP) equation. Then, we present analytical solutions that describe new highly localized ripplons of a horseshoe shape. In the limiting case, the horseshoe ripplons reduce to solitons decaying with time and having bent fronts. Such entities can play an important role in the description of strong turbulence in plasma and other media. Results obtained were recently published in: Zhang Zh., Guo Q., Stepanyants Y. Horseshoe ripplons and solitons in positive dispersion media. Wave Motion, 2024, v. 128, 103326.

Mathematical methods in continuum mechanics and wave theory, Friday 14:30-14:55 Room 401-307

Wellposedness of the initial boundary value problem for the conformal Einstein field equations

Chris Stevens[1], *Juan Valiente-Kroon*[2]

[1]University of Canterbury, [2]Queen Mary University of London

In recent years, an Initial Boundary Value Problem (IBVP) for the Conformal Einstein Field Equations (CEFE) has been used for fully non-linear simulations of gravitational waves impinging on a black hole. These equations regularly extend the Einstein equations to include “infinity”, and as a consequence, global quantities like Bondi energy and the Newman-Penrose constants are able to be computed directly on future null infinity. In these simulations, the time-like boundaries are chosen to be generated by conformal geodesics – special curves that are based on the conformal class. However, the only proof of wellposedness of an IBVP formulation of the CEFE is for the special case of asymptotically simple space-times where the conformal boundary is time-like. In this case, the outer boundary can be chosen as this geometrically special surface and the equations simplify. This talk will outline a recent result that shows wellposedness when the outer boundary is generated by an arbitrary congruence of time-like conformal geodesics. Spinors, space-spinors and their “Lorentzian” analogues are used to decompose the governing equations in an elegant way.

Recent advances in geometric PDE, Monday 16:15-16:25 Room 260-057

Modelling genome rearrangement events

Joshua Stevenson[1], *Venta Terauds*[2], *Jeremy Sumner*[1]

[1]University of Tasmania, [2]University of South Australia

Phylogenetics is the study of evolutionary relationships between present-day organisms. Evolution can occur via a number of mechanisms, and one such mechanism is the occurrence of large-scale genome rearrangement events, in which sections of the genome are broken apart and reattached in a different order or orientation. By considering the possible combinations of rearrangements that could convert one genome into another, we can estimate how closely related the organisms are. This problem has often been approached by considering the shortest possible path between genomes under a given set of rearrangements, but modelling genome rearrangement as a Markov process (where each rearrangement is assigned a probability) opens up opportunities for additional distances to be considered. I will give an overview of genome rearrangement modelling, and then present our algebraic framework for modelling genomes, along with some distance estimates that we can compute under this framework.

Contributed Session A, Thursday 11:30-11:55 Room 303-B11

Mapping class groups of manifolds with boundary and the image of the variation operator

John Stewart[1]

[1]Melbourne University

The mapping class groups of surfaces play a central role in low-dimensional topology. The mapping class groups of $(n-1)$-connected $2n$-manifolds W are analogous groups in higher dimensions. When W has non-empty boundary and diffeomorphisms are assumed to be the identity near the boundary, the action on $H_n(W)$ by diffeomrophisms should be complemented with the variation map $v : H_n(W, \partial W) \to H_n(W)$. In this talk I will report on results characterising the image of the variation map and how these combine with existing results of Kauffman and Krylov to give exact sequences computing the rel. boundary mapping class groups of $(n-1)$-connected $2n$-manifolds for $n \geq 3$.

Early Career Showcase in Low-Dimensional Topology, Monday 14:30-14:55 Room 260-073

Geometry of a four-dimensional multiplicative integrable mapping and associated fourth-order discrete Painlevé equations

Adrian Stefan Carstea[1], **Alexander Stokes**[2], *Tomoyuki Takenawa*[3]

[1]Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering, [2]Waseda University, [3]Tokyo University of Marine Science and Technology

The Sakai framework defines and classifies discrete Painlevé equations in terms of a special class of complex rational surfaces associated with affine root systems. The surfaces provide spaces of initial conditions for the equations in an analogous way to those constructed by Okamoto for the Painlevé differential equations. While there is not yet a general geometric theory of higher-order analogues of discrete Painlevé equations, an analogous construction of a space of initial conditions has been performed by Carstea and Takenawa for several examples in dimension four. We construct two further four-dimensional examples and study their spaces of initial conditions, obtained from a birational mapping of a similar form to a multiplicative QRT map. We discuss the analogues in higher dimension of various elements of the Sakai framework, including regularisation of mappings on rational varieties as pseudo-isomorphisms, root system structures in the Néron-Severi bilattice, affine Weyl group symmetries and the role of an effective anticanonical divisor on the rational varieties forming the spaces of initial conditions.
Discrete and continuous integrable systems: geometry analysis and applications, Friday 14:30-14:55 Room 260-036

An ESN Theorem for Ordered Ehresmann Semigroups

Tim Stokes[1]

[1]University of Waikato

Ehresmann semigroups may be viewed as biunary semigroups equipped with domain and range operations satisfying some equational laws. Motivated by the example of binary relations on a set, we define ordered Ehresmann semigroups, and consider their basic properties. We obtain an ESN-style theorem for ordered Ehresmann semigroups, characterising them in terms of ordered categories.
50 years of Communications in Algebra, Monday 16:30-16:55 Room 303-G15

Stability in the drawing of fibres with internal structure

Yvonne Stokes[1], *Jonathan Wylie, Nazmun Papri, Dongdong He*

[1]The University of Adelaide

Isothermal drawing of thin solid fibres, where the effect of surface tension is negligible, is unstable above a critical value $D_{\text{crit}} \approx 20.21$ of the draw ratio, i.e. where the pulling speed exceeds the feed speed by the factor D_{crit} and the cross-sectional area of the final fibre is a factor $1/D_{\text{crit}}$ smaller than the cross-sectional area of the initial preform (Matovich and Pearson, Industrial & Chemical Fundamentals 8, 1969). Nevertheless, draw ratios well in excess of D_{crit} are necessarily and successfully used in practical fibre drawing, motivating much subsequent research into the effects of other parameters, such as inertia, temperature and surface tension, on stability. Moreover, the manufacture of optical fibres containing air channels, which has revolutionised the use of optical fibres in modern technologies since the 1980s, raised the questions (Fitt et al., Journal of Engineering Mathematics 43, 2002) of how air channels in a fibre, and their possible pressurisation, affect draw stability. This talk concerns our work on the linear stability of fibre drawing when the fibre has air channels within it. We have shown that under isothermal conditions the presence of air channels within a fibre reduces the stability of the drawing process compared with than that of a solid fibre when surface tension is non-negligible. Furthermore, we have investigated the effects of hole size, pressurisation of air channels, non-isothermal conditions and the interplay between these. We have, thus, solved a number of open problems posed in the literature.

Mathematical methods in continuum mechanics and wave theory, Tuesday 15:00-15:25 Room 401-307

An operad of decorated cobordisms

Michelle Strumila[1]

[1]Monash University

Cobordisms are important to the study of topological quantum field theories (TQFTs), and they can be described using the language of operads. Decorated cobordisms have links to contact geometry and information theory; I describe decorated cobordisms in the language of operads, and explore the relationships between TQFTs and wiring diagrams.

Early Career Showcase in Low-Dimensional Topology, Friday 15:00-15:25 Room 260-073

Klein bottly alternating links

Lecheng Su[1], *Jessica Purcell*[1]

[1]Monash University

Classical alternating links have nice geometric properties. Prime alternating links are either (2, q) torus knot or hyperbolic by Menasco's work in the 1980s. More recently, Howie-Purcell decomposed alternating link complement in any 3 manifold using a checkerboard decomposition method pioneered by Thurston and Menasco. They studied hyperbolicity, embedded surfaces, volume etc using this technique, but they require orientability for their projection surfaces. In this talk, we use Howie-Purcell's techniques to study alternating links on nonorientable projection surfaces, especially Klein bottly alternating links in prism manifolds, as a natural generalisation of Adams' toroidally alternating links in lens spaces. This is joint work with Jessica Purcell.

Early Career Showcase in Low-Dimensional Topology, Tuesday 12:00-12:25 Room 260-073

Zero entropy on entire Grauert tubes

Pablo Suárez-Serrato[1]

[1]UNAM

The Monge-Ampère equation is a nonlinear partial differential equation that arises in various geometric contexts. In complex geometry, it plays a key role in understanding the structure of complex manifolds. It is intimately connected to the problem of constructing Grauert tubes. Grauert tubes are a concept in complex geometry that provides a way to "complexify" a real-analytic Riemannian manifold. A Grauert tube is a complex manifold that envelops an analytic manifold, like a tubular neighborhood, inside its tangent space. The Monge-Ampère equation helps estimate a Grauert tube's maximum radius and analyze its asymptotic behavior near the original manifold. In this talk we will explore a new dynamical restriction to the existence of entire Grauert tubes, those of infinite radius, in analytic Riemannian manifolds.
Recent advances in geometric PDE, Tuesday 15:00-15:25 Room 260-057

There Are Five Classes of Fundamental Inequalities in the Geometry of Submanifolds

Bogdan Suceava[1]

[1]California State University, Fullerton

By J. F. Nash's Theorem, any Riemannian manifold can be embedded into a Euclidean ambient space with dimension sufficiently large. S.-S. Chern pointed out in 1968 that a key technicality in applying Nash's Theorem effectively is finding useful relationships between intrinsic and extrinsic elements which characterise immersions. After 1993, when a groundbreaking work written by B.-Y. Chen on this theme was published, many explorations pursued this important avenue. We describe new relationships involving intrinsic and extrinsic curvature invariants, under natural geometric conditions. We showcase how the fundamental inequalities in the geometry of submanifolds could be classified in five categories.
Recent advances in geometric PDE, Friday 11:30-11:55 Room 260-057

On some algebraic and geometric invariants associated to matroids

Alexandru Suciu[1]

[1]Northeastern University

The Orlik–Solomon algebra of a simple matroid $\mathcal{M}$ is the quotient $A = E/I$ of the exterior algebra $E = \bigwedge^*(\mathcal{M})$ over some field k by a certain homogeneous ideal I defined in terms of the dependent subsets of $\mathcal{M}$. From this graded algebra, one may construct several other algebraic invariants, such as the holonomy Lie algebra $\mathfrak{h}(A)$ and the Koszul module $\mathfrak{B}(A)$. One then may

seek to compute the Hilbert series of these two graded objects and determine the support loci and the resonance varieties (or schemes) associated to $\mathfrak{B}(A)$. In this talk, I will explain some of the known—or conjectured—relationships between these various objects, and how to interpret them topologically in the realizable case. I will also give some structural results and intriguing examples in the case when the matroid is "decomposable, " that is, there are no elements in $\mathfrak{h}_3(A)$ besides those coming from the rank 2 flats of $\mathcal{M}$.
Algebraic Combinatorics and Matroids, Monday 15:00-15:25 Room 303-B09

On the topology of the Milnor fibration of a complex hyperplane arrangement

Alexandru Suciu[1]

[1]Northeastern University

Each hyperplane arrangement $\mathcal{A}$ in $\mathbb{C}^d$ gives rise to a Milnor fibration of its complement, $F \to M \to \mathbb{C}^*$. Although the eigenvalues of the monodromy $h\colon F \to F$ acting on the homology groups $H_i(F;\mathbb{C})$ can be expressed in terms of the jump loci for rank 1 local systems on M, explicit formulas are still lacking in full generality, even in degree $i = 1$. In this talk, I will explain some of the results relating the combinatorics of the intersection lattice of $\mathcal{A}$ to the algebraic topology of the Milnor fiber F. In the case when $b_1(F)$ is as small as possible, I will describe ways to extract information on the cohomology jump loci, the lower central series quotients, and the Chen ranks of the fundamental group of F.
Singularities, Tuesday 11:30-12:20 Room 260-024

Fitting phase-type distribution with covariates

Budhi Arta Surya[1]

[1]School of Mathematics and Statistics, Victoria University of Wellington

Phase-type (PH) distribution was first introduced by Neuts in 1975. It represents the distribution of exit times to absorbing states of Markov jump process. It has found many applications in variety of fields such as among others in biostatistics, finance, management science, marketing, queuing theory, telecommunications, etc. It was brought to survival analysis by Aalen in 2005. Asmussen et al. (1996) proposed an EM algorithm for fitting the PH distribution to dataset. However, it does not involve covariates (additional explanatory variables) in the estimation. In many applications, particularly in survival analysis, covariates may be contributed to statistically explaining the occurrence of events of interest, i.e., exits to absorbing states of the underlying Markov process. Motivated by these observations, there is a needed extension of statistical approach for fitting PH distribution with covariates. The key to this approach lies on the statistical estimation of generator matrix of Markov jump process with covariates discussed in Surya and Frydman (2024). This talk presents further details and some results on fitting the PH distribution with covariates dependent.
Probability and Mathematical Statistics, Friday 14:00-14:25 Room 260-098

Enhanced MCMC: Fully Adaptive Sampling with PDMP Samplers

Augustin Chevallier[2], *Samuel Power*[3], **Matthew Sutton**[1]

[1]University of Queensland, [2]Université de Strasbourg, [3]University of Bristol

Markov Chain Monte Carlo (MCMC) methods are commonly used in statistics for sampling from complex, high-dimensional probability distributions, particularly in cases where direct sampling is infeasible. Despite their broad applicability, achieving full adaptivity in these algorithms remains a challenge. For instance, in Hamiltonian Monte Carlo (HMC) it is possible to adaptively tune the path length, but the numerical step size cannot be adapted; it can only be tuned. In this work, we introduce a new class of algorithms based on applying a Metropolization procedure to numerical approximations of Piecewise Deterministic Markov Process (PDMP) samplers. Like HMC, these methods rely on two key parameters: a numerical step size and a path length, which guide the deterministic evolution of the sampler and promote faster mixing. However, unlike HMC, both parameters in the PDMP-based approach can be adapted automatically. This adaptivity paves the way for more robust, efficient, and automatic sampling, particularly in challenging target distributions.

Probability and Mathematical Statistics, Friday 14:30-14:40 Room 260-098

Modelling hot water cylinder usage in order to manage peak load for a residential energy distributor in New Zealand

Catherine Hassell Sweatman[1], *James Hewett*[2], *Matthew Slattery-Holmes*[3], *Liam MacDonald*[4], *Boris Baeumer*[3]

[1]Department of Mathematical Sciences, Auckland University of Technology, [2]Department of Mechanical Engineering, University of Canterbury, [3]Department of Mathematics and Statistics, University of Otago, [4]School of Mathematics and Statistics, University of Canterbury

As New Zealand reduces greenhouse gas emissions, the ways in which electricity is generated, distributed, stored and used will change. The demand for electricity is expected to increase. Orion Energy is an energy distributor, servicing approximately $190,000$ residential customers in Christchurch. Residential consumption accounts for approximately half of the network's energy demand. Heating hot water accounts for approximately one-third of the residential energy consumption. Most residential customers use hot water cylinders, which offer a controllable energy store that can be managed to optimise overall energy demand. However, there is a lack of comprehensive understanding of the daily energy demand profiles of these hot water cylinders, both individually and collectively, under various control regimes. These regimes include fixed time control, interruptible control, and uncontrolled usage. By modelling and simulating different control regimes, Orion hopes to identify the most effective methods to manage residential energy demand, enhancing overall network efficiency and reducing peak loads. The progress presented here was made during a mathematics–in–industry study group, MINZ 2024.

Industrial Mathematics, Friday 14:00-14:25 Room 402-211

Mathematics-in-Industry Study Groups in New Zealand and Furth of the Motu

Winston Sweatman[1]

[1]Massey University

I will talk about Mathematics-in-Industry Study Groups within New Zealand, both MISG (shared with Australia) and MINZ (Mathematics-in-Industry New Zealand). These lie within the context of international Study Groups beyond the country.
Industrial Mathematics, Thursday 12:00-12:25 Room 402-211

Finite dimensional projections of Hamilton-Jacobi-Bellman equations in spaces of probability measures

Andrzej Swiech[1], *Lukas Wessels*[1]

[1]Georgia Institute of Technology

In this talk we will present recent results about optimal control of large particle systems with common noise, interacting through their empirical measures. One way of analyzing the problem is by studying what happens in the limit as the number of particles n goes to infinity. We will discuss how to prove the convergence of the value functions u_n corresponding to control problems of n particles to the value function V corresponding to an appropriately defined infinite dimensional control problem, which is the unique viscosity solution of the limiting HJB equation in the Wasserstein space. The proofs of the convergence of u_n to V use PDE viscosity solution techniques. We will show that under certain additional assumptions, V is $C^{1,1}$ in the spatial variable. We will then explain that if DV is continuous, the value function V projects precisely onto the value functions u_n. We will discuss how the $C^{1,1}$ regularity of V allows to construct optimal feedback controls and how optimal controls for the finite dimensional problems correspond to optimal controls of the infinite dimensional problem and vice versa. We will also discuss how to relax assumptions on the coefficients of the cost functional by using approximation techniques in the Wasserstein space to prove that V projects precisely onto the value functions u_n when V may not be differentiable.
Stochastic Differential Equations, Tuesday 11:30-12:20 Room 260-016

Compressible magnetohydrodynamics driven by non-conservative boundary conditions

Agnieszka Swierczewska-Gwiazda[1], *Eduard Feireisl*[2], *Piotr Gwiazda*[1, 3], *Young-Sam Kwon*[4]

[1]University of Warsaw, [2]Institute of Mathematics of the Czech Academy of Sciences, [3]Institute of Mathematics of Polish Academy of Sciences, [4]Dong-A University

We propose a new concept of weak solution to the equations of compressible magnetohydrodynamics driven by large boundary data. The system of the underlying field equations is solvable globally in time in the out of equilibrium regime characteristic for turbulence. The weak solutions comply with the weak–strong uniqueness principle; they coincide with the classical solution of the problem as long as the latter exists. The choice of constitutive relations is motivated by applications in stellar magnetoconvection.

