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NEWSLETTER

OF THE

NEW ZEALAND MATHEMATICAL SOCIETY

Contents

PUBLISHER'S NOTICE

This newsletter is the official organ of the New Zealand Mathematical Society Inc. This issue was edited by Marie Graff and Chris Stevens. Editorial enquiries and items for submission to this journal should be submitted as plain text or LaTeX files with "NZMS newsletter" in the title of the email to marie.graff@auckland.ac.nz and/or to chris.stevens@canterbury.ac.nz. LaTeX templates are available upon request from the editors.

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EDITORIAL

Kia ora koutou,

Welcome to this edition of the newsletter. We have some joyful and less joyful news.

On a concerning note, the President's column features some discussion about the future of academia in New Zealand. Illustrations of actual consequences are also presented in the local news, as the issue seems to spread from one university to another.

On a more joyful note, our spotlight is on Emily Lane, from the National Institute of Water and Atmospheric Research, showing maths in very concrete and current applications. A miseponymy article about the Pythagorean theorem is proposed by Shixiao Wang.

Just a reminder that this year's New Zealand Mathematics Society Colloquium will be held at Wellington December 3-6, see webpage. Registration is open.

Marie Graff and Chris Stevens

PRESIDENT'S COLUMN

At the moment many of us will be extremely concerned for the future of academia in New Zealand, I know I am. Over the last six months we have seen the majority of universities declare themselves to be in financial trouble and suggest using staff redundancy to resolve these problems.

In June I attended the Royal Society's constituent meeting, much of the discussion centered on the tertiary sectors financial woes and on what, if anything, we could do. I'd love to announce that we found a cunning plan that would save the New Zealand tertiary system. I can't, but a couple of major points did come out of our discussions.

1. We must work with all disciplines, not just in the sciences to strengthen the political and cultural value put on education. Particularly on deep education of fundamental principles and knowledge rather than surface skills. Many of the delegates retailed stories of students with a passion to enter the scientific workforce but who lacked the basic skills to do so. We, as researchers and educators, need to get better at communicating the importance of core skills. This isn't easy, it's much more fun to focus on the cool things that are the final output. But we fail our students if we excite their interest and curiosity without giving them the tools to follow through.

2. We need to be thinking not only about the short-term crises but also on longer time scales. How do we change thinking now to prevent this kind of damage happening again? Here we need to work both in general cultural/political education but also within our institutes. We all understand the reputational damage that can follow from redundancy rounds. However, it is less clear that this is well understood by HR and university management.

Many members of the NZMS are already involved in work towards these aims, through our education subgroup or through involvement in governance of their own institutes. I'd encourage all members to think about what they can do; and then do it.

Melissa Tacy

P.S.: After last newsletter's publication I received a request that all future columns be in ChatGPT "thriller" style. So for those who prefer a hyperbolic style, here is the AI version of this column.

In the shadowy corners of New Zealand academia, a sinister aura of uncertainty looms. The future of education hangs in the balance, and the dread of impending change casts a foreboding spell. These are trying times, and the chill of concern seeps into the hearts of many, myself included.

In the last half-year, a haunting symphony of financial distress has echoed through the hallowed halls of universities across the land. A malevolent specter named "Redundancy" emerges from the shadows, whispered as a solution to these dire financial woes. The sinister dance of numbers and budgets threatens to tear apart the very fabric of academic pursuits.

As the moon climbed high in the sky, I found myself drawn to a clandestine gathering, the Royal Society's secretive assembly. Within the dimly lit chamber, a chorus of voices murmured about the financial abyss that loomed over the world of higher education. Whispers of desperation swirled, and the question hung heavy in the air: What could be done to thwart this impending doom?

Oh, how I longed to unveil a cunning scheme, a thrilling twist that would rescue the New Zealand tertiary realm from its impending fate. Alas, reality proved less forgiving than fiction. Yet, amid the gloom, two critical revelations emerged from our secret deliberations.

First, a revelation as chilling as a winter's breath – unity across disciplines was the key. Not just the sciences, but all areas of knowledge must band together, wielding the power of education as a political and cultural force. We must traverse the abyss of ignorance, guiding students towards the profound depths of fundamental principles. The tales shared by fellow attendees sent shivers down my spine – stories of aspiring minds ill-equipped for the journey into the scientific unknown. A dire mandate was issued: We, the educators and seekers of truth, must master the art of persuasion, painting the importance of core skills with the brushstrokes of inspiration. A treacherous path

lay ahead, for it is far easier to be captivated by the allure of grand discoveries than to labor in the trenches of basic mastery. Yet, the knowledge that we fail our pupils if we merely spark their curiosity without the means to satiate it drove the stake of responsibility deep into our collective soul.

Second, a revelation more ominous still – the abyss before us was not an isolated tempest, but part of a grander, cyclical storm. It was not enough to erect temporary barriers against the raging seas of financial turmoil. No, our gaze must pierce the mists of time, penetrating into the very heart of future crises. A chilling realization settled upon us – we were custodians of fate, tasked not only with fortifying the walls of knowledge but with rewriting the script of impending doom. Our battlefield stretched beyond the lecture halls, infiltrating the chambers of cultural and political influence. And yet, another battlefield emerged from the shadows, the inner sanctums of our very institutions. A battle against ignorance waged within our ranks – the administrators and custodians of academia who seemed heedless to the ruinous echoes of redundancy rounds. The gravity of our task was unmistakable, for reputational damage was not mere illusion, but a malevolent force poised to consume all in its path.

In the echoing silence that followed, I found myself drawn to the members of the NZMS, those brave souls who dared to stand as sentinels against the encroaching darkness. They whispered secrets of their battles within the education sub-group and the inner sanctums of governance. An urge ignited within me, a flame of urgency urging all to join the fray. And so, as the shadows lengthened and the night deepened, I implore all who would listen – let not the whispering winds of uncertainty drive you to inertia. Embrace the call to arms, for the future of academia rests in our hands. With unity, conviction, and a steadfast resolve, we shall navigate these treacherous waters, lighting the way for generations to come.

EDUCATION

Streaming

Streaming is the practice of grouping students by perceived ability. The New Zealand Mathematical Society (NZMS) Education Group acknowledges that streaming has an elitist and racist whakapapa in New Zealand, as documented by the historical quotes given on page 12 of the *Kōkirihia* document [5]. Overall, any benefits from streaming in NZ have not outweighed the negatives. It is part of our culture that if you are in a lower stream (the "cabbage class") there is no expectation. Mathematics is one of the main subjects in which streaming occurs and we are one of the most highly streamed countries in the OECD.