Recent advances in mathematical fluid dynamics, Wednesday 10:30-10:55 Room 401-311

The Laplace transform of first exit time of geometric Brownian motion with affine drift

Wawan Hafid Syaifudin[1], *Budhi Arta Surya*[1]

[1]Victoria University of Wellington

In this paper, we provide some results regarding the first exit time of geometric Brownian motion (GBM) with affine drift. To be more precise, we compute the Laplace transform of first exit time of GBM with affine drift to a fixed level. This paper indeed extends the earlier work of Metzler (2013) by introducing the general version of first exit time and Laplace transform. We found that the Laplace transform is given explicitly in terms of gamma and confluent hypergeometric functions. By using Ito's change-of-variable formula, one can see that the transform is characterized as a unique solution to the second-order ordinary differential equation which is equivalent to Kummer's equation.

Stochastic Differential Equations, Monday 15:00-15:25 Room 260-016

Solving constrained difference of convex (DC) optimisation problems

Sona Taheri[1], *Adil Bagirov, Andrew Eberhard, Kaniz Fatema*

[1]RMIT University

In this presentation, a novel method for addressing constrained difference of convex (DC) optimisation problems will be introduced. The proposed approach builds upon a global search method for DC optimisation and a modified subgradient method. First, by utilising the maximum of constraint functions, we transform the constrained DC problem into another constrained

DC problem with a single constraint. Then, we employ the sharp augmented Lagrangian to formulate the dual problem, which involves only three dual variables. The global search method is utilised to minimise the sharp augmented Lagrangian function for specified values of the dual variables. Depending on the solution obtained, the new algorithm either terminates or updates the dual variables using the modified subgradient method. The convergence of the proposed method is studied, and its performance is assessed using several academic test problems.
Optimisation, Thursday 14:00-14:25 Room 402-221

Predicting patterns in ionic liquid films

Alex Tam[1], *Tharindi Amarathunge*[1], *Bronwyn Hajek*[1], *Marta Krasowska*[2]

[1]UniSA STEM, The University of South Australia, [2]Future Industries Institute, The University of South Australia

Ionic liquids (ILs) are salts that are liquid at room temperature. These liquids have unrealised potential as lubricants in high-end applications. Successful lubrication relies on the IL forming a precursor film over the substrate. At present, the IL–substrate pairs that priduce the best lubrication are unknown. We use mathematical modelling and experiments to screen IL–substrate pairs that form precursor films with desired patterns. We use a local PDE(s) model derived in the short-range interaction limit of a non-local interacting particle model. Pair-correlation functions quantify the experimental patterns, and we compare these results with predictions obtained from a linear stability analysis of the model.
Industrial Mathematics, Wednesday 11:00-11:25 Room 402-211

The UniSA Mathematics Clinic: How to build an industrial mathematics ecosystem

Alex Tam[1]

[1]University of South Australia

The Mathematics Clinic of the University of South Australia, now in its 21st year, runs year-long authentic industry-sponsored research projects for small teams of final-year undergraduate mathematics students. Mathematics Clinic projects give students professional skills, experience, accomplishments, and employability. They also generate research progress and publications. We have used mathematical modelling, optimisation, differential equations, data analytics, statistics, graph theory, machine learning, scheduling, and simulation to solve problems and improve decision-making in industry and government sectors including renewables, defence, resources, utilities, the courts, emergency services, and air traffic control. I will outline how to build the necessary commitment and structure for such a programme, touching on pitching and recruitment of industry sponsors; engaging students and academic staff; curriculum; articulation with other mathematics courses; coaching students in professional skills and leadership roles; intellectual property, confidentiality, and contracts; and scoping and development of suitable projects. I'll offer some case studies, suggestions, and principles, drawn from Mathematics

Clinic experience.
Industrial Mathematics, Thursday 11:30-11:55 Room 402-211

Optimality conditions in optimization under uncertainty

Christiane Tammer[1]

[1]Martin-Luther-University Halle-Wittenberg

Most optimization problems involve uncertain data due to measurement errors, unknown future developments and modeling approximations. Stochastic optimization assumes that the uncertain parameter is probabilistic. An other approach is called robust optimization which expects the uncertain parameter to belong to a set that is known prior. In this talk, we consider scalar optimization problems under uncertainty with infinite scenario sets. We apply methods from vector optimization in general spaces, set-valued optimization and scalarization techniques to derive necessary optimality conditions for solutions of robust optimization problems.
Optimisation, Monday 14:00-14:50 Room 402-221

A decentralised algorithm for min-max problems

Matthew Tam[1]

[1]University of Melbourne

In this talk, we consider a connected network of finitely many agents working cooperatively to solve a min-max problem with convex-concave structure. We propose a decentralised first-order algorithm which can be viewed as combining features of two algorithms: PG-EXTRA for decentralised minimisation problems and the forward reflected backward method for (non-distributed) min-max problems. In each iteration of our algorithm, each agent computes the gradient of the smooth component of its local objective function as well as the proximal operator of its nonsmooth component, following by a round of communication with its neighbours.
Optimisation, Friday 14:30-14:55 Room 402-221

Lattice and Non-Lattice Markov Additive Models

Jevgenijs Ivanovs, Guy Latouche, **Peter Taylor**[1]

[1]University of Melbourne

Dating from the work of Neuts in the 1980s, the field of matrix-analytic methods has been developed to analyse discrete or continuous-time Markov chains with a two-dimensional state space in which the increment of a level variable is governed by an auxiliary phase variable. More recently, matrix-analytic techniques have been applied to general Markov additive models with a finite phase space. The basic assumption underlying these developments is that the process is one-sided, that is it is jump-free in one direction. From the Markov additive perspective, traditional matrix analytic models can be viewed as special cases: increments in the level are constrained to be lattice random variables or they have to be piecewise linear. In this talk, I shall discuss one-sided lattice and non-lattice Markov additive processes in parallel. Results that are standard in one tradition are interpreted in the other, and new perspectives emerge. In particular, using three fundamental matrices, we address hitting, two-sided exit, and creeping probabilities.

Probability and Mathematical Statistics, Tuesday 11:30-11:55 Room 260-098

A Monge-Ampere equation on hypersurfaces in projective geometry

Stuart Teisseire[1], *Rod Gover*

[1]University of Auckland

Projective geometry is the study of manifolds equipped with unparameterised geodesics. We start by giving a brief introduction to the projective tractor calculus, featuring a natural projectively invariant connection. We then describe a projectively invariant Monge-Ampere type PDE which emerges naturally along a sufficiently curved hypersurface. We use a formal approach to find a solution of the PDE to high order, and show that this can be used to proliferate projective hypersurface invariants. Our results allow us to concretely describe the interaction of hypersurface's conformal strucure with the ambient projective geometry. A significant step towards this goal is to express the hypersurface's conformal tractor calculus in terms of the ambient projective tractor calculus. This work has strong links to the Fefferman-Graham ambient metric approach to conformal geometry.

Differential geometry and geometric analysis, Tuesday 16:00-16:25 Room 260-005

Principal Ideals and Filters of an Almost Distributive Fuzzy Lattice.

Zekarias Gashu Terefe[1]

[1]Bahir Dar University

This presentation will explore the concepts of principal ideals and principal filters within Almost Distributive Fuzzy Lattices, specifically focusing on the structure of the lattice $L = (R, A)$. Key findings will include the demonstration that the principal ideal generated by a maximal element, when such an element exists, equals the entire set R . Additionally, we will investigate the relationships between principal ideals $(a]_A$ and $(b]_A$ and principal filters $[a)_A$ and $[b)_A$ generated by elements $a, b \in R$. Furthermore, we will define the principal ideal and principal filter generated by amicable elements in an Almost Distributive Fuzzy Lattice and examine several of their foundational properties. This work aims to contribute to the understanding of these structures and foster connections among mathematicians engaged in similar research

areas.
Contributed Session B, Tuesday 15:00-15:25 Room 260-036

Fractional index and exact quantization

Guo Chuan Thiang

[1]Peking University

Counterintuitively, the most exact quantization phenomena occur in macroscopic systems, and come in integral and fractional versions. The basic mechanism involves a coarse-geometric Dirac index possessing exactly integral higher trace. Using the principal function theory of Carey-Pincus, we uncover further hidden fractional traces, guided by the fractional quantum Hall effect.
Index Theory in Geometry and Mathematical Physics, Wednesday 11:00-11:25 Room 260-022

Trees and related species

Anne Thomas[1]

[1]The University of Sydney

Group actions on trees and related objects, such as buildings and cube complexes, are of central importance in geometric group theory. I will survey several connections between such actions and operator algebras.
Functional Analysis and Operator Algebras, Tuesday 14:00-14:25 Room 260-055

Hypergraph index and divergence in Coxeter groups

Pallavi Dani, Yusra Naqvi, Ignat Soroko, **Anne Thomas**[1]

[1]The University of Sydney

We introduce the hypergraph index of an arbitrary Coxeter system (W, S). This is a computable combinatorial invariant which we relate (partly conjecturally) to difficult-to-compute quasi-isometry invariants of the group W. We also show that hypergraph index is bounded above by the first Betti number of the underlying graph of the associated Dynkin diagram.
Groups, actions and computations, Thursday 14:00-14:50 Room 260-051

The sum of a prime cubed and a cube-free number

Simon Thomas[1]

[1]The University of Queensland

In this talk I will discuss some recent work on the problem of determining which integers can be expressed as the sum of the cube of a prime and a cube-free number. This makes explicit a theorem of Rao that every sufficiently large integer may be written in this way.
Computational Number Theory and Applications, Tuesday 14:00-14:10 Room 405-422

Ricci solitons that fibre over hyperbolic surfaces

Adam Thompson[1]

[1]University of Queensland

We will discuss our construction of Ricci solitons on fibre bundles over compact hyperbolic surfaces. These solitons appear as limits of immortal Ricci flows on compact manifolds that collapse to a surface.
Differential geometry and geometric analysis, Monday 16:00-16:25 Room 260-005

On the complexity of hyperbolic knots obtained by Dehn filling the 'magic manifold'

Em Thompson[1]

[1]Monash University

Triangulations are an important tool used to encode the topology of manifolds combinatorially, enabling the effective computation of many invariants. Since all 3-manifolds can be triangulated in infinitely many ways, the fewest tetrahedra required to do so gives a natural measure of complexity for 3-manifolds. As a result of efforts by numerous authors since the 90s, a census exists for the 1267 hyperbolic knots whose minimal triangulations consist of up to 9 ideal tetrahedra. However, beyond this census, there are very few hyperbolic knots for which minimal triangulations are known.

In this talk, we consider knots that can be realised by Dehn filling 2 components of the 3-component chain link M_3 (otherwise known as the 'magic manifold'). By identifying triangulations of M_3 that are compatible with well-known techniques for triangulating Dehn fillings, we outline explicit constructions for infinitely many knot complements. These triangulations are veritably minimal for the 229 knots recognised from the census, and they provide upper bounds for the complexity of the remaining knots that they describe. To conclude, I will highlight the 42 families containing census knots and justify my conjecture that these triangulations continue

to be minimal beyond the census.
Early Career Showcase in Low-Dimensional Topology, Tuesday 16:00-16:25 Room 260-073

Computing the Heegaard Genus of 3-Manifold Triangulations

Finn Thompson[1]

[1]University of Queensland

Topological invariants are critical to the classification and recognition of manifolds. One such invariant for 3-manifolds is the Heegaard genus, which is the minimal genus of a surface that splits a 3-manifold into two handlebodies. Computing the Heegaard genus of a triangulated 3-manifold is NP-hard — the existing theoretical algorithms use almost normal surfaces, which are an extension of the algorithm-friendly normal surface theory but which add considerable complexity for both running time and implementation. We take a new approach which allows us to modify an input triangulation so that a Heegaard splittings may be found in terms of normal surfaces alone. Our methods prove successful in practice, finding precise values for a large set of hyperbolic 3-manifolds.
Early Career Showcase in Low-Dimensional Topology, Tuesday 16:30-16:55 Room 260-073

Actions of Inverse Semigroups and their Étale Groupoids

Ryan Thompson[1]

[1]Victoria University of Wellington

We investigate the actions of an inverse semigroups on locally compact, Hausdorff spaces, and their associated germ groupoids. Following Paterson (1999), we study the universal groupoid of an inverse semigroup S, as well as the groupoid of ultragerms, which can be identified with the groupoid of ultrafilters on S. We establish a condition called wideness under which a Boolean inverse sub-semigroup W of a Boolean inverse semigroup S gives rise to the same universal groupoid as S, and discuss a corresponding result for the groupoid of ultragerms. Lastly, we present some examples of universal groupoids and groupoids of ultragerms for basic inverse semigroups.
Functional Analysis and Operator Algebras, Monday 16:00-16:25 Room 260-055

On class operators for the lower radical class and semisimple closure constructions.

Lauren Thornton[1]

[1]University of The Sunshine Coast

Research in radical theory has been under way for more than a century, with key notions of the theory extended to mathematical objects having suitable internal structure (for example groups and topological spaces). While some object properties satisfy the Kurosh-Amitsur framework, a central problem has been to identify a smallest suitable (radical) subobject acting as the kernel for a mapping so that the image induced is free from radical subobjects (and called semisimple). The collection of radical objects forms a radical class and the collection of semisimple objects forms a semisimple class. Class operators were shown to be a suitable vehicle to re-introduce the theory in terms of base radical and base semisimple classes, and were used effectively to determine the radical theory possible in certain universal classes containing a finite number of class objects. The cost of this simpler construction is that the class subobject so constructed may no longer be the smallest radical subobject to contain the object property under consideration. The class operators used to date are not generally able to construct the suitable radical subobject and so we introduce appropriate additional operators to close this gap. In this presentation we construct the lower radical class and the semisimple closure for a given class using new class operators and detail some of the properties of these operators and their interplay with the operators already used in radical theory. The setting is the class of algebras introduced by Puczylowski which ensures the results hold in groups, multi-operator groups such as rings, as well as loops and hoops.
Contributed Session B, Monday 14:00-14:25 Room 303-B05

Towards non-linear scattering of gravitational waves

Sebenele Thwala[1]

[1]University of Canterbury

Gravitational waves are ripples in the fabric of space-time that propagate at the speed of light. First proposed in 1916, they are produced by extremely compact objects such as neutron stars or black holes. These waves are governed by non-linear equations, namely the Einstein equations, and hence self-interact. In recent years, due to the pioneering work by the LIGO/VIRGO collaborations, we are now able to detect gravitational waves here on earth. To properly decode the information contained in these gravitational waves, a rigorous understanding of their self-interaction properties is necessary. In this talk two things will be discussed: The scattering problem for gravitational waves. The process of scattering is arguably the most important tool in fundamental physics for understanding interactions, with nearly everything known about nuclear and atomic physics coming from scattering experiments. This process includes an initial state, an interaction, and a final state. We will introduce what this process looks like for gravitational waves and the mathematics required to set up such a problem. We will then present the numerical framework, that utilises a system called the Generalised Conformal field equations (GCFE). This is a system of equations obtained by conformally rescaling the Einstein

equations to represent infinity in a finite manner. With this framework, we relate, in the fully non-linear regime, the gravitational in states to the gravitational out states. This is based on research done under the supervision of Dr. Chris Stevens

Recent advances in geometric PDE, Wednesday 11:30-11:40 Room 260-057

Data-Driven Water Quality Modelling and Prediction for New Zealand Rivers: A Predictive Approach to Environmental Sustainability

Parul Tiwari[1], *Channa Rajanayaka*[2], *Jing Yang*[3]

[1]Auckland University of Technology, [2]National Institute of Water and Atmospheric Research (NIWA), [3]National Institute of Water and Atmospheric Research (NIWA)

Water quality is a fundamental aspect of environmental sustainability. Clean water is vital to our health. This study focuses on data-driven water quality modeling and prediction for New Zealand rivers, aiming to provide an effective and predictive framework to assess and manage water quality. Fast and efficient alternative methods are needed for effective water quality management. The diverse applications of machine learning algorithms and computational intelligence have made them essential decision-making tools in water quality management. Several machine learning algorithms have been used in current study to understand the relationships among physical, chemical and biological variables. Explainable Artificial Intelligence (XAI) algorithms are applied (i) to develop models to predict E. coli concentrations in New Zealand rivers by selecting and transforming the most important features and (ii) to evaluate and compare the prediction accuracy of the machine learning models. The model's predictive abilities allow for real-time tracking and early warnings, helping to respond quickly to pollution, algal blooms, and other water quality issues. The accurate and scalable models suggested in this study support long-term plans to protect rivers, ensuring both the health of the ecosystems and the well-being of living beings. By applying data science and artificial intelligence, this study provides new insights into tackling environmental challenges and preserving natural resources in a changing world.

Industrial Mathematics, Tuesday 11:30-11:40 Room 402-211

Small Triangulations of Simply Connected 4-Manifolds

Lucy Tobin[1], *Jonathan Spreer*[1]

[1]The University of Sydney

Every simply connected, closed, piecewise-linear 4-manifold is – modulo Matsumoto's longstanding 11/8 conjecture – homeomorphic to a *standard* one: a connected sum of the PL-standard $\mathbb{CP}^2$, $S^2 \times S^2$ and $K3$ surface. We construct explicit triangulations of all connected sums of $\mathbb{CP}^2$ and $S^2 \times S^2$ with precisely $2\beta_2 + 2$ pentachora, which we conjecture to be the minimum possible. This leaves us just one component away from having (conjecturally) minimal triangulations representing *all* topological types of simply connected closed PL manifolds, verified to have the standard PL type. We discuss these triangulations, how their construction relates to

Kirby diagrams, why we believe them to be minimal, and the strategy used to verify their PL types.
Early Career Showcase in Low-Dimensional Topology, Monday 16:30-16:55 Room 260-073

Isomorphisms of quantum graphs

Ivan Todorov[1]

[1]University of Delaware

In a fruitful interaction between quantum information theory and operator theory, about a decade ago, finite simple graphs were used as a ground input of non-local games, allowing to define graph homomorphisms and graph isomorphisms of quantum type, that can be genuinely less restrictive than the corresponding classical graph-theoretic notions. At the same time, quantum versions of graphs arose within zero-error quantum information theory, and a notion of classical homomorphism between quantum graphs was proposed. In this talk, I will describe the quantum non-local game approach to homomorphisms and isomorphisms of quantum graphs, and will show how a theorem characterizing quantum graph isomorphisms in operator-algebraic terms can be lifted to the quantum setting. The talk is based on a joint work with Mike Brannan, Sam Haris, and Lyudmila Turowska.
Functional Analysis and Operator Algebras, Thursday 11:30-11:55 Room 260-055

Characterisation and perturbations of the Lyapunov-Oseledets spectrum for a class of random dynamical systems

Cecilia González Tokman[1]

[1]University of Queensland

The Lyapunov-Oseledets spectrum associated to transfer operator cocycles contains essential information about dynamical properties of random dynamical systems. In this talk we describe such a spectrum for a class of analytic circle maps. Furthermore, we analyse stability and instability properties of this spectrum under perturbations. (Joint work with Anthony Quas and Joshua Peters.)
Ergodic Theory and Dynamical Systems, Thursday 14:30-14:55 Room 303-G23

Stably finite and purely infinite crossed products

Becky Armstrong[1], *Lisa Clark*[1], *Astrid an Huef*[1], **Ilija Tolich**[1], *Diego Martínez*[2]

[1]Te Herenga Waka, Victoria University of Wellington, [2]KU Leuven

The C*-algebra associated to a topological groupoid can be viewed as a crossed product: by the partial action of the inverse semigroup of bisections on the continuous functions on the unit space. Analogously we can consider inverse semigroup crossed products of arbitrary C*-algebras. For certain classes of Hausdorff groupoids there is a known dichotomy: the groupoid C*-algebra is either stably finite or purely infinite. Allowing for inverse semigroup crossed products introduces non-trivial obstacles to extending these results. We will outline the crossed product construction and present work towards the purely infinite-stably finite dichotomy. Joint work with Becky Armstrong, Lisa Clark, Astrid an Huef and Diego Martínez.
Functional Analysis and Operator Algebras, Friday 11:30-11:55 Room 260-055

Eigenstates of an Integrable XY Model

Willem Jacobus Petrus Van Tonder[1]

[1]The University of Queensland

An anisotropic BCS-Richardson (XYZ) model was recently diagonalised using a modified algebraic Bethe ansatz [Skrypnyk 2022]. In concurrent work an XY central spin model was shown to be integrable [van Tonder 2023]. We show that the Hamiltonian and its conserved charges for the XY model can be obtained through a limit of the XYZ model. This would then provide a diagonalisation of the XY model through the XYZ model eigenstates. However, the eigenstates are singular in this limit requiring us to first apply an appropriate reparametrisation. Once this is done we obtain the eigenstates for the XY model for generic parameters after observing that one of the Bethe roots diverge.
Mathematical Physics, Tuesday 16:00-16:25 Room 260-221

Some recent results on existence and regularity of Brakke flow

Yoshihiro Tonegawa[1]

[1]Institute of Science Tokyo

I report various recent results and projects regarding the mean curvature flow in the setting of geometric measure theory called the Brakke flow, in particular about the existence and regularity aspects.
Mathematics of nonlinear diffusion processes, Tuesday 14:00-14:50 Room 260-018

Applications of Riemann–Hilbert problems with theta-function asymptotics

Tom Trogdon[1]

[1]University of Washington

We consider Riemann–Hilbert problems that are asymptotically posed on a union of disjoint intervals. The primary applications we discuss are to (1) the numerical solution of the computation of the finite-genus/primitive solutions of the KdV equation and to (2) the computation of the three-term recurrence coefficients for polynomials orthogonal on multiple intervals. With regard to (1), we give a new numerical method to solve the periodic initial-value problem for the KdV equation and compute large-genus solutions. For (2), an outcome of the work is a new implementation of inner-product free iterative solvers for indefinite linear systems.
Discrete and continuous integrable systems: geometry analysis and applications, Friday 14:00-14:25 Room 260-036

M&M's

Tim Trudgian[1]

[1]UNSW Canberra at ADFA

I will provide free samples of M&M's, possibly the confectionery or possibly two sums involving the Moebius μ function. These appear in upcoming work joint with Mike Mossinghoff. The suggested serving size of theory and computation in this talk will not exceed one's recommended daily intake of arithmetic.
Computational Number Theory and Applications, Monday 14:00-14:10 Room 405-422

Relative equilibria for the n-body problem

Warwick Tucker[1], *Piotr Zgliczyński*[2], *Jordi-Lluís Figueras*[3]

[1]Monash University, [2]Jagiellonian University, [3]Uppsala University

We will discuss the classical problem from celestial mechanics of determining the number of relative equilibria a set of planets can display. Several already established results will be presented, as well as a new contribution (in terms of a new proof) for the restricted 4-body problem. We will discuss its possible extensions to harder instances of the general problem. This is joint work with Piotr Zgliczynski and Jordi-Lluis Figueras.
Ergodic Theory and Dynamical Systems, Wednesday 11:30-11:55 Room 303-G23

The Generalized Divisor Problem

Sebastian Tudzi[1]

[1]University of New South Wales

In this talk, we will delve into significant advancements made in several specific cases of the Generalized Divisor Problem. Our focus will be on the explicit results that have been established, highlighting key breakthroughs in understanding the behavior of divisor functions in these contexts. We will examine how these results contribute to refining error bounds and improving asymptotic estimates, particularly in cases involving higher-order divisor functions.
Arithmetic Geometry and Number Theory, Tuesday 16:30-16:40 Room 405-430

Fundamental Gap Estimates in Various Geometries

Malik Tuerkoen[1]

[1]UC Santa Barbara

The fundamental gap is the difference of the first two eigenvalues of the Laplace operator, which is important both in mathematics and physics and has been extensively studied. For the Dirichlet boundary condition the log-concavity of the first eigenfunction plays a crucial role in proving lower bounds, which was established for convex domains in the Euclidean space and the round sphere. In recent works, there has been progress in proving gap estimates on perturbations of the round sphere in dimension two and conformal deformations in higher dimensions. For negatively curved spaces, it turns out that there is no uniform lower bound of the fundamental gap. Hence it is natural to ask whether one can prove a fundamental gap estimate, assuming a stronger notion of convexity. In recent work there has been progress on answering this question. This is based on joint work with G. Khan, H. Nguyen, S. Saha and G. Wei in various subsets.
Recent advances in geometric PDE, Tuesday 16:30-16:40 Room 260-057

Weakly linked embeddings of pairs of complete graphs in $\mathbb{R}^3$

Christopher Tuffley[1], *Erica Flapan*[2]

[1]Massey University, [2]Pomona College

Given two complete graphs $G \cong K_m$ and $H \cong K_n$ disjointly embedded in $\mathbb{R}^3$, we say that G and H are *weakly linked* if some cycle in G links some cycle in H, but no cycle in either graph links a cycle in the other with linking number greater than 1 in absolute value. I'll give a complete algebraic classification of weakly linked embeddings. In particular, we'll see that there is either a vertex of G common to all triangles in G that link H, or there is a triangle T^* in G such that a triangle T of G links H if and only if it shares an edge with T^*, with the possible exception

of T^* itself.
Early Career Showcase in Low-Dimensional Topology, Thursday 15:00-15:25 Room 260-073

A linear finite group action on a lattice and mod q permutation representation

Ryo Uchiumi[1], *Masahiko Yoshinaga*[1]

[1]Osaka University

For given linear action of a finite group on a lattice and a positive integer q, the mod q permutation representation is induced. We study the dependency of the representation on q. As a main result, we prove that it is a quasi-polynomial in q. Additionally, we establish several results that can be considered as mod q-analogues of results by Stapledon for equivariant Ehrhart quasi-polynomials.
Algebraic Combinatorics and Matroids, Friday 12:00-12:25 Room 303-B09

The Calderon Problem for Nonlocal Operators

Gunther Uhlmann[1]

[1]University Of Washington

We discuss in this talk recent results on the problem of recovering coefficients of a nonlocal elliptic PDE from exterior measurements.
Microlocal analysis and inverse problems, Friday 11:30-12:20 Room 260-009

Hypertwined Regularity and Applications

Adrian Vajiac[1]

[1]Chapman University

Hypertwined analysis is a refinement of the general hypercomplex theory of partial differential operators, hypertwined regular functions being in the kernel of certain systems of partial differential operators, and admitting a decomposition in a hypertwined sum of regular functions in certain subalgebras. As examples, I introduce notions of hypertwined regularity for quaternionic, biquaternionic, and split-quaternionic spaces. The hypertwined quaternionic regularity lies in between slice regularity and the modified Cauchy-Fueter theories, and proves to have a direct impact on reformulations of quaternionic and spacetime algebra quantum theories. In the same context, I will discuss several interpretations of notions and results in Quantum Field Theory (QFT), such as supersymmetry, path-integral quantization, cancellation of anomalies,

et al. Particular QFTs of interest in this study are Topological QFTs such as supersymmetric Yang-Mills theories on a four-manifold, topological sigma models, and Chern-Simmons gauge theory, which are deeply related with Donaldson and Seiberg-Witten invariants, Gromov-Witten invariants, and knot and links invariants, respectively.
Recent advances in geometric PDE, Friday 12:00-12:25 Room 260-057

On the density of the Weihrauch degrees

Manlio Valenti[1]

[1]Swansea University

Recall that, in a partial order $(P, \leq)$, b is a minimal cover of a if the interval (a, b) is empty. A strengthening of this notion is the one of strong minimal cover, namely b is a strong minimal cover of a if $c < b$ implies $c \leq a$. In this talk, we provide a complete characterization of how minimal covers and strong minimal covers in the Weihrauch degrees look like. In particular, letting $\{p\}^+ = \{\langle e, q\rangle : \Phi_e(p) = q \text{ and } q \not\leq_{\mathrm{T}} p\}$, we obtain the following two characterization (where $\leq_{\mathrm{M}}$ and $\leq_{\mathrm{W}}$ denote Medvedev and Weihrauch reducibility respectively).
Theorem *Let f and h be partial multi-valued functions on Baire space. The following are equivalent:*

1. *f is a minimal cover of h in the Weihrauch degrees.*
2. *$f \equiv_{\mathrm{W}} h \sqcup \mathrm{id}_{\{p\}}$ for some p with $\mathrm{dom}(h) \not\leq_{\mathrm{M}} \{p\}$ and $\mathrm{dom}(h) \leq_{\mathrm{M}} \{p\}^+$.*

Theorem *Let f and h be partial multi-valued functions on Baire space. The following are equivalent:*

1. *f is a strong minimal cover of h in the Weihrauch degrees.*
2. *There is $p \in \mathbb{N}^{\mathbb{N}}$ such that $f \equiv_{\mathrm{W}} \mathrm{id}_{\{p\}}$ and $h \equiv_{\mathrm{W}} \mathrm{id}_{\{p\}^+}$.*

From the above results, it follows that the degree of id can be defined as the highest top of a strong minimal cover, or the least degree whose upper cone is dense. In other words, "being (uniformly) computable" is a first-order definable property in $(\mathcal{W}, \leq_{\mathrm{W}})$ (as it corresponds to being $\leq_{\mathrm{W}}$ id). This implies that the first-order theory of the Weihrauch degrees (below id) is recursively isomorphic to the third-order theory of true arithmetic. This is joint work with Steffen Lempp, Joe Miller, Arno Pauly, and Mariya Soskova.
Computability Theory and Applications, Thursday 14:30-15:20 Room 303-B07

Exponent-Critical Groups

Geetha Venkataraman[1]

[1]Dr. B. R. Ambedkar University Delhi

A finite group is said to be exponent-critical if its exponent is not the least common multiple of the exponents of its proper non-abelian subgroups. It turns out that exponent-critical groups are solvable and the order of a non-abelian exponent-critical group is divisible by at most three distinct primes. We explore properties of exponent-critical groups and give a characterization of such groups. This characterization generalises a classical result of Miller and Moreno on minimal non-abelian groups and interesting families of p-groups appear. We prove the following results. Let G be a non-abelian finite group whose order is divisible by exactly three distinct primes. Then G is exponent-critical if and only if G is a direct product of a cyclic Sylow subgroup of G and its complement, which is minimal non-abelian. The case when G is a non-abelian exponent-critical group whose order is divisible by exactly two distinct primes proves to be more complex. Further, in the case of exponent-critical p-groups P, the problem naturally splits into two cases, depending on the number of abelian maximal subgroups of P. We say that an exponent-critical p-group P is of type $\mathcal{A}$ if P has exactly one maximal subgroup which is abelian, and is of type $\mathcal{B}$ if P has more than one abelian maximal subgroup. This is joint work with Simon R Blackburn, William Cocke and Andrew Misseldine [1]. Reference: [1] Simon R. Blackburn, William Cocke, Andrew Misseldine and Geetha Venkataraman, Exponent-Critical Groups, arXiv:2401.07834.
Contributed Session B, Tuesday 11:30-11:55 Room 303-G14

Popularising and Strengthening Mathematics Learning: Some Experiments and Experiences

Geetha Venkataraman[1]

[1]Dr. B. R. Ambedkar University Delhi

In this presentation I want to touch on some efforts that I have been involved with in India at various levels to help popularising and strengthening mathematics learning. More than half the people one interacts with speak about their nightmarish experiences of learning mathematics at school which usually happens during middle school and these experiences inform their reactions to mathematics even as adults. I wish to speak about two kinds of interventions one at a formal level and the other at an informal level. In our university, we created a non-calculus-based course which allowed students to get back into thinking mathematically by learning about basic set theory, symmetry, perspective and art, logic and data modelling. This led to vast number of students who had dropped mathematics after the X grade to see mathematical thinking and a mathematical lens as fun and something which would be useful. The other is giving talks and being involved in projects related to mathematics in the modern world. The Department of Science and Technology, Govt. of India organises an exhibition which is held during the Science Congress and is open to public. For several years we organised an exhibition titled Mathematics in the Modern World, bringing to the public the myriad ways in which mathematics has contributed to bettering their lives. We used this opportunity to also explain to informed lay public, to the extent we could, the mathematics behind these applications. This

has also provided a basis for creating popular talks which have been delivered in online modes to the public ('Kappi with Curiosity'), to undergraduate students and high school students. In 1981, Serge Lang delivered three public lectures in Paris on the beauty of doing Mathematics. It is imperative that as professional mathematicians we also considering communicating the beauty of mathematics. If time permits, I will also speak about the DST Inspire mentorship for high school students; Vigyanjyoti, an initiative to encourage school girls to continue with mathematics and science; efforts of the Maths Teachers' Association (India) to bring school and tertiary mathematics practitioners under the same roof, as well as the efforts of the Indian Women and Mathematics which provides meaningful interventions at the tertiary level.
Engagement with mathematics through communication and outreach, Thursday 14:00-14:25 Room 260-009

Counting points on surfaces in polynomial time.