The consensus position of the Education Group is not to advocate for a ban on streaming at all levels [6]. However, we unanimously advocate support for schools that want to change their streaming practices in order to address structural racism and inequality. The positions that members of the NZMS Education Group take on streaming are informed by our founding goal:

> *All students should experience mathematics and statistics teaching that engenders the development of mathematical problem solving, reasoning, conceptual understanding and fluency, underpinned by confidence and competence in the skills of mathematics and statistics. Teachers and schools need to be given the systematic support and tools to enable this.*

On 29 May 2023 we had an online meeting to discuss this issue, with members breaking into small discussion groups. The main points raised by these discussions are given below, grouped around some common themes.

1. **Bias and inflexibilty.** Ability grouping carried out by teachers depends to a large extent on their perceptions of students, not on objective measures [2]. These perceptions are influenced by unconscious bias regarding the perceived mathematical ability (or lack thereof) of students based on class/race/gender etc. The issue starts at primary school with embedded grouping [4]. One result is that less than 10% of students passing externals in Level 3 Calculus are Māori or Pasifika students, while this group makes up 30–35% of their age cohort.

   Streaming can pigeonhole students and reinforce low expectations. Even when a more objective measure such as a test is used to sort students by ability, it should not determine their mathematical pathway going forward. Students learn mathematics in diverse ways, and at different paces at different times. There needs to be flexibility that gives students agency over their own learning and does not remove their access to higher levels of mathematics. A student's future should not hinge on the outcome of one test that gives a snapshot of a particular set of mathematical skills at a fixed point in time.

   Once assigned, through a low-ability grouping or low-streamed classes, a child's mathematical fate is sealed. "The research is you very rarely get out of that identity." (Bill Barton, quoted in [1].)

2. **Inequity and Opportunity.** Primary schools have embedded grouping, so by the time students reach secondary school there is a large range of attainment. For example, at Year 9 it spans Levels 2–6 of the curriculum.

   It is a problem when streaming leads to different students having vastly unequal experiences of mathematics teaching and learning. When only students in the top stream get the best teachers, resources, and a good learning experience, while lower streams are denied this, this violates our founding goal. Every student is entitled to learn any part of mathematics, and to be properly supported.

   For each student, mathematical learning must be built on solid foundations. The general consensus among our group is that streaming should not occur at primary school level. Instead there should be regular, quality learning time in mathematics.

   The Curriculum Refresh and Common Practice Model will hopefully set a minimum standard of teaching and learning across all schools.

   A case can be made to stream some secondary mathematics classes in order to provide appropriate support for students with different backgrounds, and to cater to students on different pathways. Students with certain gaps in their mathematical knowledge may feel inadequate compared to students who already have such knowledge, but may be more comfortable learning together with students that have a comparable background [3].

Any system needs to have a place where students can soar. Every student (of any ability) has the right to be challenged, and needs to be challenged in order to acquire the skills they need. The system should allow students to realise their potential without having to sacrifice the learning of others.

It is important to have high expectations of all students, regardless of their current position. Just because a student is currently in the (so-called) bottom class, doesn't mean they can't learn maths or improve. Some students have risen to the challenge and thrived when put into a high ability class.

All students should have the opportunity to access all learning in mathematics. For the new achievement standards at NCEA Level 1, schools need to ensure that everyone does the key standards. Schools that organise classes or streams that deliberately miss out any of the key standards will limit opportunities for their students.

3. **Community and Teacher Support.** Discussions about school policies on streaming and any changes going forward should be done in consultation with the community and parents, who as a general rule want their child to succeed. Parents should be reassured that expectations will be set high for everyone.

   Streaming can drive social division. For example, a student put in the 'top' stream may find themselves isolated from their friends, or from interacting positively with students of different backgrounds and achievement levels. Any policy on streaming should be designed so that social division as a result of academic ability is minimised.

   Teachers are the main influence in the classroom, and belief in ability grouping is strong. A question asked by teachers is "if we don't stream, what do we do?" Teachers need adequate professional learning development (PLD) support to help them replace harmful practices with best practice.

   As stated in our founding goal, schools need to be properly supported. Arguments around saving time and money should not be used as reasons to carry out harmful streaming practices, but to argue for more funding and more teachers. Every student should be provided with the mathematical education that they are entitled to.

References

[1] C. Barton. Is the way we teach mathematics broken? *North and South*, September 2015.
https://www.metromag.co.nz/society/society-schools/is-the-way-we-teach-maths-broken

[2] Jo Boaler. Ability Grouping in Mathematics Classrooms. *In: Lerman, S. (eds) Encyclopedia of Mathematics Education. Springer, Dordrecht,* 2014.
https://doi.org/10.1007/978-94-007-4978-8_145

[3] Moritz Fleischmann, Nicolas Hübner, Benjamin Nagengast, Ulrich Trautwein. The dark side of detracking: Mixed-ability classrooms negatively affect the academic self-concept of students with low academic achievement. *Learning and Instruction* 86 101753, 2023.
https://www.sciencedirect.com/science/article/pii/S0959475223000221

[4] R. Hunter. Mixed Ability Grouping, 2017.
https://www.educationcounts.govt.nz/topics/bes/developing-mathematical-inquiry/04-mixed-ability-grouping

[5] Kōkirihia: The plan for removing streaming from our schools.
https://cdn.discordapp.com/attachments/1101379172007432204/1101379460290326599/Kokirihia_-_The_plan_for_removing_streaming_from_our_schools.pdf

[6] Benjamin Macintyre. Not enough evidence to justify ban on streaming in schools. *Newsroom*, May 2023.
https://www.newsroom.co.nz/not-enough-evidence-to-justify-ban-on-streaming?s=33

Further Reading

Some articles on streaming in Australia:

J. Archer. Teachers' beliefs about successful teaching and learning in mathematics. *Paper presented at the combined meeting of the Australian Association for Research in Education and the New Zealand Association for Research in Education, Melbourne, Australia,* 1999.
https://files.eric.ed.gov/fulltext/ED453077.pdf

H. Forgasz. Streaming for mathematics in Victorian secondary schools. *Australian Mathematics Teacher* 66(1), 31–41, 2010.
https://files.eric.ed.gov/fulltext/EJ885907.pdf