Madhavan Venkatesh[1], *Nitin Saxena*[1]

[1]Indian Institute of Technology Kanpur

This talk will be on a recent algorithm to compute the number of points on a surface X over a finite field $\mathbb{F}_q$ (obtained via good reduction from $\mathcal{X}$ over a number field K at a prime $\mathfrak{p} \subset \mathcal{O}_K$) in time polynomial in $\log q$, affirming a conjecture of Couveignes and Edixhoven. We make the etale cohomology groups (with constant torsion coefficients) of a surface explicit and compute the action of Frobenius on them. The main ingredients are the theory of vanishing cycles associated to a Lefschetz pencil, using Puiseux expansions to lift vanishing cycles at a singular point to the generic fibre (moving to characteristic 0 in between to ensure consistency) and computing pairings there via specialisation. Parallelly, Arakelov theory is used in the characteristic zero setting to keep track of height-bounds of the lifts being considered. This is the first poly-time explicitisation result on etale cohomology in higher degrees and extends the frontier of ℓ-adic point counting to higher dimensions. This is joint work with my advisor Nitin Saxena.
Arithmetic Geometry and Number Theory, Friday 11:30-11:55 Room 405-430

Density of quotient orders in groups and applications to locally-transitive graphs

Gabriel Verret[1]

[1]University of Auckland

We will discuss a recent result that the set of orders of finite quotients of a finitely generated group has natural density 0, 1/2 or 1. We also discuss applications of this result to the natural density of the set of orders of various families of symmetric graphs.
Groups, actions and computations, Friday 14:00-14:25 Room 260-051

Pearson's correlation statistic for a pair of Brownian motions: a Wiener chaos approach to its discrete-time asymptotics.

Philip Ernst[2], **Frederi Viens**[1]

[1]Rice University, [2]Imperial College London

The empirical (Pearson) correlation statistic ρ_n for two series of data of length n can easily fail to converge to an underlying correlation coefficient, particularly for highly non-stationary series. G. Udny Yule showed empirically in 1926 that for two independent standard random walks, far from converging to 0, ρ_n is quite diffuse and appears to converge to a specific distribution over the entire interval $(-1, 1)$. Ignorance of this empirical fact has lead practitioners to incorrect assessments of associations and attribution, occasionally in dramatically public fashion, particularly in environmental observational studies. The classical Donsker's theorem (infinite-dimensional version of a central limit theorem) easily implies convergence of the law of ρ_n to the law of a random variable ρ written explicitly using quadratic functionals of two Wiener processes. But what are the fluctuations in this limit? In this talk, we present elements of a new result by which $n(\rho - \rho_n)$ has an asymptotic distribution in the so-called second Wiener chaos, whose characteristics are partly exogenous to the original data, as one would expect for a standard central limit theorem, and are partly conditional on the data. We will discuss the implications of this discovery in practical testing for independence and for attribution in environmental time series. Applications include projects related to climate change on which we are currently working, and other extensions.
Probability and Mathematical Statistics, Wednesday 10:30-10:55 Room 260-098

A priori and a posteriori error bounds for the fully mixed FEM formulation of poroelasticity with stress-dependent permeability

Segundo Villa-fuentes[1], *Ricardo Ruiz Baier, Bishnu Lamishhane, Arbaz Khan*

[1]Monash University

We develop a family of mixed finite element methods for a model of nonlinear poroelasticity where, thanks to a rewriting of the constitutive equations, the permeability depends on the total poroelastic stress and on the fluid pressure and therefore we can use the Hellinger–Reissner principle with weakly imposed stress symmetry for Biot's equations. The problem is adequately structured into a coupled system consisting of one saddle-point formulation, one linearised perturbed saddle-point formulation, and two off-diagonal perturbations. This system's unique solvability requires assumptions on regularity and Lipschitz continuity of the inverse permeability, and the analysis follows fixed-point arguments and the Babuska–Brezzi theory. The discrete problem is shown uniquely solvable by applying similar fixed-point and saddle-point techniques as for the continuous case. The method is based on the classical PEERS elements, it is exactly momentum and mass conservative, and it is robust with respect to the nearly incompressible as well as vanishing storativity limits. We derive a priori error estimates, we also propose fully computable residual-based a posteriori error indicators, and show that they are reliable and efficient with respect to the natural norms, and robust in the limit of near incompressibility. These a posteriori error estimates are used to drive adaptive mesh refinement. The theoretical

analysis is supported and illustrated by several numerical examples in 2D and 3D.
Computational Mathematics, Tuesday 16:00-16:25 Room 402-231

Well-posedness for a Magnetohydrodynamical Model with Intrinsic Magnetisation

Noah Vinod[1], *Thanh Tran*[1]

[1]UNSW

The Landau-Lifshitz-Gilbert (LLG) equation, modelling the magnetisation of a ferromagnetic material, has undergone extensive mathematical study over the past few decades. Questions involving the existence, uniqueness and regularity of solutions have been answered thoroughly and numerical algorithms to approximate the solutions have also been developed. More recently, the interactions of magnetisation alongside other physical effects have been studied mathematically by coupling the LLG equation with the corresponding equations for those effects. For example, the LLG equation has been coupled with Maxwell's equations (e.g., [1]) or with the Navier-Stokes equation (e.g., [2]) or even with the Navier-Stokes equation and the elastic equation (e.g., [3]). However, the combination of the LLG equation with the Navier-Stokes equation and Maxwell's equations has not yet been studied. In recent years, the work of Lingam [4] has given physical justification for such a system - one that models electrically conducting fluids with intrinsic magnetisation i.e., a magnetohydrodynamical model with intrinsic magnetisation. In this talk, we detail our examination of the well-posedness of solutions to this system. [1] S. Ding, B. Guo. Existence of partially regular weak solutions to Landau–Lifshitz–Maxwell equations. Journal of Differential Equations, 244(10):2448-2472, 2008. [2] J. Fan, H. Gao, B. Guo. Regularity criteria for the Navier–Stokes–Landau–Lifshitz system. Journal of Mathematical Analysis and Applications. 363(1):29-37, 2010. [3] B. Benesova, J. Forster, C. Liu, A. Schlomerkemper. Existence of Weak Solutions to an Evolutionary Model for Magnetoelasticity. SIAM Journal on Mathematical Analysis. 50(1):1200-1236, 2018. [4] M. Lingam. Dissipative effects in magnetohydrodynamical models with intrinsic magnetization. Communications in Nonlinear Science and Numerical Simulation. 28(1–3):223-231, 2015.
Recent advances in mathematical fluid dynamics, Tuesday 16:30-16:55 Room 401-311

Number fields generated by points in linear systems on curves

Irmak Balçik, Stephanie Chan, Yuan Liu, **Bianca Viray**[1]

[1]University of Washington

Given a nonconstant morphism from a curve C to $\mathbb{P}^1$ over a number field k, Hilbert's irreducibility theorem implies that there are infinitely many points $t \in \mathbb{P}^1(k)$ such that the fiber C_t is irreducible. In this paper, we study the local splitting type of the fields of definition of these fibers (alternatively, the residue fields of the closed points C_t). We show that the possible ramification and inertia degrees are constrained by the geometry of the morphism, and that,

outside these constraints, all possible ramification and inertia degrees are realized.
Arithmetic Geometry and Number Theory, Tuesday 12:00-12:25 Room 405-430

The Continuum Calogero-Moser Models

Monica Visan[1]

[1]UCLA

We introduce the continuum Calogero-Moser models, which are completely integrable equations exhibiting novel and interesting phenomena. We survey new and existing results and outline some of the main ideas in these proofs. This is based on joint work with Rowan Killip and Thierry Laurens.
Deterministic and Probabilistic Aspects of Dispersive Partial Differential Equations, Friday 11:30-12:20 Room 260-022

Singularities of High Codimension Mean Curvature Flow in Riemannian Manifolds

Artemis Aikaterini Vogiatzi[1]

[1]University of Copenhagen

We study the mean curvature flow of smooth n-dimensional compact submanifolds with quadratic pinching in a Riemannian manifold $\mathbb{N}^{n+m}$. Our main focus is on the case of high codimension, $m \geq 2$. We establish a codimension estimate that shows in regions of high curvature, the submanifold becomes approximately codimension one in a quantifiable way. This estimate enables us to prove that at a singular time of the flow, there exists a rescaling that converges to a smooth codimension-one limiting flow in Euclidean space. Under a cylindrical type pinching, this limiting flow is weakly convex and moves by translation. These estimates allow us to analyse the behaviour of the flow near singularities and establish the existence of the limiting flow. When considering spaces like $\mathbb{S}^{n+m}$ or $\mathbb{C}P^n$, the rescaling can converge smoothly to a totally geodesic limit in infinite time. We provide a classification of singularity models under the quadratic pinching condition.
Differential geometry and geometric analysis, Friday 14:30-14:55 Room 260-005

Conic bundle threefolds differing by a constant Brauer class and connections to rationality

Sarah Frei[1], *Lena Ji*[2], *Soumya Sankar*[3], *Bianca Viray*[4], **Isabel Vogt[5]**

[1]Dartmouth University, [2]University of Illinois Urbana-Champaign, [3]Utrecht University, [4]University of Washington, [5]Brown University

In this talk I'll discuss joint work with Sarah Frei, Lena Ji, Soumya Sankar and Bianca Viray on the problem of determining when a geometrically rational variety is birational to projective space over its field of definition. Our main interest is the rationality problem for conic bundles over P^2 with quartic discriminant curve, where there exist both rational and irrational examples over nonclosed fields. I will discuss our perspective on the failure of the intermediate Jacobian torsor obstruction to characterize rationality, which leads us to study conic bundles that differ by a constant Brauer class.

Arithmetic Geometry and Number Theory, Friday 15:00-15:25 Room 405-430

A computational investigation into modular forms attached to rigid surfaces of geometric genus 2

Asher Auel, Adam Logan, **John Voight[1]**

[1]The University of Sydney

We present constructions of rigid surfaces of geometric genus 2 and compute (conjectural) modular forms attached to them.

Computational Number Theory and Applications, Tuesday 16:30-16:55 Room 405-422

"I'm Better at This Than You" - Does AI's Thematic Analysis Outshine Human Expertise in STEM Education Research?

Matthew Voigt[1]

[1]Michigan State University

This study explores the potential and pitfalls of generative artificial intelligence (AI) in qualitative research, specifically in the context of identifying and comparing themes related to Queer students' experiences in mathematics. A key aspect of this current study was the use of AI to identify themes and discourses within the dataset and those were then compared to researcher-identified themes through traditional qualitative analysis methods (Voigt, 2020). The original research involved individual interviews with 17 Queer STEM students, focusing on their perceptions of their Queer identity within mathematical learning environments. The researcher-driven data analysis process employed a phenomenological approach, utilizing coding techniques and member checking to identify and refine themes. The emergent findings within this comparative

study revealed both alignment and distinctions between the AI-generated themes and those identified by the researcher. Both approaches captured core discourses/themes highlighting the challenges Queer students face in STEM. In particular, both analysis approaches identified the nature of exclusion, selective disclosure, and the impact of societal beliefs about meritocracy in mathematics. The comparison also showcased key differences in the identification and framing of themes within the data. For instance, AI-generated themes more centrally located issues of intersectionality but took a less liberatory approach to framing the neutrality of STEM. The researcher-identified additional themes in how queer students understood their identity and linked them to underlying constructs or exclusion and irrelevancy. However, the AI output suggested that it identified "additional themes and nuances not explicitly recognized by the researcher, suggesting its potential to enhance the depth and breadth of qualitative analysis." In conclusion, this research contributes to the growing body of literature on the use of AI in qualitative research, specifically in the context of mathematics education. The findings suggest that AI can be a valuable tool for identifying researcher bias when conducting thematic analysis, but it should be used in conjunction with human expertise to ensure the validity and richness of the findings. Future research should continue to explore the potential of AI in qualitative research, addressing its limitations and ethical considerations to maximize its benefits for advancing knowledge and understanding in various fields.
MATHEMATICS EDUCATION, TUESDAY 14:30-14:40 ROOM 260-115

Irreducibility of curves over finite fields

Felipe Voloch[1]

[1]University of Canterbury

We discuss some problems on algebraic curves over finite fields motivated by list decoding algorithms for Reed-Solomon codes. We look at certain linear systems of curves and bound how many of these are reducible over the finite field. We also consider a sufficient condition for irreducibility for those curves and bound the number of curves failing it. Preliminary report.
ARITHMETIC GEOMETRY AND NUMBER THEORY, FRIDAY 12:00-12:25 ROOM 405-430

The probability of two subspaces spanning a classical space

Geertrui Van de Voorde[1], *Maarten De Boeck*

[1]University of Canterbury

Glasby, Niemeyer and Praeger (and later Glasby, Ihringer and Mattheus) derived lower bounds for the probability of spanning a non-degenerate classical space by two non-degenerate subspaces. This problem is motivated by algorithms to recognise classical groups. More precisely, given a vector space V and a quadratic, symplectic, or unitary form f on V, these authors determine lower bounds on the proportion of pairs (U, U') of non-degenerate subspaces U, U' with respect to f, such that U and U' are trivially intersecting and $\langle U, U' \rangle$ is a non-degenerate subspace of V among all such pairs of non-degenerate subspaces (U, U'). In recent joint work

with Maarten De Boeck, we improve on those results by deriving the exact formulae for this proportion for symplectic, hermitian and odd characteristic quadratic forms.
Groups, actions and computations, Monday 15:00-15:25 Room 260-051

An assessment of active learning in large first year maths courses

Raymond Vozzo[1], *Stuart Johnson*[1], *Jonathan Tuke*[1]

[1]University of Adelaide

Many recent studies have expounded the benefits of active learning in tertiary education. It can be challenging to implement these techniques at large scale (for example in first year mathematics courses). A common method for actively engaging students in large classes is through online quizzes, which may include peer instruction. In this talk, I will describe recent work in which we investigate the effect of having students answer quiz-style questions during class both with and without discussion in a first year mathematics course. We also investigate the short- and long-term effects of each protocol. This is joint work with Stuart Johnson and Jonathan Tuke.
Mathematics Education, Thursday 11:30-11:55 Room 260-115

The fluid dynamics of intrusions

Carl Vu[1]

[1]Monash University

We shall describe intrusions generated from a source into a linearly stratified ambient, at the level of neutral buoyancy. Our analysis focuses on 2D and 3D numerical simulations for the Navier-Stokes equation under the Boussinesq approximation. We find that for a wide, lazy source the intrusion profiles show a remarkably clear self-similar collapse, but do not match the solutions of the existing shallow-water model. Additionally, we observe the generation of waves travelling ahead of the intrusions and alongside the intrusions, correlating with surface oscillations at the interface. We also study the stability analysis to identify how these wave modes are generated and how they interact with each other. The robustness across parameter space suggests that the dominant effects controlling the flow may be more readily identified in this geometry of planar intrusions generated from a wide, lazy source, thus providing valuable additional insight for an improved reduced-order model.
Mathematical methods in continuum mechanics and wave theory, Wednesday 10:45-10:55 Room 401-307

(Biological) Evolution is similar to misspecified (stochastic) filtering

Philipp Wacker[1], *Sahani Pathiraja*

[1]University of Canterbury

There are a lot of mathematical models describing evolution (mutation + selection influencing reproductive success). Here, we will talk about the replicator-mutator equation, which is a partial differential equation modelling a distribution of traits over time. Connections between evolution and Bayesian inversion have been pointed out before, but in this talk we will see how the dynamics of the evolutionary model is very similar to a method called misspecified filtering, which performs continuous assimilation of observations using a misspecified dynamical model. In brief: Evolution "finds" suitable traits in a mathematically similar way to how filtering algorithms reconstruct a hidden state from indirect and noisy observations.
Stochastic Differential Equations, Thursday 12:00-12:25 Room 260-016

Nested Sampling for Rare Event Estimation

Philipp Wacker[1], *Jonas Latz*[2], *Doris Schneider*[3]

[1]University of Canterbury, [2]University of Manchester, [3]Ostbayerische Technische Hochschule Amberg-Weiden

Rare event estimation (i.e., quantifying the probability that a rare but critical event occurs) is a difficult problem in computational statistics. We will talk about Nested Sampling as a numerical method to perform rare event estimation. Nested Sampling can be interpreted as a "Lebesgue-style" Monte Carlo integration, because it discretises the level sets of the integrand rather than the integration domain (which is what most Monte Carlo methods implicitly do).
Stochastic and Deterministic Inverse Problems, Friday 14:00-14:25 Room 260-040

Unusual nonlocal calculus assists cancer cell growth treatments

Graeme Wake[1], *Bruce van-Brunt*[2], *Bruce Baguley*[3], *Steve Taylor*[4], *Ali Zaidi*[5]

[1]Massey University, Albany; [2]Massey University, Palmerston North; [3]University of Auckland Cancer Research Group; [4]University of Auckland; [5]Lahore Universty of Management

Modelling of cell-growth in growing and proliferating cancer-cell cohorts gives rise to an unusual functional differential equation of an advanced type (not in time) which showed stability in time by retaining the shape of the steady size-distribution of cells (SSDs). The history, development, and use of this problem will be described in this presentation. The project started in 1989, initially with plant root cells. The need for more comprehensive data sets so as to audit the model, shifted the focus to cancer cells, where DNA content became a proxy for size which is measured by a fluorescent beam process. The model describing the temporal evolution of SSDs

greatly reduces the amount of experimental work required to underpin decision processes of testing the value of proposed new drug treatments. The development is ongoing, though delayed by the shortage of funding. The model is simple enough to require many fewer parameters obtained by less experiments and delays, and therefore concentrated on just the Mitosis phase of cell division.
Industrial Mathematics, Monday 15:00-15:25 Room 402-211

A dynamic vegetation roughness model for coastal dune systems

Sarah Wakes[1], *Teresa Konlechner*[1], *Michael Hilton*[1]

[1]University of Otago

Dune systems are an important defence against storms and the effect of climate changes for coastal populations. Being able to predict how a dune systems will behave in different wind conditions allows coastal managers, communities and local government to plan mitigation and adaptation strategies. Many of these systems are already highly managed and interventions such as vegetation planting for stablisation, notching for sand transportation and beach sand replenishment have been implemented to differing degrees of success. Simulations of the wind flow patterns over these dune systems can be a useful tool in evaluating the effectiveness of existing, past and future interventions. Modelling must therefore represent as much of the significant interactions in these systems as is possible. The complexity of the dune topology is able to be captured and used to create realistic simulations. However, the interaction of the vegetation growing on the dunes with the wind flow is often neglected or at best simplified to a constant roughness parameter acting on the dune surface. Vegetation has a modifying effect on the air flow characteristics in the boundary layer close to the dune surface so plays an important secondary role in dune system dynamics by affecting sand capture and deflecting flow. Most coastal plants on dunes will lodge in a high energy coastal environment. Lodging occurs when an increasing wind speed changes the effective plant canopy density as the plants bend over and alters the surface roughness. However, in a coastal environment wind velocity and direction can vary rapidly and cause a dynamic lodging response from dune plants which can mean the perceived roughness of the dune surface is not constant. A dynamic vegetation roughness model has been developed that captures this aspect of plant behaviour on coastal dunes. Initial models have been developed from field experiment data to represent vegetation lodging for some common dune plants. It is seen that vegetation position on the dune also affects surface roughness values. Dynamic roughness models have been implemented into Computational Fluid Dynamics simulation software and comparisons of flows over representative dune geometries are made with other simpler representations of dune vegetation roughness. The implications of using this new vegetation model in understanding how coastal dune systems respond to wind conditions will be discussed along with improvements that can be made to the model.
Mathematical methods in continuum mechanics and wave theory, Friday 11:30-11:55 Room 401-307

The foundation of a generalized parallel connection

Matt Baker[2], *Oliver Lorscheid*[3], **Zach Walsh**[1], *Tianyi Zhang*[2]

[1]Auburn University, [2]Georgia Institute of Technology, [3]University of Groningen

The foundation of a matroid is an algebraic invariant that controls representations over any partial field, hyperfield, or more generally, any pasture. We show that, under certain conditions, the foundation of a generalized parallel connection of two matroids is the relative tensor product of their foundations. We apply this to show that the foundation of a 2-sum of two matroids is the absolute tensor product of their foundations. This is joint work with Matt Baker, Oliver Lorscheid, and Tianyi Zhang.
Structural aspects of matroids and graphs, Tuesday 16:00-16:25 Room 303-B09

Harmonic Chain Barcode and Stability

Salman Parsa[2], **Bei Wang**[1]

[1]University of Utah, [2]DePaul University

The persistence barcode is a topological descriptor of data that plays a fundamental role in topological data analysis. Given a filtration of the space of data, a persistence barcode tracks the evolution of its homological features. In this paper, we introduce a novel type of barcode, referred to as the canonical barcode of harmonic chains, or harmonic chain barcode for short, which tracks the evolution of harmonic chains. As our main result, we show that the harmonic chain barcode is stable and it captures both geometric and topological information of data. We also discuss an algorithm to compute the harmonic chain barcode. Consequently, a harmonic chain barcode can be utilized in applications in which a persistence barcode is applicable, such as feature vectorization and machine learning. Our work provides strong evidence in a growing list of literature that geometric (not just topological) information can be recovered from a persistence filtration.
Applied and Computational Topology, Tuesday 16:00-16:25 Room 260-223

Positive mass theorem and positive scalar curvature for singular metrics

Xianzhe Dai[1], *Yukai Sun*[2], **Changliang Wang**[3]

[1]University of Californai, Santa Barbara, [2]Peking University, [3]Tongji University

The positive mass theorem of Schoen-Yau and Witten is one of the fundamental results about scalar curvature. It is closely related to the existence problem of positive scalar curvaure metrics. The studies of weak notions of positive scalar curvature motivate to the studies of these problems for singular metrics. In this talk, I will review some previous results on this topic, and talk about our work on positive mass theorem and Geroch type theorem for metrics with isolated

conical singularities. This is a joint work with Professor Xianzhe Dai and Dr. Yukai Sun.
Index Theory in Geometry and Mathematical Physics, Monday 15:00-15:25 Room 260-022

Discontinuous non-equilibrium phase transition in Schloegl's second model for autocatalysis

Chi-Jen Wang[1], *Da-Jiang Liu*[2], *James W. Evans*[2, 3]

[1]Department of Mathematics, National Chung Cheng University, [2]Ames Laboratory—USDOE, Iowa State University, [3]Department of Physics & Astronomy and Department of Mathematics, Iowa State University

Bistable nonequilibrium systems are realized in catalytic reaction-diffusion processes, biological transport and regulation, spatial epidemics, etc. Behavior in spatially continuous formulations, described at the mean-field level by reaction-diffusion equations (RDEs), often mimics that of classic equilibrium van der Waals type systems. When accounting for noise, similarities include a discontinuous phase transition at some value, p_{eq}, of a control parameter, p with metastability and hysteresis around p_{eq}. For each p, there is a unique critical droplet of the more stable phase embedded in the less stable or metastable phase which is stationary (neither shrinking nor growing), and with size diverging as $p \to p_{eq}$. Spatially discrete analogs of these mean-field formulations, described by lattice differential equations (LDEs), are more appropriate for some applications. It is recognized that LDEs can exhibit richer behavior than RDEs, specifically propagation failure for planar interphases separating distinct phases. We consider Schloegl models to show this feature, together with an orientation dependence of planar interface propagation also deriving from spatial discreteness, results in the occurrence of entire families of stationary droplets. The extent of these families increases approaching the transition and can be infinite if propagation failure is realized. In addition, there can exist a regime of generic two-phase coexistence where arbitrarily large droplets of either phase always shrink. Such rich behavior is qualitatively distinct from that for classic nucleation in equilibrium and spatially continuous nonequilibrium systems.
Stochastic Differential Equations, Thursday 14:30-14:55 Room 260-016

Mass lower bounds for asymptotically locally flat manifolds

Jian Wang[1]

[1]Chinese Academy of Science

The ADM mass, a crucial global geometric invariant, intricately relates with scalar curvature in the different setting. I will explain the relation between asymptotically locally flat (ALF) 4-manifolds and their ADM mass. Specifically, I will talk about how the topology at infinity influences the ADM mass within the ALF setting.
Differential geometry and geometric analysis, Friday 14:00-14:25 Room 260-005

Partial sum of the Möbius function under the Riemann hypothesis

Liang Wang[1]

[1]UNSW Canberra at ADFA

Let $M(x)$ denote the partial sum of the Möbius function up to x, commonly known as the Mertens function. The study of this function holds significant importance in analytic number theory, as the Riemann hypothesis (RH) is equivalent to the estimate $M(x) = O(x^{1/2+o(1)})$. Following a series of works by Landau, Titchmarsh, Maier and Montgomery, Soundararajan, and Balazard and de Roton, the stronger estimate $M(x) = O(x^{1/2} \exp((\log x)^{1/2}(\log \log x)^{5/2+o(1)}))$ is known under RH. By adopting a hybrid Euler–Hadamard product into Soundararajan's argument, we improve upon the preceding result. This is joint work with Nicol Leong.
Computational Number Theory and Applications, Tuesday 14:15-14:25 Room 405-422

The dynamics of the quasi-Keplerian flow

Shixiao Wang[1]

[1]Auckland University

It is a fundamental question for the evolution of an accretion disk surrounding a black hole: Does the swirling fluid motion of an accretion disk ever become turbulent? The motion of an accretion disk has been extensively studied both experimentally and numerically in the past two decades by using a prototype flow model, the quasi-Keplerian flow, a special type of Taylor-Couette flow with restricted flow parameters. It has been found that the quasi-Keplerian flows preserve laminar states for all the high Re numbers applied. This is in sharp contrast to all other shear flows, which, as observed, will eventually go to turbulent states at sufficiently high Re numbers. In this talk, I will present a viscous extension of Arnold's flow stability theory developed by our research group and a crucial connection to the specific dynamics of the quasi-Keplerian flow as stated above. Namely, Taylor-Couette flow's nonlinear axisymmetric flow stability can be established precisely within the quasi-Keplerian flow regime. The method engaged cannot be extended to the flows beyond this flow regime. It seems to suggest that the nonlinear axisymmetric flow stability of quasi-Keplerian flow may imply the 3D global flow stability, thus preserving its laminar state. I will discuss relevant pieces of evidence that support this conjecture.
Recent advances in mathematical fluid dynamics, Friday 14:30-14:55 Room 401-311

Finding the number of latent states in hidden Markov models using information criteria

Ting Wang[1], *Jodie Buckby*[1], *David Fletcher*[2], *Jiancang Zhuang*[3], *Akiko Takeo*[4], *Kazushige Obara*[4]

[1]University of Otago, [2]David Fletcher Consulting Limited, [3]Institute of Statistical Mathematics, [4]University of Tokyo

Hidden Markov models (HMMs) are often used to model time series data and are applied widely in many fields of research. However, estimating the unknown number of hidden states in the Markov chain is a non-trivial component of HMM model selection and an area of active research. Currently, AIC and BIC are commonly used for this purpose, despite theoretical issues and some evidence of poor performance in the literature. Here, motivated by the HMMs developed to model seismic tremor data, we use simulation studies to compare the performance of a number of information criteria when used to select the number of hidden states in HMMs, and propose an adjusted BIC not previously used with HMMs. We find that AIC and BIC are not always reliable tools for selecting the number of hidden states in HMMs and that other information criteria such as adjusted BIC can actually perform better, depending on factors such as sample size and sojourn times in each state. We apply the information criteria to a set of HMMs fitted to seismic tremor data and compare the models selected by the different criteria.

Recent developments in data science and machine learning, Monday 14:00-14:25 Room 402-220

Hierarchical Bayesian inverse problems: a high-dimensional statistics viewpoint

Nathan Waniorek[1], *Daniel Sanz-Alonso*[1]

[1]University of Chicago

We analyze hierarchical Bayesian inverse problems using techniques from high-dimensional statistics. Our analysis leverages a property of hierarchical Bayesian regularizers that we call approximate decomposability to obtain non-asymptotic bounds on the reconstruction error attained by maximum a posteriori estimators. The new theory explains how hierarchical Bayesian models that exploit sparsity, group sparsity, and sparse representations of the unknown parameter can achieve accurate reconstructions in high-dimensional settings.

Stochastic and Deterministic Inverse Problems, Thursday 12:00-12:25 Room 260-040

Difference sets in Diophantine approximation

Victor Beresnevich[2], *Shreyasi Datta*[2], *Anish Ghosh*[3], **Benjamin Ward**[1]

[1]La Trobe University, [2]University of York, [3]Tata Institute of Fundamental Research (TIFR)

I will present a general framework of badly approximable points in a metric space X equipped with a σ-finite Borel regular measure μ. We establish that under mild assumptions the μ-measure of the set of badly approximable points is always zero. The result is achieved by introducing and establishing a 'constant invariance' property for a large class of limsup sets of neighbourhoods of subsets of a metric measure space. Time dependent I will show a variety of settings in Diophantine approximation and dynamical systems that the framework can be applied to.
Arithmetic Geometry and Number Theory, Monday 14:45-14:55 Room 405-430

Jointly estimating epidemiological dynamics of Covid-19 from case and wastewater data in Aotearoa New Zealand

Leighton Watson[1], *Michael Plank*[1], *Bridget Armstrong*[2], *Joanne Chapman*[2], *Joanne Hewitt*[2], *Helen Morris*[2], *Alvaro Orsi*[2], *Michael Bunce*[2], *Christl Donnelly*[3], *Nicholas Steyn*[3]

[1]University of Canterbury, [2]ESR, [3]University of Oxford

Timely and informed public health responses to infectious diseases such as COVID-19 necessitate reliable information about infection dynamics. The case ascertainment rate (CAR), the proportion of infections that are reported as cases, is typically much less than one and varies with testing practices and behaviours, making reported cases unreliable as the sole source of data. The concentration of viral RNA in wastewater samples provides an alternate measure of infection prevalence that is not affected by clinical testing, healthcare-seeking behaviour or access to care. We construct a state-space model with observed data of levels of SARS-CoV-2 in wastewater and reported case incidence and estimate the hidden states of the effective reproduction number, R, and CAR using sequential Monte Carlo methods. We analyse data from 1 January 2022 to 31 March 2023 from Aotearoa New Zealand. Our model estimates that R peaks at 2.76 (95% CrI 2.20, 3.83) around 18 February 2022 and the CAR peaks around 12 March 2022. We calculate that New Zealand's second Omicron wave in July 2022 is similar in size to the first, despite fewer reported cases. We estimate that the CAR in the BA.5 Omicron wave in July 2022 is approximately 50% lower than in the BA.1/BA.2 Omicron wave in March 2022. Estimating R, CAR, and cumulative number of infections provides useful information for planning public health responses and understanding the state of immunity in the population. This model is a useful disease surveillance tool, improving situational awareness of infectious disease dynamics in real-time.
Contributed Session A, Thursday 15:00-15:25 Room 303-B11

Performance analysis of the activated sludge model number 1 in a two reactor cascade

Simon Watt[1]

[1]UNSW Canberra

We consider the activated sludge process in a two reactor cascade with an ideal settling unit. The process configuration contains a settling unit and a recycle unit. We investigate how the removal of organic carbon and total nitrogen depend upon the hydraulic retention time as well as the process configuration, namely the impact of aeration, the presence of a settling unit, and recirculation of mixed liquor from the second reactor to the first reactor. As the hydraulic retention time increases from zero there are two critical values, each being a transcritical bifurcation. Organic carbon can only be removed for values of the retention time higher than the first critical value. Removal of organic nitrogen occurs in conjunction with the removal of organic carbon. Autotrophic biomass are only viable for values of hydraulic retention larger than the second critical value. Inorganic nitrogen can only be significantly removed when autotrophic biomass are present. However, the removal of inorganic nitrogen is significantly influenced by the process configuration.
Industrial Mathematics, Friday 12:00-12:25 Room 402-211

The volume entropy rigidities for RCD spaces

Guofang Wei[1]

[1]University of California at Santa Barbara

The volume entropy is a fundamental geometric invariant defined as the exponential growth rate of volumes of balls in the universal cover. It is a very subtle invariant which has attracted extensive study. The fundamental rigidity results here are the maximal volume entropy rigidity result of Ledrappier-Wang and the minimal volume rigidity theorem of Besson-Courtois-Gallot. The latter is a far reaching generalization of various famous rigidity results such as the Mostow rigidity for hyperbolic manifolds. We will report on joint work with Chris Connell, Xianzhe Dai, Jesus Nunez-Zimbron, Requel Perales, Pablo Suarez-Serrato concerning the generalizations to RCD spaces of these rigidity results.
Recent advances in geometric PDE, Tuesday 11:30-12:20 Room 260-057

Leveraging free energy in pretraining model selection for improved fine-tuning

Susan Wei[1]