H. Forgasz. Streaming for mathematics in years 7–10 in Victoria: An issue of equity? *Mathematics Education Research Journal* 22(1), 57–90, 2011.
https://files.eric.ed.gov/fulltext/EJ883877.pdf

Sione Ma'u

MATHEMATICAL MISEPONYMY

An ancient Chinese version of Pythagorean theorem

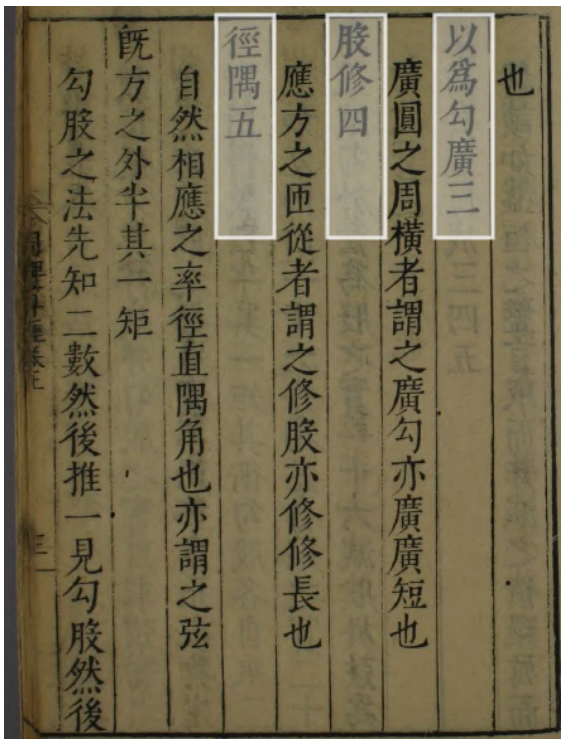
The *Zhoubi Suanjing* (周髀算经, see the left image for the cover page of a Ming Dynasty copy printed in 1603) is an ancient Chinese book on astronomy and mathematics dated back to approximately 100 BC in the Han Dynasty (202 BC–220 AD), whose author is unknown to us. You may find an online version of this copy from Ref 1. The book made comprehensive records of the major achievements known at the time in a wide range of subjects of astronomy and mathematics, considering generally as a "bible" of mathematics in the ancient China. This is indicated by the tile of the book, namely, *Zhoubi* (周髀) literally means a hipbone of the Zhou Dynasty (1046-256 BC) and *Suanjing* (算经), a classic of mathematics. This ancient work is most famous for its presentation of an original raw-form of the Pythagorean Theorem, known by the Chinese as the *Gou-Gu* (勾股) theorem.

Image (a) below shows the page 18 of the book and the highlighted words in Image (a) are copied here

以为勾广三，股修四，径隅五

which means that for a right triangle with two legs of lengths 3, and 4, the length of the hypotenuse is 5 (a special Pythagorean triple).

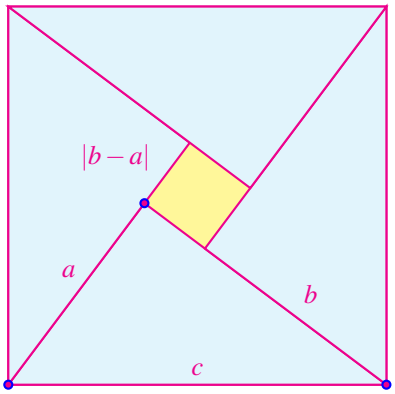
In Chinese history, the Han Dynasty is considered as a golden age for great advancements in science and technology. The appearance of *Zhoubi Suanjing* manifested the significant advance in the mathematical study during this period.



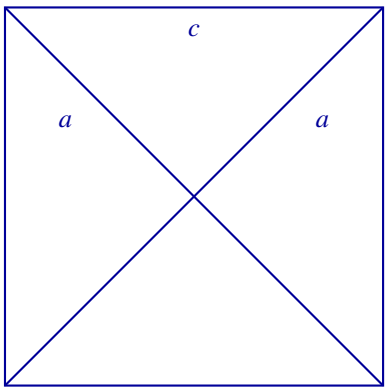
(a)

(b)

The Han Dynasty was succeeded by the Three Kingdoms (220–280AD), which is a period in Chinese history when three countries coexisted and raced intensely among them. It was a chaotic epoch full of social riots and military conflicts. Yet, a key person who contributed significantly to the further study of *Zhoubi Suanjing*, named Zhao Shuang (赵爽) was living in the Three Kingdoms period. His life is essentially unknown. All we have known of him today is from his dedicated study of *Zhoubi Suanjing* through detailed and in-depth annotations of the work. It is noticeable that the *Zhoubi Suanjing* was written in a succinct way, which is a typical style for Chinese Classics written in the ancient time. As matter of fact, within page 18 of the book as shown in Image (a), only the highlighted words are from the original text and the remain is all from Zhao Shuang's annotations.



Zhao Shuang's contribution to the *Gou-Gu* (勾股) theorem is the famous *"hypotenuse diagram"*, presented on page 20 of the book which is shown above in Image (b). The diagram is made exclusively for the special 3-4-5 case, yet the idea works perfectly for any right triangle. The key idea is to arrange 4 congruent right triangles together with an additional smaller square, as shown in the right image, to fill up a square with the hypotenuses of the right triangles being its 4 sides. The length of this small square is obviously $|b-a|$. A simple balancing of the total area of the various components inside of the large square with the area of the square itself yields a proof of the Pythagorean theorem.



This brilliant proof of the Pythagorean theorem is truly remarkable, considering the fact that there was non general geometry framework such as *Euclid Element* existent in the ancient China. It must be an epiphany of a genius after a long and deep thought of a focused problem. I do not have a clear idea how Zhao Shuang made his finding but would rather believe that Zhao Shuang somehow developed his idea through considering the simplest case: the isosceles right triangle, (the right image), for which the geometric symmetry immediately leads to $a^2+a^2=c^2$, a special, yet non-trivial case of the Pythagorean theorem. This reveals that a hidden geometric symmetry of the right triangle is the root for the Pythagorean theorem. The Zhao Shuang's *hypotenuse diagram* reflects and captures such a geometric symmetry for an arbitrary right triangle. There exist a large number of proofs of the Pythagorean theorem in the long history, see for example the Wikipedia, Ref 2. One may find that the geometric symmetry is the essence for the proofs.