[1]Monash University

Recent advances in artificial intelligence have been fueled by the development of foundation mod-

els such as BERT, GPT, T5, and Vision Transformers. These models are first pre-trained on vast and diverse datasets and then adapted to specific downstream tasks, often with significantly less data. However, the mechanisms behind the success of this ubiquitous pretrain-then-adapt paradigm remain under-explored, particularly the characteristics of pre-training checkpoints that lend themselves to good downstream adaptation. We introduce a Bayesian model selection criterion, called the downstream free energy, which quantifies a checkpoint's adaptability by measuring the concentration of nearby favorable parameters for the downstream task. We demonstrate that this free energy criterion can be effectively implemented without access to the downstream data or prior knowledge of the downstream task. We provide empirical evidence that the free energy criterion reliably correlates with improved fine-tuning performance of pretraining checkpoints, offering a principled approach to predicting adaptability.
Recent developments in data science and machine learning, Tuesday 11:30-11:55 Room 402-220

Tensor maximum principle and its applications

Yong Wei[1]

[1]University of Science and Technology of China

Tensor maximum principle was introduced by Hamilton in 1982 to prove that 3D Ricci flow preserves the positivity of Ricci curvature. Since then it has been used to find curvature / convexity conditions preserved in many geometric flows. In this talk, we first describe Andrews' (2007) generalized tensor maximum principle and discuss our applications in proving convexity preserving along volume preserving curvature flows in hyperbolic space; then we will introduce a new generalized tensor maximum principle with suitable boundary condition and use it to study curvature flows for hypersurfaces with capillary boundary. This talk is based on some joint work with Ben Andrews, Yingxiang Hu, Haizhong Li, Bo Yang and Tailong Zhou.
Mathematics of nonlinear diffusion processes, Friday 14:00-14:50 Room 260-018

Counting points on character varieties

Bailey Whitbread[1]

[1]University of Queensland

This talk is about two closely-related varieties called the multiplicative and additive character varieties. We study these varieties by counting their points over finite fields, an idea going back to the Weil conjectures, and prove the number of points is polynomial. We discuss striking features of these polynomials, such as their non-negative and palindromic coefficients. Using Julia, we quickly and automatically compute these polynomials, making their study amenable to machine learning techniques. This talk contains recent work with Masoud Kamgarpour, GyeongHyeon Nam and Stefano Giannini, found in our preprint https://arxiv.org/abs/2409.04735.
Arithmetic Geometry and Number Theory, Monday 14:00-14:10 Room 405-430

Reaching the equilibrium: Long-term stable numerical schemes for SPDEs

Joern Wichmann[1], *Kim-Ngan Le*[1], *Jerome Droniou*[1, 2]

[1]Monash University, [2]Centre national de la recherche scientifique (CNRS)

Partial Differential Equations appear in many applications, such as modelling of fluids, porous media and superconductors, and are typically derived from physical principles. In extreme cases (e.g. at very fast or small scales), additional features need to be considered: Randomness takes into account model uncertainties that arise, for example, from thermal fluctuations and measurement errors. This motivates the use of SPDEs to improve the model's accuracy. In many cases, these models possess an energy structure, which characterises the stationary states of these systems. Unsteady solutions eventually tend to a steady state by dissipating their energy. In this talk, we will explain how transport noise, a specific stochastic structure, enables full understanding of the energy dissipation of generalised Stokes' equations and how this relates to the stochastic steady state – an invariant measure. Moreover, we discuss how the energy dissipation can be preserved on the discrete level for a broad class of spatial discretisations. We conclude with numerical simulations.

Stochastic Differential Equations, Friday 12:00-12:25 Room 260-016

Semigroups of modules

Roger Wiegand[1], *Sylvia Wiegand*[1]

[1]University of Nebraska

Let R be a commutative, local, Noetherian ring. A "semigroup of modules" is a set of isomorphism classes of finitely generated R-modules that is closed under finite direct sums. Which semigroups can occur in this way? For example, can one have a relation such as $a+a = b+b+b$, where a and b are indecomposable? What about the relation $a+b = c+c+c$? We will consider such relations and show that some cannot exist, and also show by example that others are possible. This talk is dedicated to the memory of Nick Baeth,

50 years of Communications in Algebra, Tuesday 16:30-16:55 Room 303-G15

Prime ideals in polynomial-power series rings

Sylvia Wiegand[1], *Ela Celikbas*[1], *Christina Eubanks-Turner*[1]

[1]University of Nebraska

We describe the partially ordered sets that arise as prime spectra of two-dimensional homo-

morphic images of commutative Noetherian rings of power series or polynomials. Let R be a countable, one-dimensional Noetherian domain with infinitely many maximal ideals, let k be a countable field, and let x, y, z be indeterminates over R or k. For Q a height-one prime ideal not containing x, we characterize the prime spectra of $R[y][[x]]/Q$, of $R[[x]][y]/Q$, and of $k[[x]][z, y]/Q$, The characterization depends on the choice of Q. For the field $\mathbf{Q}$ of rational numbers, no characterization of Spec $(\mathbf{Q}[y, z])$ as a partially ordered set is known. Thus we cannot characterize Spec $(\mathbf{Q}[[x]][y, z]]/(x))$.
50 years of Communications in Algebra, Tuesday 15:00-15:25 Room 303-G15

From Kleinian singularities to rational elliptic surfaces

Graeme Wilkin[1]

[1]University of York

A famous construction of Kronheimer shows that all hyperkahler ALE four manifolds have underlying complex manifolds given by deformations and/or resolutions of Kleinian singularities. More recently, Chen and Chen's classification shows that all hyperkahler ALG spaces have underlying complex manifolds given by removing a fibre from certain rational elliptic surfaces. In this talk I will explain a general construction that uses Brieskorn's theorem to relate these two classes of complex manifolds, and then describe joint work in progress with Rafe Mazzeo in which we aim to give a new construction of the hyperkahler ALG metrics for the type A case.
Index Theory in Geometry and Mathematical Physics, Wednesday 11:30-11:55 Room 260-022

Representation stability and K-theory

Rufus Willett[1]

[1]University of Hawai'i at Mänoa

Let G be a group that is finitely presented with finite generating set S, and finite set of relations R so each element of R is a finite string of letters from S. For example, if G is the free abelian group of rank two, then one can take $S = \{a, b\}$, and $R = \{aba^{(-1)}b^{(-1)}\}$. A (finite-dimensional, unitary) representation of G is the same thing as a map from S to a finite-dimensional unitary group with the property that all words in R get sent to the identity. Representation stability asks the following question: if one has a map from S to a unitary group that sends all words in R 'close' to the identity, then is the map 'close' to another map that actually sends all elements of R to the identity. The answer is 'no' in general: there are topological obstructions as shown by Kazhdan, Voiculescu, Loring, Exel, and others. I'll explain these obstructions, and what happens when they vanish. The key tools come from K-theory, C*-algebra classification theory, and the Baum-Connes conjecture; I won't assume prior knowledge of those things.
Functional Analysis and Operator Algebras, Friday 14:00-14:25 Room 260-055

Biochemical reaction networks and reflected diffusions

Ruth Williams[1], *Felipe Campos, Saul Leite*

[1]UC San Diego

Leite and Williams have proposed certain reflected diffusion processes as approximations to continuous time Markov chain models frequently used to model biochemical reaction networks. These diffusions live in the positive orthant of d-dimensional space and are confined there by a smoothly varying oblique reflection field on the boundary. Leite and Williams showed that, under mild conditions, these diffusions can be obtained as weak limits of certain jump-diffusion extensions of the traditional Langevin approximations, and therefore called these constrained Langevin approximations. In this talk, we will review this approximation and describe some progress on proving error estimates for strong versions of this approximation and also describe some remaining open problems.

Probability and Mathematical Statistics, Tuesday 12:00-12:25 Room 260-098

Verifiable categorification of Characteristic subgroups

James Wilson[1], *Peter Brooksbank*[2], *Heiko Dietrich*[3], *Joshua Maglione*[4], *Eamonn O'Brien*[5]

[1]Colorado State University, [2]Bucknell University, [3]Monash University, [4]University of Galway, [5]University of Auckland

A structure is characteristic if it is invariant under automorphisms. We prove that all characteristic structure arises from a representation theory of categories acting on one another. I will discuss the implications to isomorphism testing and formal verification.

Groups, actions and computations, Monday 14:00-14:50 Room 260-051

Maths Craft in a Box

Phil Wilson[1]

[1]University of Canterbury

Maths Craft New Zealand is New Zealand's largest mathematics outreach initiative, having reached over 37, 000 people, with over NZ$1 million in funding. A major focus of recent years has been Maths Craft in a Box, with Box 1 being a free, self-contained Box dedicated to exploring fractals in the school classroom aimed primarily at years 7-13. Over 400 schools and 20, 000 students nationwide have received the Box. The Box contains craft supplies to make fractal sculptures, reusable student zines designed to be a guided and reflective introduction to the mathematics of fractals, and instructional videos. Teacher resources include a teacher version of the zine, lesson outlines, and curriculum links. In this talk, we will present the design and development process for the Box, which involved mathematicians, a designer specialising in science communication, and an education researcher who is a former teacher. Central to the successful development process was the inclusion from the start of all of these areas of expertise. We will discuss the prototyping and pilot stages of the Box, the gathering of teacher and student feedback, and the refinement of the Box from local pilot to national release. We will also touch on some of the theory behind the embodied mathematics of Maths Craft, and our plans for future Boxes.

Engagement with mathematics through communication and outreach, Tuesday 14:00-14:25 Room 260-040

Parabolic subgroups of Artin groups via categorification. Preliminary report.

Sinead Wilson[1]

[1]Australian National University

Recent work of Cumplido, Gebhardt, Gonzales-Meneses and Wiest, and of Morris-Wright, has defined the complex of (irreducible, spherical) parabolic subgroups associated to an Artin group. This complex plays an analogous role to the curve complex of a surface; in the case of an Artin braid group on n strands, it coincides with the curve complex of the $n + 1$-punctured disk. In this talk we outline a new approach to studying the complex of parabolic subgroups using methods from the categorical representation theory of Artin groups.

Representation Theory and Tensor Categories, Thursday 12:00-12:25 Room 303-G14

How to Predict and Quantify the Impacts of Radical Tobacco Policies in New Zealand

Tim Wilson[1]

[1]University of Melbourne

The SHINE group at the University of Melbourne models the health and economic impacts of health interventions. In 2022, we contributed to a report by the New Zealand Ministry of Health on proposed groundbreaking tobacco legislation, which was passed but later repealed. This legislation sparked interest from researchers and policymakers around the world, which led us to extend and refine the model. For example, the model now supports highly detailed demographic groups, and has a more sophisticated treatment of vaping. The model simulates cohorts into the future, including their prevalence of the top 20-30 tobacco-related diseases, and the impact of reduced smoking prevalence on the incidence of those diseases. This is known as a proportional multi-state lifetable model, and it differs from many common types of health model in its natural handling of time lags between risk factors and diseases. For tobacco modelling, the risk factor distribution comes from a compartmental model of smoking and vaping behaviour. Calibrating smoking and vaping behaviour is one of the more difficult parts of developing the model, and it is a vital component because health interventions act on uptake and cessation rates. This presentation is a tour of the model: its background, structure, assumptions, and

the interesting optimisation problems that arose during its development.
Industrial Mathematics, Monday 16:00-16:25 Room 402-211

Online Estimation for Dairy Processing

James Winchester[1]

[1]Fonterra APC

Online estimation is fundamental for Advanced Process Control (APC). In Fonterra online estimation is widely used for APC, with applications across hundreds of processes and achieving significant financial benefit via Model Predictive Control applications. The ongoing development of online estimation is therefore a topic of significant interest for Fonterra. From simple Luenberger estimators, or Kalman Filtering estimators, to online batch estimation. The application of online estimation with Model Predictive Control will be explained. Why do we need online estimation and how does it work with Model Predictive Control? Various types of online estimation will then be explained, with extensions to hierarchical estimation, i.e., estimators that rely on other estimators, and so on. Finally, some simple examples used in Fonterra will be discussed.
Industrial Mathematics, Tuesday 12:00-12:10 Room 402-211

Taft algebras and Nichols algebras

Sarah Witherspoon[1]

[1]Texas A&M University

Earl Taft introduced Taft algebras as an important class of Hopf algebras in a 1971 Proceedings of the National Academy of Sciences paper. Warren Nichols introduced Nichols algebras, of which Taft algebras are examples, in a 1978 Communications in Algebra paper. These Taft and Nichols algebras later turned out to be prototypical subalgebras of some types of quantum groups and of related more general Hopf algebras, fundamental to understanding their structure. In this talk, we will describe these algebras in historical context. We will mention selectively some current research landscapes in which Taft and Nichols algebras appear.
50 years of Communications in Algebra, Tuesday 14:00-14:25 Room 303-G15

The distribution of zeros of the derivative of the Riemann Zeta function via random unitary matrices

Nicholas Witte[1]

[1]Victoria University of Wellington

In 1935 Speiser formulated an equivalent statement to the Riemann hypothesis in terms of the zeros of the derivative of the Riemann zeta function: that $\zeta'(s)$ has no zeros to the left of the critical line, $Re(s) < 1/2$. We accept this statement and pose the question of the location of such zeros to the right of the critical line $Re(s) < 1/2$, focusing on those high up the imaginary axis. However we are not going to consider individual zeros but adopt a statistical approach to the limitless number of zeros at our disposal and consider the empirical distribution of these with respect to their horizontal distance from the critical line. We model $\zeta'(s)$ by the derivative of the characteristic polynomial of a random matrix drawn from U(N) according to Haar measure, an approach initiated by Mezzadri 2003 and developed further by Dueñez et al 2010, and deduce the radial distribution of its zeros within the unit circle, which corresponds to the region on the right-hand side of the critical line. However we reveal that this distribution is determined by an integrable system, namely a degenerate member of the Garnier family of the triple variable extension to the univariate Painlevé equations. One can then leverage this fact to infer knowledge about the distribution as N grows. The correspondence of our distribution with data from the Riemann zeta function is remarkable and predicts the curious features observed in the latter.

Discrete and continuous integrable systems: geometry analysis and applications, Wednesday 10:30-11:20 Room 260-036

EDMD errors in chaotic and random dynamics: qualitatively similar but quantitatively different

Caroline Wormell[1]

[1]The University of Sydney

Koopman operators provide a powerful, general mathematical framework to study dynamical systems, particularly for systems with mixing dynamics. Their eigenvalues and eigenfunctions providing simple and often effective reductions of the system's dynamics. These operators and their spectral information can often be approximated from time series data, but the numerical stability of this remains somewhat mysterious. In this talk, I will discuss some rigorous results around one kind of Koopman operator discretisation (Extended Dynamical Mode Decomposition) in the underfitting regime for two types of dynamics: stochastic, and uniformly expanding chaotic dynamics. In both cases the finite data error is of central limit theorem form as expected. However, in deterministic chaos, the constants associated to the central limit theorem are much more sensitive to dictionary size than in stochastic systems. This is because for stochastic systems the Koopman operator has interesting discrete spectrum in L^2, whereas in chaotic systems the discrete spectrum is revealed only in differentiable function spaces. Hence, valid approximation of the Koopman operator in chaotic systems may depend upon some kind

of control of derivatives.
Recent developments in data science and machine learning, Monday 16:00-16:25 Room 402-220

On the exponential integrability of the derivative of intersection and self-intersection local time for Brownian motion and related processes

Binghao Wu[1], *Gregory Markowsky, Kaustav Das*

[1]Monash University

We show that the derivative of the intersection and self-intersection local times of alpha-stable processes are exponentially integrable for certain parameter values. This includes the Brownian motion case. We also discuss related results present in the literature for fractional Brownian motion, and in particular give a counter-example to a result in [Guo, J., Hu, Y., and Xiao, Y., Higher-order derivative of intersection local time for two independent fractional Brownian motions, Journal of Theoretical Probability 32, (2019), pp. 1190-1201] related to this question.
Probability and Mathematical Statistics, Monday 16:15-16:25 Room 260-098

Explicit relation between invariants from Eisenstein series and theta lifts, with an application to Arthur packets

Chenyan Wu[1]

[1]The University of Melbourne

To a cuspidal automorphic representation of a classical group or a metaplectic group and a conjugate self-dual character, we associate an Eisenstein series and a family of representations that are called theta lifts. We establish a precise relation between the poles of the Eisenstein series and the lowest occurrence index among the theta lifts. As an application, we derive some properties of Arthur packets and L-functions.
Arithmetic Geometry and Number Theory, Tuesday 16:45-16:55 Room 405-430

Reverse Mathematics of Theorems in Lattice Theory

Guohua Wu[1]

[1]Nanyang Technological University Singapore

In this talk, I will present some recent results of the logical strength of theorems in lattice theory. In particular, we consider the existence of maximal ideals, prime ideals in countable lattices $(L; \leq, \vee, \wedge, 0, 1)$. We will show that the Dedekind-Birkhoff theorem (a lattice L is distributive

if and only if neither N_5 nor M_3 cannot be embedded into L) can be proved in RCA_0. We will also consider the strength of the extension of ideals to prime ideals and maximal ideals in countable lattices. It is a joint work with Ru Junren.
Computability Theory and Applications, Tuesday 16:30-16:55 Room 303-B07

From directed graphs of groups to Kirchberg algebras

Victor Wu[1]

[1]The University of Sydney

Directed graph algebras have long been studied as tractable examples of C*-algebras, but they are limited by their inability to have torsion in their K_1-group. Graphs of groups, which are famed in geometric group theory because of their intimate connection with group actions on trees, are a more recent addition to the C*-algebra scene. In this talk, I will introduce the child of these two concepts—directed graphs of groups—and describe how their algebras inherit the best properties of its parents', with a view to outlining how we can use these algebras to model a class of C*-algebras (stable UCT Kirchberg algebras) which is classified completely by K-theory.
Functional Analysis and Operator Algebras, Tuesday 14:30-14:55 Room 260-055

Coefficient-based lq- regularized direct learning for estimating individual treatment rule

Daohong Xiang[1]

[1]Zhejiang Normal University

The aim of precision medicine is to identify the best treatment approach for each individual patient by taking into account their unique characteristics. This involves developing a decision function, known as an individual treatment rule (ITR), which maximizes the expected clinical outcome. Direct learning (D-learning) is one of the main algorithms estimating the optimal ITR. In this talk, we mainly study the coefficient-based D-learning with lq -regularizer (where $1 < q \leq 2$) with unbounded clinical outcome. We establish the error bounds for the algorithm by constructing the stepping stone function and applying concentration inequality with empirical covering numbers. Fast learning rates are derived explicitly under a moment condition on the clinical outcome.
Recent developments in data science and machine learning, Thursday 11:30-11:55 Room 402-220

Periodic braids and slicings

Oded Yacobi[1], *Anthony Licata*[2], *Ed Heng*[3]

[1]The University of Sydney, [2]The Australian National University, [3]IHES

I will explain how a new relationship between period braids and slicings on triangulated categories. This is part of a bigger project, on connections between Coxeter theoretic structures in braids groups, dynamical properties of mapping class groups, and homological algebra. Joint work with Ed Heng and Tony Licata.
Representation Theory and Tensor Categories, Friday 11:30-11:55 Room 303-G14

Asymptotic decay for defocusing semilinear wave equations

Shiwu Yang[1]

[1]Peking University

In this talk, I will talk about global behaviors for solutions of energy subcritical defocusing semilinear wave equations with pure power nonlinearity. We prove various type of decay estimates for the solutions in Minkowski space for all space dimensions. The proof is based on vector field method with new multipliers. We also extend similar results to the Schwarzschild black hole spacetimes and to the Chern-Simons-Higgs model in planar physics. These are based on joint works with H. Mei and D. Wei.
Harmonic analysis and Hamiltonian PDE, Thursday 11:30-12:20 Room 260-028

An Exact Method for the Bi-objective p-median Max-sum Diversity Problem

Yingying Yang, *Hoa Bui*, *Ryan Loxton*

[1]Curtin University

In this talk, we introduce a bi-objective facility location problem with two conflicting objectives. The first objective is to minimize the total distance between the selected p facilities and the end users they serve (commonly referred to as the p-median objective). The second objective is to maximize the total distance between the selected facility locations (commonly referred to as the max-sum diversity objective). The problem follows the bi-level max-sum framework by including a dispersion constraint that prevents selecting two facilities that are within a certain specified distance of each other. If this distance is too large, then the problem is infeasible. Determining an upper bound for feasibility requires solving a max-min dispersion problem, and we develop an improved bi-section search algorithm for doing this, which is more efficient than current exact methods. Then, for the bi-objective p-median max-sum diversity problem (with a fixed value for the distance cut-off in the dispersion constraint), we develop an exact algorithm based on the epsilon-constraint method for determining all Pareto optimal solutions. This

involves repeatedly solving a subproblem with quadratic constraints (arising from the quadratic diversity objective), and we combine tangent cutting planes with Benders decomposition to accelerate convergence. Computational results on the GKD-d dataset demonstrate that our exact method is effective for large instances with up to 500 locations.
Optimisation, Tuesday 16:00-16:25 Room 402-221

Stochastic Inverse Problem: stability, regularization, and Wasserstein gradient flow

Qin Li[2], *Maria Oprea*[1], *Li Wang*[3], **Yunan Yang**[1]

[1]Cornell University, [2]UW Madison, [3]UMN Twin Cities

Inverse problems in physical or biological sciences often involve recovering an unknown parameter that is random. The sought-after quantity is a probability distribution of the unknown parameter that produces data that aligns with measurements. Consequently, these problems are naturally framed as stochastic inverse problems. In this talk, we explore three aspects of this problem: direct inversion, variational formulation with regularization, and optimization via gradient flows, drawing parallels with deterministic inverse problems. A key difference from the deterministic case is the space in which we operate. Here, we work within probability space rather than Euclidean or Sobolev spaces, making tools from measure transport theory necessary for the study. Our findings reveal that the choice of metric — both in the design of the loss function and in the optimization process — significantly impacts the stability and properties of the optimizer.
Stochastic and Deterministic Inverse Problems, Thursday 14:00-14:25 Room 260-040

A pair of Garside shadows

Piotr Przytycki[1], **Yeeka Yau**[2]

[1]McGill University, [2]The University of Sydney

Motivated by the word problem in Artin-Tits monoids, Dehornoy, Dyer, and Hohlweg introduced Garside shadows in Coxeter groups - a subset that contains the simple reflections S and is closed under suffix and join. Dyer and Hohlweg showed that every Coxeter group admits finite Garside shadows. These structures have proven to be deeply connected to objects such as finite state automata and hyperplane arrangements, leading to several exciting discoveries in recent years. In this talk, we will present an overview of the theory of Garside shadows, with a focus on two canonical examples: the gates of the Cone type partition and the set of Low elements. We will also highlight several intriguing open questions. This is joint work with Piotr Przytycki.
Groups and Geometry, Friday 12:00-12:25 Room 260-092

Partition ranks and cranks from a combinatorial point of view

Ae Ja Yee[1]

[1]Penn State University

These results are unified by a common technique in q-series noted in a single paper by Hansraj Gupta in the 1970s, but otherwise forgotten except to the field of combinatorial geometry. We will conclude this talk with at least one conjecture.
Special Functions, q-Series and Beyond, Monday 14:00-14:50 Room 401-312

Optimal Rates for Gradient Descent Methods with Two-layer ReLU Networks

Yiming Ying[1]

[1]The University of Sydney

Recently, there have been numerous studies focusing on understanding the generalisation of neural networks trained by gradient descent methods in the Neural Tangent Kernel (NTK) regime. One central question is to obtain their optimal statistical rates, comparable to those achieved by gradient descent methods in the kernel setting. While the existing work addressed this question, they either require the smallest eigenvalue of the NTK Gram matrix to be strictly larger than 0 or only focus on smooth activation functions. In this talk, I will present our recent work on generalisation analysis of both gradient descent (GD) and stochastic gradient descent (SGD) for two-layer ReLU networks without imposing restrictive conditions on the NTK Gram matrix. In particular, we show that optimal excess risk rates can be achieved by GD and SGD for training two-layer networks with the non-smooth ReLU activation function if the network width grows polynomially with the size of the training data. These rates are on par with those in the classical RKHS setting. This is joint work with Puyu Wang, Junyu Zhou, Yunwen Lei, and Jun Fan.
Recent developments in data science and machine learning, Thursday 15:00-15:25 Room 402-220

On the hierarchy above ATR_0

Keita Yokoyama[1]

[1]Tohoku University

In the study of reverse mathematics, many mathematical theorems are classified into the big five subsystems of second-order arithmetic. Among these systems, the gap between the fourth system, ATR_0, and the fifth (strongest) system, Π^1_1-CA_0, is relatively large, with many mathematical theorems falling in between. These theorems are often described by Π^1_2-sentences. However, it is known that no Π^1_2-sentence can imply Π^1_1-CA_0, indicating they must be strictly weaker than Π^1_1-CA_0. In this talk, we examine the hierarchy above ATR_0 to calibrate these theorems within the frameworks of reverse mathematics and Weihrauch degrees. This is a joint work with Yudai Suzuki.

Computability Theory and Applications, Friday 12:00-12:25 Room 303-B07

Effectiveness of Littlewood-Paley theory in the study of turbulence and machine learning

Tsuyoshi Yoneda[1]

[1]Hitotsubashi University

In this talk, I will explain recent works on turbulence and machine learning in terms of scale decomposition. Goto-Saito-Kawahara (2017) employed the Littlewood-Paley decomposition applying to 3D Navier-Stokes turbulence. By direct numerical simulations, they discovered that each scale vortices transfer energy to the adjacent smaller scale vortices through stretching process. In this talk, I will explain that the vortex stretching spills over into the dissipation range and mathematically show that the vortex stretching truly enhances the dissipation rate. Next, I will explain that such scale decomposition method is also useful for machine learning (Reservoir computing). More specifically, I will present a future forecasting study of the El Niño phenomenon.

Recent advances in mathematical fluid dynamics, Tuesday 16:00-16:25 Room 401-311

Quotient order density of triangle groups

Darius Young[1]

[1]University of Auckland

For positive integers r, s and t, the ordinary (r, s, t) triangle group is the group with presentation $\langle x, y, z | x^r = y^s = z^t = 1\rangle$. Via their finite quotients, Triangle groups play a key role in the study of discrete structures with large automorphism groups, including regular and chiral maps, algebraic curves and compact Riemann surfaces. In this talk, I will introduce some powerful but relatively elementary techniques from number theory, which will help us answer an interesting question about the finite quotients of triangle groups. Namely, fixing a triangle group T, what is the probability that a "randomly chosen" natural number is the order of a finite quotient of T? Not only is the answer surprising, but the techniques used to derive it turn out to have a number of surprising applications for counting finite quotients of other groups as well.

Contributed Session B, Tuesday 16:00-16:25 Room 303-B11

Pattern formation in coiling of falling viscous threads

Will Sze[1], *Eusebius J. Doedel*[1], *Ida Karimfazli*[1], **Behrooz Yousefzadeh**[1]

[1]Concordia University

A viscous thread falling onto a moving surface creates a variety of stitch-like patterns depending on the fall height and the speed of the moving surface. When the height of the fall is low enough that inertial effects can be neglected, the patterns can be described by the geometry and elasticity of the thread at the contact point. A system of three ordinary differential equations, the geometric model (GM), already exists for this purpose. In this work, we report on a set of experiments that revisits the formation of coiling patterns at low fall heights. We compare the measurements with the predictions made by the GM and discuss the discrepancies between the two results. These deviations hint at unaccounted dynamics that merit further theoretical investigation.

New directions in pattern formation, Tuesday 14:30-14:55 Room 303-B11

Analysis of non-reciprocity in vibration transmission problems using continuation methods

Ali Kogani[1], *Andrus Giraldo*[2], **Behrooz Yousefzadeh**[1]

[1]Concordia University, [2]Korea Institute for Advanced Study

Reciprocity theorems describe important properties of vibration transmission problems. In typical structures (linear, time-invariant systems), the transmission characteristics remain invariant upon exchanging the locations of the source and receiver. Devices that do not operate with this restriction can be used for isolation or focusing of vibration energy. Understanding the mechanisms for nonrecirpocal vibration transmission is therefore important in designing devices for wave engineering. A common realization of nonreciprocal dynamics relies on implementation of nonlinear internal forces within the system. In this work, we highlight the application of numerical continuation techniques for the study of nonreciprocity in discrete models of mechanical systems. We identify and discuss different manifestations of nonreciprocity in systems of coupled oscillators. For nonreciprocal dynamics to exist, it is understood that the mirror symmetry of the system needs to be broken. We show that a second symmetry-breaking parameter can counteract the original asymmetry and ultimately restore reciprocal dynamics in a system with broken mirror symmetry, even at frequencies near the system resonances. Thus, breaking the mirror symmetry is shown to be a necessary but insufficient condition for realizing nonreciprocity.

Computational Methods and Applications of Dynamical Systems, Friday 12:00-12:25 Room 303-G20

Numerical analysis of a Biot–Kirchhoff–Love poro–thermoelastic plate model

Aamir Yousuf[1]

[1]Monash University

We investigate the well-posedness of a coupled hyperbolic-parabolic system that models the interaction between thermal effects and poromechanics in a Biot–Kirchhoff–Love plate. The unique solvability of the system is established through a Galerkin approach. Furthermore, we propose a discretization strategy employing a Newmark-nonconforming (C0-IP) scheme for displacement and a Crank–Nicolson-conforming scheme for thermal and fluid pressure moments. We demonstrate the convergence of both the semi- and fully discrete schemes to the weak solution, contingent on the additional regularity of the weak solution, which is proven by considering smooth initial data. Several numerical examples are presented to validate the theoretical findings.

Computational Mathematics, Tuesday 11:30-11:55 Room 402-231

Construction of plectonemic and stretched two-phase dynamics of DNA supercoiling

Biao Wan[1], **Jin Yu**[2]

[1]Beijing Computational Science Research Center, [2]University of California Irvine

DNA supercoils are generated in genome regulation processes such as transcription and replication and provide mechanical feedback. Under tension, a DNA supercoil can present a coexistence state of plectonemic (P) and stretched (S) phases. In current work, we developed a highly coarse-grained model of DNA supercoiling dynamics according to the P and S phases based on the polymer physics model of DNA, i.e., the worm-like chain (WLC) model. We identified fast toque transport dynamics along DNA within each phase and derived slow stochastic dynamics of the two-phase boundary upon averaging out the fast dynamics. With such developments, we captured the buckling transition in the DNA supercoiling generation, demonstrated quasi-equilibrium supercoiling accumulation during transcription, and reproduced the time-dependent supercoiling dynamics detected experimentally, in particular, on the plectoneme diffusion, nucleation, and hopping.

Topology, geometry and combinatorics of biopolymers, Thursday 11:30-11:55 Room 260-221

A "Soft" Framework for Designing Outreach About Mathematical Thinking

Louis Yudowitz[1], *Yudhi Bunjamin*[2]

[1]Kth Royal Institute of Technology, [2]UNSW

Currently, the prevailing method of doing mathematical outreach seems to be of the "hard" variety. That is, the activities are mainly designed around understanding a particular theorem and/or method of proof in order to train the next generation of mathematicians. This is not to say "hard" programs are detrimental. It merely means they are not necessarily the best form of outreach when communicating with people without a strong mathematical background or who are disinclined to engage with mathematical content. This is where a "soft" (that is, process driven) approach can come in handy. This design philosophy is concerned with creating workshops around general, robust learning outcomes related to elements of mathematical thinking. If designed well, such workshops allow us to engage with and make an impact on people of all levels of motivation and mathematical skill. In this talk, I will discuss the "soft" approach further and use a workshop currently being designed with Yudhi Bunjamin as an example of this approach in action.

Engagement with mathematics through communication and outreach, Monday 16:30-16:55 Room 260-040

Semi-Continuity of the Morse Index for Ricci Shrinkers

Louis Yudowitz[1]

[1]KTH Royal Institute of Technology

When studying the compactness theory for solutions to geometric PDEs, one can encounter the formation of singularities. This occurs, for instance, for sequences of harmonic maps, Einstein manifolds, minimal surfaces, and gradient shrinking Ricci solitons. Provided the singular set consists of isolated points, a common strategy to study them is to construct a "bubble tree" through an iterative blow-up procedure. Moreover, supplementing this with analytic, geometric, and topological arguments allows for the recovery of information lost due to the bubbling behavior. In this talk I will discuss bubbling for gradient Ricci shrinkers, with a focus on how it affects the stability of singularity models for Ricci flow. In particular, I will give an overview of how to prove upper and lower semi-continuity of the Morse index for Ricci shrinkers by studying a certain weighted eigenvalue problem. I will also explain how the same techniques can be applied to show a quantitative relation between the stability of an asymptotically conical Ricci shrinker and that of its asymptotic cone.

Recent advances in geometric PDE, Tuesday 16:00-16:25 Room 260-057

Dynamical Stability and Instability of Poincare-Einstein Manifolds

Louis Yudowitz[1], *Klaus Kröncke*[1]

[1]KTH Royal Institute of Technology

A lot of work in recent years has been devoted to proving the stability of Ricci solitons (of which Einstein manifolds are a special case) in the compact setting. These solitons evolve self-similarly under Ricci flow and arise as critical points of certain geometric functionals. On the other hand, the non-compact case still poses issues, in large part due to a lack of suitable functionals. In this talk, we will see how to overcome this for Poincaré-Einstein manifolds (that is, negative Einstein manifolds which are asymptotically hyperbolic) and develop a complete picture of their dynamical stability. In particular, stability will depend on the metric being a local maximizer of a relative entropy functional for asymptotically hyperbolic manifolds, which was recently introduced by Dahl–Kröncke–McCormick. The main technical tool is a Łojasiewicz-Simon inequality for the entropy. We will also see that stability is equivalent to a local positive mass theorem and a volume comparison result.