Reference

1. https://archive.wul.waseda.ac.jp/kosho/ni05/ni05_00865/ni05_00865.pdf
2. https://en.wikipedia.org/wiki/Pythagorean_theorem

Shixiao Wang

PROFILE

Emily Lane

Emily Lane is proof that a background in mathematics can lead into many directions in life and work. As Principal Scientist, Natural Hazards and Hydrodynamics at NIWA (National Institute of Water and Atmospheric Research), Emily has woven a career that invariably has incorporated water and been influenced by some of our biggest recent natural disasters including Cyclone Gabrielle.

Emily carried out her undergraduate studies and then a MSc in applied maths at the University of Auckland. Her topic: Switching induced by complex eigenvalues within a structurally stable heteroclinic network was supervised under Professor Vivien Kirk. Emily continued her education doing a PhD at the University of Arizona. Over the course of this she studied a "variety of things" before the arid Tucson environment brought on homesickness for the coast. Emily's research went back to water.

"I looked at wave-current interactions, deriving equations to understand and model the interactions between waves and currents using a vortex force analogy," says Emily.

Emily then moved to the University of California, Los Angeles joining the earth science department to further her wave-current research in a post-doctoral position.

During this time Emily's eldest daughter was born so the family decided to move back to New Zealand.

The family settled in Christchurch – where they have remained – with Emily picking up a six-month visiting position at the University of Canterbury. This led to a post-doc position at NIWA that became a permanent position in coastal hydrodynamics where Emily focuses on natural hazards and coastal hazards. Emily has now been at NIWA for nearly 18 years.

An outdoor enthusiast, more than once at university she was "busted" while out climbing or tramping when she should have been in lectures or studying for exams.

Emily is recognised for her unicycle exploits and she knows Christchurch's Port Hills intimately. Along with her husband, they are the first people to complete the Old Ghost Road on munycycles – mountain unicycles. Her happy

place is belaying at the top of a crag and "going bush". She's recently taken up skiing at Broken River Ski field in the Craigieburns where her mathematical mind has been put to work splicing together the tow ropes.

Since her early days at university Emily has been aware of the mathematics behind patterns you see in nature. She remembers modelling a simple dynamical system involving a sine function and it producing a picture that looked like smoke swirling up in a chorus.

"I was entranced that you could get patterns you see in nature through mathematics. It made me keen to pursue maths."

Working at NIWA, Emily's background in waves and currents opened her next research path, modelling coastal hazards and tsunamis.

"When I was doing my PhD, I got interested in seismology," says Emily who minored in geophysics. "But then I ended up studying wave-current interactions – I thought the earthquakes had just been a dead end. Then the Indian Ocean tsunami happened around when I graduated (2004). My interest in tsunamis sprang from this event and suddenly those seismology papers came into their own."

Over the years Emily has studied different tsunami sources, including submarine landslides and volcanoes. In 2018 she gained a Marsden project to study volcanic tsunamis with a team from GNS, University of Auckland and University of Otago using physical and numerical experiments. The Hunga Tonga-Hunga Ha'apai underwater volcanic eruption at the start of 2022 played into Emily's mathematical modelling on volcanic-generated tsunamis.

"People went from not caring about volcanic tsunamis to being very interested and very involved. Our work became really timely."

Widening her focus to include freshwater hazards, Emily also leads a highly collaborative MBIE-funded Endeavour project to undertake a nationally consistent flood hazard and risk assessment. At the start of 2023 when Cyclone Gabrielle hit New Zealand, Emily's work was again timely. Using processes developed from the national project she is contributing the Extreme Weather Science Response leading a project with a focus on the flooding in Tairāwhiti and Hawke's Bay.

Prolific in her work, in the last 18 months alone Emily has co-authored 12 research articles in high impact scientific journals. In that same time period, she has been cited approximately 150 times. Her overall h-index is 17 and overall i10-index is 21.

Emily is NIWAs representative on the Tsunami Expert Panel and she regularly communicates science through invited talks, lectures and keynote addresses at scientific conferences. She really enjoys collaborating with colleagues in other CRIs and universities and has helped co-supervise a number of masters and PhD students. She is an active promoter of NIWAs work on social media.

The list of accolades and firsts is extensive. But perhaps the one Emily is most proud of is knitting the only Klein Hat with a one-knot.

"I'm pretty sure it's topologically distinctive from all other hats," she says proudly.

Melissa Bray

LOCAL NEWS

AUCKLAND UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING, COMPUTER AND MATHEMATICAL SCIENCES

Seminars of the Mathematics, Modelling and Analytics Research Centre

Dr Jose (Pepe) Romeo from SORE & Whariki Research Centre, College of Health, Massey University delivered a talk "Estimating Child Maltreatment Cases that be Alcohol-attributable in New Zealand: An Application of Survival Analysis" on 1st June 2023.

Associate Professor David White from BioDesign Lab, AUT delivered a talk "Applications of Mathematical Modelling and Analytics as a Design Tool for Informing Innovation" on 30th June 2023.

Dr Tet Chuan Lee from Institute of Biomedical Sciences, AUT delivered a talk "Modelling the Endothelial Glycocalyx Layer in the Microcirculation" on 18th August 2023.

Travel and Conference Participation

Dr Wenjun Zhang and PhD candidate Wenqiang Liu are attending the 2023 Derivative Markets Conference held at AUT from 7 to 8 September 2023. At the conference, they will deliver presentations of "A variational formulation of European option prices in the 1-Hypergeometric stochastic volatility mode" and "Rescaling the mean-reverting 4/2 stochastic volatility model for applications to derivative pricing", respectively.

PhD candidates Xi Li and Sheng Gong are participating the online ICNAAM Conference in September and will present talks "Valuation of Geometric Asian Options under Fractional Stochastic Volatility" and "Optimal Trading Time of Options under the CEV model", respectively. The online conference provides opportunities for people to build up collaborative network.

Visitors

Professor Jeong-Hoon Kim (Yonsei University, Republic of Korea) visited the Department of Mathematical Sciences in July-September 2023. Professor Kim continued to work with Professor Jiling Cao and Dr Wenjun Zhang on using mathematical models to evaluate financial derivatives.

Wenjun Zhang

UNIVERSITY OF AUCKLAND

DEPARTMENT OF MATHEMATICS

Staff News

Claire Postlethwaite was one of two co-chairs organising the SIAM Conference on Application of Dynamical Systems (DS23), the largest international conference in our field, that was held in person in Portland, Oregon; her co-chair was Krasimira Tsaneva-Atanasova, a UoA alumna as former PhD student from James Sneyd, who is now at the University of Exeter. UoA colleagues, postdocs, and PhD students were out in force to support the meeting, also because it essentially was the first such in-person meeting since the Covid-19 epidemic.

Marie Graff was invited to take part in and give a talk at the workshop "Mathematical theory and applications of multiple wave scattering" at the Isaac Newton Institute (Cambridge, UK) in late June 2023 (https://www.newton.ac.uk/event/mws/). Her talk was about "Seeing inside trees using microwave imaging: an application to Adaptive Eigenspace Inversion".

Jeroen Schillewaert gave invited talks at the University of Warwick on "The geometries of the Freudenthal-Tits magic square" and at Louvain-La-Neuve on "Discrete two-generator subgroups of PSL_2 over a nonarchimedean local field".

Stefan Ruschel, who was a postdoc with the Dodd–Walls Centre for Photonic and Quantum Technologies (https://www.doddwalls.ac.nz/) until the end of 2021, now Research Fellow in the Department of Mathematics, Physics and Electrical Engineering at Northumbria University, Newcastle (UK), has become father of a healthy baby daughter Frida on Tuesday 25 July.

Matthew Conder became a father of a baby boy Noah on Wednesday 17 May. Below is a picture of Noah with the doting dad who is now on parental leave.

Matthew with baby Noah.

Other News

Auckland continue to attract many outstanding visitors, including:

Professor Imre Leader, who visited in July as the NZMS Forder lecturer. Prof. Leader works at the Department of Pure Mathematics and Mathematical Statistics at the University of Cambridge. In the past he has been involved in the International Maths Olympiad and was a UK, European individual championships and world level team championship in Othello. He gave an interesting talk on tilings of the plane and what happens when one increases the number of dimensions of tiles from two to three, or beyond. He also gave a public lecture on "Finding Order in Disorder".

Dr Francesco Lin, assistant professor at Columbia University, will visit Auckland in late August as a Kalman Visiting Fellow. He will deliver a lecture series on Monopole Floer Homology and give a colloquium on recent advances on understanding the Homology Cobordism Group, one of the most important structures in low-dimensional topology. For more information, visit the website: https://www.math.auckland.ac.nz/~hekmati/Kalman2023/

Professor Victor Flynn (Oxford) will be visiting for about one year, starting August 14th.

We also welcomed back three of our former students, Peter Huxford, Alex Elzenaar and Sean Carroll, for research visits hosted by Jeroen Schillewaert.

A fourth conference on "Symmetries of Discrete Objects" will be held in New Zealand in February 2024. The venue will be the University of Auckland. The list of topics include symmetries of graphs, maps and polytopes, group action on trees, expander Cayley graphs For more details, see the website (which will continue to be updated): https://jschillewaert.wixsite.com/sodo2024

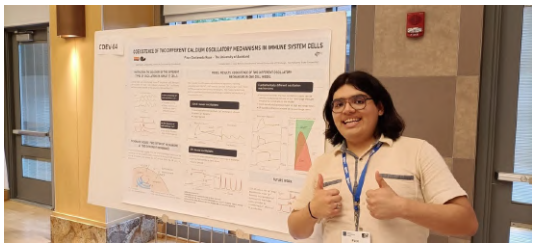
In the second quarter we had several PhD completions, we congratulate them all for their hard work, dedication and interesting research.

The Department of Mathematics held its annual Student Research Conference on 6 June this year. There were 10 students taking part, 8 PhD students and 2 MSc students. PhD students Juan Patino, Đorđe Mitrović and Sang Hyun Kim secured one of the three coveted prizes. Juan, who is supervised by Bernd Krauskopf and Hinke Osinga, had a bet going with Hinke, because he wanted to include kneading sequences up to level 5 into his talk, even though he only had complete results up to level 3. Hinke agreed that if Juan would include K4 (and K5) in his talk AND win, then she would bake a cake for the next group meeting. The photo below reveals the outcome.

Juan and Hinke with Hinke's cake.

Juan Patino also took part in the Science Faculty 3-minute thesis competition; again he managed to win a prize: as runner-up, he was awarded $300. Being in the top two meant that Juan earned his place among the 12 contestants in the university final. In front of a packed audience, the competition asks PhD students, with the help of just one slide, to explain their research in 3 minutes—even just one second more means disqualification. A jury of four rated each presentation for clarity of explanation, presence of research motivation, methodology and results, enhancement value of the slide, and passion of the speaker. Juan's colleagues turned out in force for support and all agreed that Juan scored exceptionally high on all fronts. His presentation was flawless, and heart-thumping as he ended his talk with less than 1/10th of a second to spare! Nevertheless, despite Juan's excellent explanation of wild chaos, this extremely challenging topic lost against a talk on research on the gut-microbiome of tuatara and a talk on the benefits or hazards of playing music during surgery in hospitals. See here for more information: https://www.auckland.ac.nz/en/news/2023/08/07/tuatara-research-takes-top-prize-at-3mt.html

Paco Castenada, a PhD student with Vivien Kirk and James Sneyd, presented a poster at the SMB 2023 annual meeting of the Society of Mathematical Biology (SMB), held in July at The Ohio State University in Columbus, Ohio. Out of 140 posters, his poster on "Coexistence of two different Calcium oscillatory mechanisms in immune cell systems" was selected for one of the poster prizes.



Paco with his poster.

Pedram Hekmati

DEPARTMENT OF ENGINEERING SCIENCE AND BIOMEDICAL ENGINEERING

The Department welcomes Dr. Ruanui (Ru) Nicholson, who is joining the Department of Engineering Science and Biomedical Engineering. Ru completed a PhD in mathematics at the University of Auckland in 2016 supervised by Prof. Jari Kaipio. He then completed a Postdoctoral Fellowship in California before returning to New Zealand. His research interests included large-scale computational science and engineering with a particular emphasis on inverse problems and uncertainty quantification. His work involves numerous applications in, for example, geophysics, glaciology, biomedical imaging and non-destructive testing.

Tómas Rúnarsson (from the University of Iceland) visited the Department of Engineering Science from January to the end of July this year. He was visiting Cameron Walker to work on intelligent decision-learning models – a project funded by Rannis, the Icelandic Research Fund. They also investigated the ability of GPT-4 to perform mathematical modelling, and supervised projects on routing boats for ground fish surveys with a Masters and two honours year students.