Differential geometry and geometric analysis, Friday 15:00-15:25 Room 260-005

Discrete Strichartz estimates in low dimensions

Po-Lam Yung[1]

[1]Australian National University

Sharp discrete Strichartz estimates had recently been obtained in 2+1 dimensions in a breakthrough work of Herr and Kwak. I will explain analytical aspects of their ingenious proof, and discuss the state of affairs in 1+1 dimensions. The latter is based on earlier joint work with Shaoming Guo and Zane Kun Li.

Harmonic analysis and Hamiltonian PDE, Tuesday 16:00-16:25 Room 260-028

Automated mathematics assessment: should I use it and how?

Adriana Zanca[1]

[1]The University of Melbourne

There are multiple automated assessment tools for mathematics available (as well as other tools that were not developed specifically for mathematics). Many of these (mathematics specific) tools are open source and have their origins in mathematics departments looking to embrace technology as part of their assessment structure and to give students further, and tailored, study resources. In this talk, I will compare experiences for staff and students (at an Australian university) implementing and using the following online homework systems: WebWork, STACK and Numbas. We found that all systems have an initial setup barrier, and each system has different strengths and weaknesses, on both the instructor side and student facing side. Beyond these systems themselves, I will also discuss how other online assessment systems can be used in mathematics courses to complement the available suite of mathematics specific automated systems and the role of humans in increasingly automated spaces.

Mathematics Education, Monday 16:15-16:25 Room 260-115

Skeins, Clusters and Wavefunctions

Eric Zaslow[1]

[1]Northwestern University

This talk will try to summarize recent work on the relation between q-difference equations, brane wavefunctions and cluster theory. I will try to make the talk a survey of ideas and constructions. That said, here are some details, for the interested reader. Recently with Gus Schrader and Linhui Shen, cluster theory was used to construct wavefunctions for branes in threespace and conjecturally relate them to open Gromov-Witten invariants. This was done by defining a quantum Lagrangian subvariety of a quantum cluster variety, and mutating a simple solution to the defining equations in a distinguished seed. (These defining equations are q-difference equations.) In this talk, we explain the above and extend the construction to incorporate the skein-theoretic approach to open Gromov-Witten theory of Ekholm-Shende, which is recent work with Gus Schrader and Mingyuan Hu. In particular, we define a skein-theoretic version of cluster theory, including the groupoid of seeds and mutations and a skein-theoretic version of the quantum dilogarithm. We prove a pentagon relation in the skein of the closed torus in this context, and give strong evidence that its analogue holds for arbitrary surfaces. We propose face relations satisfied by the skein-theoretic wavefunction, prove their invariance under mutations, and show their solution is unique. We define a skein version of framings in the story, and use the novel cluster structure to compute wavefunctions in several examples. The skein approach incorporates moduli spaces of sheaves of higher microlocal rank and their quantizations.
Discrete and continuous integrable systems: geometry analysis and applications, Friday 15:00-15:25 Room 260-036

Lorentz gases on quasicrystals

Agnieszka Zelerowicz[1]

[1]University of California, Riverside

The Lorentz gas was originally introduced as a model for the movement of electrons in metals. It consists of a massless point particle (electron) moving through Euclidean space bouncing off a given set of scatterers $\mathcal{S}$ (atoms of the metal) with elastic collisions at the boundaries $\partial\mathcal{S}$. If the set of scatterers is periodic in space, then the quotient system, which is compact, is known as the Sinai billiard. There is a great body of work devoted to Sinai billiards and in many ways their dynamics is well understood. In contrast, very little is known about the behavior of the Lorentz gases with aperiodic configurations of scatterers which model quasicrystals and other low-complexity aperiodic sets. This case is the focus of our joint work with Rodrigo Treviño. We establish some dynamical properties which are common for the periodic and quasiperiodic billiard. We also point out some significant differences between the two. The novelty of our approach is the use of tiling spaces to obtain a compact model of the aperiodic Lorentz gas on the plane.
Ergodic Theory and Dynamical Systems, Monday 15:00-15:25 Room 303-G23

The Characteristic Cycle of Restricted Constructible Functions

Xia Liao[1], **Xiping Zhang[2]**

[1]Huaqiao University, [2]Tongji University

When a constructible function is restricted to a hypersurface complement, its characteristic cycle is classically described by specializing the sharp operation of Ginzburg. When the divisor is SNC, Maxim-Rodriguez-Wang-Wu recently proved that this process is equivalent to pulling back the logarithmic characteristic cycle. In this talk we will discuss some generalizations of this result when the divisor is free and strongly Euler homogeneous. This is a joint work with Xia Liao.

Singularities, Thursday 14:00-14:50 Room 260-024

Noncrossing algebras and (co)homology complexes for Milnor fibres

Yang Zhang[1]

[1]University of Queensland

In this talk, we introduce an algebraic structure called the "non-crossing algebra, " associated with a finite Coxeter group W, which has connections to both the hyperplane complement of W and the associated Milnor fibre. We will show how this structure leads to the construction of simpler and more general chain and cochain complexes that compute the integral homology and cohomology groups of the Milnor fibres of reflection arrangements. In the process, we will define a new, larger braided Hopf algebra that appears to be "dual" to the Fomin-Kirillov algebra and reveals an intriguing connection to the Orlik-Solomon algebra. This framework allows us to determine the multiplicities of irreducible representations of W that appear in the cohomology groups of both the Milnor fibres and hyperplane complements associated with W. This is joint work with Gus Lehrer.

Singularities, Monday 16:00-16:50 Room 260-024

Homology of noncrossing partition lattices

Yang Zhang[1]

[1]University of Queensland

In this talk, we consider the noncrossing partition lattice L associated with a finite Coxeter group W. We will present explicit bases for the top homology groups of intervals and rank-selected subposets of L, and introduce a multiplicative structure on the Whitney homology. This structure exhibits similarities with the Orlik-Solomon algebra and offers new insights into the combinatorial and topological properties of L. As an application, we will discuss how this framework yields chain complexes that compute the integral homology of various objects related

to W, such as Milnor fibres and Artin groups.
Algebraic Combinatorics and Matroids, Friday 11:30-11:55 Room 303-B09

On the modified KdV equation in modulation spaces

Yunfeng Zhang[1]

[1]University of Cincinnati

In a recent breakthrough of Harrop-Griffiths–Killip–Visan, the complex modified KdV equation (mKdV) on the real line was shown to be globally well-posed in H^s for the sharp range $s > -1/2$. A natural question is what happens beyond Sobolev spaces? In particular, are there any other almost scaling-critical function spaces in which the mKdV is well-posed? I will present such a result in modulation spaces. This is joint work with S. Haque, R. Killip and M. Visan.
Harmonic analysis and Hamiltonian PDE, Tuesday 16:30-16:55 Room 260-028

Diagonal operators, Hausdorff measure and non-commutative symmetric spaces

Aleksey Ber[2], *Fedor Sukochev*[1], *Dmitriy Zanin*[1], **Hongyin Zhao**[1]

[1]University of New South Wales, [2]National University of Uzbekistan

Suppose $\mathcal{M}$ is a semifinite von Neumann algebra and $L_p(\mathcal{M}), p \geq 1$ is the corresponding non-commutative L_p-space. Let $(\alpha(j))_{j=1}^n \in \mathcal{M}^n$ be an n-tuple of commuting self-adjoint operators and let $\varepsilon > 0$. Can we find an n-tuple $(\delta(j))_{j=1}^n \in \mathcal{M}^n$ of commuting diagonal operators such that $\max_{1\leq j\leq n} \|\alpha(j) - \delta(j)\|_{L_p(\mathcal{M})} < \varepsilon$? In this talk, we shall discuss the conditions that enable such an approximation, which are related to the Hausdorff-p measure of the spectrum of $(\alpha(j))_{j=1}^n$. We shall also discuss the approximation when $L_p(\mathcal{M})$ is replaced by a non-commutative symmetric space $E(\mathcal{M})$ associated with $\mathcal{M}$, which is the non-commutative analogue of a classical rearrangement-invariant function space E on $(0, \infty)$. We show that if $E \cap L_\infty \not\subset L_{n,1}$, where $L_{n,1}$ is the Lorentz function space with the fundamental function $\varphi(t) = t^{1/n}$, then every commuting self-adjoint n-tuple $(\alpha(j))_{j=1}^n \in \mathcal{M}^n$ can be approximated by n-tuples of commuting diagonal operators in $\mathcal{M}$ with respect to the norm $\|\cdot\|_{E(\mathcal{M})}$. These results are also related to the non-commutative Weyl-von Neumann theorem of Voiculescu.
Functional Analysis and Operator Algebras, Tuesday 11:30-11:55 Room 260-055

Noncommutative Logarithmic Sobolev Inequalities

Yong Jiao[2], *Sijie Luo*[2], *Dimitriy Zanin*[1], **Dejian Zhou**[1]

[1]The University of New South Wales, [2]Central South University

We show that the logarithmic Sobolev inequality holds for an arbitrary hypercontractive semigroup $\{e^{-tP}\}_{t\geq 0}$ acting on a noncommutative probability space $(\mathcal{M}, \tau)$:

$$\|x\|_{L_p(\log L)^{ps}(\mathcal{M})} \leq c_{p,s}\|P^s(x)\|_{L_p(\mathcal{M})}, \quad 1 < p < \infty,$$

for every mean zero x and $0 < s < \infty$. By selecting $s = 1/2$, one can recover the p-logarithmic Sobolev inequality whenever the Riesz transform is bounded. Our inequality applies to numerous concrete cases, including Poisson semigroups for free groups, the Ornstein-Uhlenbeck semigroup for mixed Q-gaussian von Neumann algebras, the free product for Ornstein-Uhlenbeck semigroups etc. This provides a unified approach for functional analysis form of logarithmic Sobolev inequalities in general noncommutative setting.
Contributed Session B, Monday 15:00-15:25 Room 303-B05

The role of structures in neural networks

Ding-Xuan Zhou[1]

[1]The University of Sydney

The classical approximation theory developed 35 years ago is for fully-connected neural networks. This theory does not apply to neural networks with structures arising from applications of deep learning in speech recognition, computer vision, natural language processing, and many other domains. The structures and related network architectures raise some essential differences between the classical fully-connected neural networks and structured ones used in deep learning. This talk describes some approximation and generalization properties of structured neural networks such as deep convolutional neural networks.
Recent developments in data science and machine learning, Thursday 14:00-14:25 Room 402-220

Effect of 'student-lecturing' teaching model on eighth grade students' attitude towards mathematics

Minglin Zhou[1]

[1]University of Auckland

Student-lecturing is an innovative teaching model which allows students to express their problem-solving strategies and ways of thinking using mathematical language. It not only allows students to demonstrate their thinking process, but also creates a relaxed classroom environment

for students to overcome their fear of expressing mathematics, thus changing their attitude toward mathematics. However, the traditional teaching method place students in a passive accepting position, causing them to believe that mathematics is difficult and dull, leading to a loss of interest in the mathematics. This study analyzed the effect of the student-lecturing teaching model on student attitude toward mathematics (ATM) through a one and half year controlled-experiment with eighth-grade students in China. The student-lecturing teaching model has three stages to operate. Quasi-experiment was used to investigate whether the student-lecturing teaching model has an impact on 8th grade students' ATM in Shaoguan, China with the instrument ATMI. And the control experiment approach was used including two groups and two tests (pre-test and post-test) in this study. The result of this study shows that the student-lecturing teaching model not only helps to develop students' problem-solving and communication skills, but also gives students the opportunity to express themselves with mathematical language, which in turn enhances their attitude toward learning mathematics.
Keywords: student-lecturing teaching model, attitude towards mathematics, communication skill, problem-solving skills
MATHEMATICS EDUCATION, TUESDAY 15:00-15:25 ROOM 260-115

High Codimension Mean Curvature Flow Of Spacelike Convex Submanifolds With Pseudo Euclidean Background

Qiyu Zhou[1]

[1]ANU

We study the mean curvature flow of spacelike (mean) convex submanifolds with one spacelike codimension and arbitrary timelike codimension in a pseudo-Euclidean background. We present recent results on the flow, including the preservation of spacelike (mean) convexity, a pinching estimate, a noncollapsing result in high codimension, and some geometric implications of these findings.
DIFFERENTIAL GEOMETRY AND GEOMETRIC ANALYSIS, THURSDAY 12:00-12:25 ROOM 260-005

Optimal Classification-based Anomaly Detection with Neural Networks: Theory and Practice in Cybersecurity

Tian-Yi Zhou[1], *Matthew Lau*[1], *Jizhou Chen*[1], *Wenke Lee*[1], *Xiaoming Huo*[1]

[1]Georgia Institute of Technology

Anomaly detection is an important problem in many application areas, such as network security. Many deep learning methods for unsupervised anomaly detection produce good empirical performance but lack theoretical guarantees. By casting anomaly detection into a binary classification problem, we establish non-asymptotic upper bounds and a convergence rate on the excess risk on rectified linear unit (ReLU) neural networks trained on synthetic anomalies. Our convergence rate on the excess risk matches the minimax optimal rate in the literature. Furthermore, we provide lower and upper bounds on the number of synthetic anomalies that

can attain this optimality. For practical implementation, we relax some conditions to improve the search for the empirical risk minimizer, which leads to competitive performance to other classification-based methods for anomaly detection. Overall, our work provides the first theoretical guarantees of unsupervised neural network-based anomaly detectors and empirical insights on how to design them well.
Recent developments in data science and machine learning, Monday 15:00-15:25 Room 402-220

Convergence of numerical methods for total variation flow

Huateng Zhu[1]

[1]Monash University

We perform numerical analysis for the regularised total variation flow using gradient discretisation method (GDM). GDM is an unified convergence analysis frame- work that covers conforming and non-conforming numerical methods, for instance, con- forming and non-conforming P1 finite element, and two-point flux approximation etc.. We proposed a gradient scheme (GS), proved the existence and uniqueness of the solution to the GS, analysed stability and consistency of the GS, and established the error estimates for the GS.
Computational Mathematics, Monday 14:30-14:55 Room 402-231

A New Finite Element Method Wave Propagation on Graphene Sheets

Jichun Li [2], **Li Zhu**[1], *Todd Arbogast*[3]

[1]Portland State University, [2]University of Nevada Las Vegas, [3]University of Texas at Austin

In this presentation, I will introduce an innovative variational approach tailored for simulating the propagation of surface plasmon polaritons on graphene surfaces. The methodology treats graphene as a current-conducting thin sheet, employing an effective conductivity model. For the first time, a novel finite element time-domain method is proposed and analyzed specifically for solving this graphene model. The presentation includes rigorous demonstrations of discrete stability and error estimations for our method. Additionally, numerical findings are showcased to highlight the efficacy of this graphene-based model in accurately simulating the propagation of surface plasmon polaritons on graphene sheets.
Computational Mathematics, Wednesday 11:00-11:25 Room 402-231

The exceptional series and the Yang–Baxter equation

Paul Zinn-Justin[1], *Bruce Westbury*

[1]The University of Melbourne

We set up, in the framework of ribbon categories, a sequence of algebras which interpolate the centraliser algebras of tensor powers of the adjoint representation of the so-called exceptional series, which includes all exceptional Lie algebras. We extend this construction to a "dilute" category which plays a similar role for the direct sum of the adjoint and trivial representations. We provide explicit presentations of the 2-strand and 3-strand algebras. This allows to define a quantum R-matrix in the dilute 2-strand algebra and to show that it satisfies the Yang-Baxter equation. This is joint work with Bruce Westbury.

Representation Theory and Tensor Categories, Tuesday 15:00-15:25 Room 303-G14

Lipschitz Spinors and Higher Horospheres

Orion Zymaris[1], *Daniel Mathews*[1]

[1]Monash University

In prior work of the second author, an equivariant correspondence is constructed between complex spinors and horospheres in H^3 equipped with extra information in the form of oriented parallel line fields in their Euclidean geometry. This correspondence gives a new geometric interpretation of spinors to complement the null-flag interpretation of Penrose and Rindler. This new work (currently still in progress) hopes to give an arbitrary-dimensional generalization of this result, an equivariant correspondence between two-component spinors that take values in particular subsets of Clifford algebras and higher horospheres in H^n equipped with spin lifts of orthonormal frame fields.

Early Career Showcase in Low-Dimensional Topology, Monday 14:00-14:25 Room 260-073

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