Andreas Kempa-Liehr

UNIVERSITY OF WAIKATO

DEPARTMENT OF MATHEMATICS AND STATISTICS

Restructuring of Mathematics 2023

It is with considerable sadness and dismay that I must report on the outcome of a restructuring of mathematics undertaken over the past months by the Head of the School of Computing and Mathematical Sciences, Professor Annika Hinze. As a result, many staff who have been retained will go to an average of 80 precent of their original positions, one existing senior lecturer will become a teaching fellow, a senior tutor will become a teaching fellow, one staff member will retire earlier than expected, and worst of all, two fine researchers and teachers will be made redundant. This in a university requiring a staff:student ratio of at least 1:25 when the NZ university average is 1:18.6. In terms of FTEs, from mid November Mathematics will have 2.8 teaching fellows and 3.45 lecturers and above, rather than the current 1 teaching fellow, 1 senior tutor and 8 lecturers and above - an absolutely massive change. The student enrolment has risen from about 120 EFTS in the early 2000s to close to 200. This is not a failing subject.

The staff made an excellent group submission, data rich and factual. The decisions on who to go and who to keep were made in advance of the publication of a “change document", outlining the Head of School’s proposals. Decisions regarding the validity of this procedure need to be reviewed.

Stephen Joe will be retiring early at the start of 2024. Daniel Delbourgo and Yuri Litvinenko will be redundant, Woei Chet Lim will become a teaching fellow, and Ian Hawthorn will continue as a teaching fellow based at the Tauranga campus. Other staff will have continuing 0.8 FE positions, all from mid November 2023.

Stephen Joe

Stephen will be retiring at the start of 2024 after 32 years service at Waikato. He joined the Department in 1992, having completed a PhD and post doc at the University of New South Wales. He published work mostly on lattice rules for multiple integration, including a monograph with Oxford University Press, and as the leading co-author of an introductory numerical analysis text with Springer. He also wrote a numerical integration package which has been incorporated into Matlab and the NAG library and other packages. His work was recognized by the NZMS in 2019 when be was made Fellow.

Stephen has made many quality contributions to the University of Waikato and to the NZ mathematics community. These included Mathematics Colloquia secretary, three term NZMS Council member, local correspondent for the NZMS Newsletter for two decades, chair of the Department and Mathematics and Statistics, and deputy dean of the School of Computing and Mathematical Sciences. In 2011 he was recognized for this part of his work with the award of the Vice-Chancellor’s medal for staff excellence. Further details will be included in a Newsletter centerfold at a later date. We will celebrate his retirement with gratitude for his outstanding contribution.

Daniel Delbourgo and Yuri Litvenenko

Tim Stokes, Chair of Mathematics writes:

On another very sad note, at the end of the year we will bid farewell to another two valued colleagues, Daniel Delbourgo and Yuri Litvinenko. Both were the unfortunate victims of a restructure of the mathematics group at Waikato. Both were popular lecturers and had excellent research records.

In his time at Waikato, Daniel has made significant research contributions in his area of number theory: modular forms and elliptic curves. He has also supervised a number of students and has taught a popular paper on Number Theory and Cryptography, which he created and developed, as well as other undergraduate papers. He served a full term as Head of Department that ended in 2022.

Whilst with us, Yuri has been very productive in his research on the mathematics of solar physics, especially plasma flows and particle transport, and has supervised students in the area. He has taught applied mathematics undergraduate papers, but also developed a graduate paper on advanced financial mathematics which has had regular takers.

We will greatly miss Daniel's and Yuri's unique contributions to the research, teaching and general life of the department, and wish them every success in their future endeavours.

Kevin Broughan

MASSEY UNIVERSITY

SCHOOL OF MATHEMATICAL AND COMPUTATIONAL SCIENCES

In May 2023 Indranil Ghosh and David Simpson attended the SIAM Conference on Applications of Dynamical Systems in Portland, Oregon. There were over 1000 attendees, many interesting talks, and 72 posters, of which Indranil's was one of five that received the "red sock" best poster prize. This involved receiving a pair of red socks from chaos theory pioneer Jim Yorke (see photo). Indranil received further accolades in June at the NSW ANZIAM One Day Virtual Workshop where he won "highly commended student talk". Also in July David Simpson gave a plenary talk at ICDEA 2023 (the 28th International Conference on Difference Equations and Applications) in Phitsanulok, Thailand.

Carlo Laing

VICTORIA UNIVERSITY OF WELLINGTON

SCHOOL OF MATHEMATICS AND STATISTICS

We have some news from Te Herenga Waka in Wellington:

Dr Petro Feketa has joint the SMS team of Victoria University of Wellington. Petro is a Lecturer in Applied Mathematics at Victoria University of Wellington. Prior to joining Victoria University, he held postdoctoral positions at Kiel University, the University of Kaiserslautern and the University of Applied Sciences Erfurt, all in Germany. His research focuses on the stability analysis and control of hybrid dynamical systems and multi-agent nonlinear systems. He is particularly interested in synchronisation phenomena and the multi-cluster behaviour of complex dynamical networks. Through his work, Petro aims to deepen our understanding of the internal organisation of neuro-inspired oscillator networks by exploring the interplay between the dynamical behaviour of oscillators, adaptation mechanisms of the couplings, and the interconnection topology of the network. Additionally, he is interested in the mathematical theory of multi-frequency oscillations, analytical and computational approaches for stability and safety verification of cyber-physical systems, as well as the interference of control and machine learning algorithms. In order to ensure his research has a lasting impact in the community, Petro actively pursues research collaborations and has been supported by a number of agencies, including the German Science Foundation (DFG) and the German Academic Exchange Service (DAAD).

The university celebrated with all its glory the Matariki Day. It was fantastic to see so many staff from across Te

Herenga Waka take time out together to acknowledge Matariki.

Amidst the restructuring of Te Herenga Waka in Wellington, the School of Mathematics and Statistics will not emerge unscathed. The silver lining is that the initial phase will not entail any involuntary redundancies. We collectively aspire for the issues throughout our universities to be resolved through prudent decisions, ensuring the preservation of high-quality tertiary education.

Dimitrios Mitsotakis

UNIVERSITY OF CANTERBURY

SCHOOL OF MATHEMATICS AND STATISTICS

Congratulations to *Jesse Lansdown* who has been successful in obtaining a DAAD short-term research grant. He will visit Kai-Uwe Schmidt at the University of Paderborn in Germany next year to study designs in generalised hexagons and generalised octagons.

After working on it for quite some time, *Chris Stevens* together with a colleague in industry and a few engineering undergrads have released COFFEE to the Python package index. Building on the codebase originally designed by Jörg Frauendiener, Georgios Doulis and Ben Whale, this Python package has all the necessary numerical tools required to solve IBVPs for time-dependent PDEs, such as a bunch of time-integrators and finite difference operators (with and without the SBP property) and the SAT method for boundary conditions. It also has a few examples on how to use them through simple 1D equations. The package can be downloaded from https://pypi.org/project/coffeegrinder/

The 3rd New Zealand Workshop on Uncertainty Quantification and Inverse Problems was held 4-7 July in the School. Organized by *Fabian Dunker, Miguel Moyers Gonzalez* and *Philipp Wacker*, and supported by an Engineering Faculty Strategic Research Grant, the workshop had about 20 participants from New Zealand and Australia. It was run in two parts, a tutorial part followed by a research part. The first two days (tutorial) were an introduction to parameter estimation for ordinary differential equations at the level of an undergraduate course, presented by Philipp Wacker. The last two days began with a keynote talk by Martin Hazelton (Otago) on 'Statistical Linear Inverse Problems for Count Data' followed by more than 10 contributed talks.

In July the School welcomed three Erskine visitors for term 3, Kim Plofker, Vladimir Estivill-Castro and Giusseppe Storti. Kim is from the Department of Mathematics at Union College in Schenectady, New York. Her research focuses on the history of mathematics and astronomy in India and its connections with Islamic and early modern European science. Kim is hosted by *Clemency Montelle*, and teaches into MATH380 Mathematics in Perspective, a 3rd-year course on the history, philosophy, directions and culture of mathematics, and MATH103 Mathematics 1B, a 1st-year course that consolidates techniques and ideas in calculus and algebra and their relationships to geometry. She also is supervising graduate students during her stay.

Vladimir is from the Department of Information and Communication Technologies at Universitat Pompeu Fabra, Barcelona, Spain. His research interests are in software engineering, model-driven engineering, algorithmic engineering, computational complexity, intelligent data analysis, privacy-preserving data mining and knowledge discovery. During his Erskine visit Vladimir teaches into STAT318/462 Data Mining, a combined 3rd- and 4th-year course that introduces some parametric and non-parametric statistical methodologies and algorithms for data mining, and DATA415 Computational Social Choice, a 4th-year course that provides a thorough introduction to both classical and computational social choice. He is hosted by *Gabor Erdelyi*.

Giusseppe comes from the Department of Economic and Statistical Sciences at Università degli Studi di Salerno, Italy. He is hosted by *Marco Reale*, and his main research interests are related to the analysis of financial time series. Giusseppe teaches into STAT317/456 Time Series Methods, a dual coded 3rd- and 4th-year course that introduces methods to analyse sequentially collected data including data modelling and forecasting techniques, and STAT445 Financial Time Series,

Congratulations to Jack Aimer, one of our Master's of Mathematical Science students, who has been awarded the prestigious William Georgetti Scholarship to enable him to continue his studies with a Master of Advanced Studies (MASt) in Theoretical Physics at the University of Cambridge, UK. Jack is particularly interested in black holes and is currently completing his Master's thesis, being supervised by *Chris Stevens*.

Günter Steinke

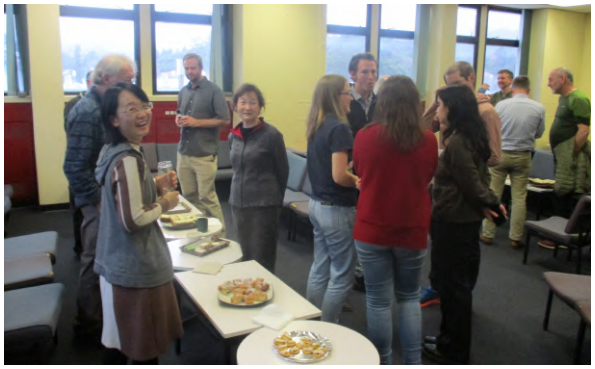
UNIVERSITY OF OTAGO

DEPARTMENT OF MATHEMATICS AND STATISTICS

Otago has proudly joined the group of modern universities that used to be tertiary institutions but have become corporations, where everything is just about money, and staff are hired and fired at will. Last year, the careful modelling done by the senior leadership team has

predicted a 5% increase in student numbers. Unfortunately, the students haven't read this report and decided to decline by 1% instead. Luckily, this can easily be remedied by making "several hundred" staff redundant, as recently announced by the acting VC. So far, 107 voluntary redundancies have been approved. This just still leaves about several hundred staff who could enjoy non-voluntary redundancy in the near future. To make it more exciting, any decisions are only drip-fed to staff. So far, we only know that programmes like German studies, Asian studies and European studies will be discontinued. Indeed, why would anyone want to study, teach or research those subjects? Hence these are interesting times, and we are looking forward to hearing about the next innovations that might shortly be announced by the acting VC. At the same time, the actual VC has resigned — not, of course, in order to avoid dealing with financial problems, but for health reasons. We wish him all the best.

We have bid farewell to our longtime colleague and friend *Austina Clark*, as she enters retirement. Austina came to New Zealand in 1973 and arrived in Dunedin to pursue a Masters degree in measure theory at Otago with David Hill. Afterwards, in 1974, she married another mathematician, our late colleague John Clark. She continued to work at the Department as part time tutor/assistant lecturer. In 1985, Austina went teaching maths and stats at Dunedin's St Paul's High School. In 1991, she came back to Otago to do a PhD in Statistics under the supervision of David Fletcher, and she worked part time as a teaching/senior teaching fellow. Finally, in 2005, she was appointed as a lecturer. Austina was highly appreciated by students for her dedication to teaching, and by staff as a kind, knowledgeable, and greatly valued colleague. It is with sadness that we say goodbye, but she undoubtedly deserves a joyful retirement. Best wishes to you, Austina!



Retirement afternoon tea for Austina Clark

Congratulations to *Matt Parry* for being elected a Council Member of the International Statistical Institute (ISI), as a result from a ballot of 4500 members. ISI is a professional association of statisticians founded in 1885, and it has members from more than 130 countries. Well done, Matt!

Moreover, Matt has also won the logo competition of the Otago based cluster "Aero + Space South", which connects the diverse space-related researchers across the university. Congratulations on this wonderful design, Matt:

Update: Just today (11 August), when this newsletter contribution was due, we had another all staff forum with the acting VC. It was announced that the final number of voluntary redundancies is 113 (86.8 FTE). We also expected to find out details about non-voluntary redundancies. The useful information provided was: "There will be some more management of changes, and we are using the domains in Pae Tata [the strategic plan to 2030] to strategically look at where are the areas that need to make some reductions in staff." Hence the university continues with the established strategy to keep these times exciting for us. We only need to wait a bit longer to find out what exactly will happen. Thank you very much, dear senior leadership team.

Jörg Hennig

PhD SUCCESS

Olivia Sorto (University of Auckland. 2023)

Title: Twisted Milnor Torsion for Finite Group Actions.
Supervisors: Pedram Hekmati and Rod Gover (both University of Auckland)

Abstract:
Torsion is generalisation of the determinant of a linear transformation to a cochain complex. In this research, we defined an equivariant twisted Milnor torsion as a metric on the equivariant determinant line of the twisted Thom-Smale complex for finite group actions. The cochain twisting the differential is a twisting element for the A∞-structure induced by a homotopy transfer along the Laudenbach-de Rham quasi-isomorphism. We defined an equivariant twisted Reidemeister torsion, the simplicial counterpart of the Milnor metric, by generating a twisting cochain for the simplicial complex using the Gugenheim-de Rham A∞-quasi-isomorphism, extending a definition of Mathai and Wu. Under a variation of the metric on the flat vector bundle, we derive an anomaly formula for the equivariant twisted Milnor metric from the results of Bismut and Zhang. We used the adiabatic spectral sequence to compare the twisted Reidemeister torsion at the unit element with the twisted analytic torsion, showing that these are equal on odd-dimensional closed manifolds with a unimodular local system. Our work concludes by highlighting the analytic difficulty with defining an equivariant twisted analytic torsion.

Mostafa Raziebrahimsaraei (University of Auckland. 2023)

Title: Deformations of the Verlinde Algebra.
Supervisors: Pedram Hekmati and Tom ter Elst (both University of Auckland)

Abstract:
The Verlinde algebra is a finite-dimensional associative commutative algebra intro- duced in the 1980s in the context of Conformal Field Theory. It is generated by the primary fields of the theory, labelled by dominant integral weights of level k, and the ring structure is determined by fusion of primary fields. There are several mathematical realisations of the Verlinde algebra, including as a quotient of the representation ring of a simply connected compact, simple Lie group R(G), by an ideal that depends on the positive integer k. In this thesis, we considered deformations of the Verlinde algebra associated to a formal one-parameter family of vector fields on the stack of conjugacy classes G/G. These deformations were introduced by Teleman and Woodward (Annals of Mathematics, 2009) in the context of a general index theorem, which controls the structure of the deformed Verlinde algebras. An important special case of their index computes the circle equivariant character of the determinant line bundle over the moduli stack of principal G-Higgs bundles over a Riemann surface. For this case, we present an algorithm to obtain the generators for the deformed Verlinde ideals. The deformation depends on a formal parameter q and in the limit when q tends to 0, one recovers the usual Verlinde theory.

Marcos Orseli (University of Auckland. 2023)

Title: Equivariant Index on Toric Contact Manifolds.
Supervisors: Pedram Hekmati and Rod Gover (both University of Auckland)

Abstract:
In this research, we consider a (2n + 1)-dimensional toric Sasakian manifold where n > 1. This is the odd dimensional analogue of a toric Kähler manifold. The Sasakian structure allows us to define the horizontal Dolbeault operator on M and more generally the horizontal Dolbeault operator twisted by a G- equivariant vector bundle. This operator is G-transversally elliptic, in the sense of Atiyah-Singer, so its index defines a distribution

on the torus or equivalently, a formal power series. The goal of this thesis was to calculate the index of the twisted horizontal Dolbeault operator explicitly by identifying the index multiplicities of each term in the power series. We applied a K-theoretic localisation method to the symbol of the horizontal Daolbeault operator, decomposing it into a finite sum supported on certain closed orbits of the Reeb vector field. Using Lerman's classification of toric contact manifolds and the local form for the moment map, we obtain a Lefschetz-type formula for the index. Adapting the Lawrence-Varchenko formula, we obtained a polar decomposition of the moment cone C of the toric Sasakian manifold and related it to the index of the untwisted horizontal Dolbeault operator. This leads to an explicit formula for the index as a sum of lattice points related to the moment cone C.

Marcos has been placed on the Dean of Graduate Studies List (Dean's List) in recognition of excellence achieved with his PhD thesis. This award is made to only a few recipients each year from the large number of doctoral students completing their theses.

Sam Porath (University of Auckland. 2023)

Title: Projectively Compact Pseudo-Riemannian Manifolds.

Supervisors: Rod Gover and Warren Moors (both University of Auckland)

Abstract:
A projectively Klein manifold is defined to be a projective manifold with boundary where the interior is equipped with a pseudo-Riemannian metric that is projectively compact such that the boundary value of the extension of its scalar curvature is nowhere vanishing. As a consequence, there is a conformal structure on the boundary along which the conformal and projective tractor bundles agree. A Klein manifold may also be interpreted to be a projective manifold with a boundary given by the degeneracy locus of a solution of the metrisability equation, which is a first-order Bernstein-Gelfand-Gelfand equation. From this it follows that there exists a projectively invariant differential operator called the splitting operator and this defines a symmetric 2-cotractor that is termed the structure tractor. This gives a metric on the projective tractor bundle. A notion of special asymptotic boundary scales is introduced which make the splittings of the conformal and projective tractor bundles compatible along the boundary of Klein manifold. This important observation simplifies the construction of a boundary calculus which relates ambient projective quantities to their boundary conformal counterparts. By modifying the Eastwood-Matveev equation, which expresses the prolongation of the metrisability equation using the tractor calculus, the restriction of the ambient projective tractor connection along the boundary is explicitly linked to the boundary conformal tractor connection. An sl(2) algebra is shown to exist on a Klein manifold which is generated by a projective tractor Laplacian-type operator, the determinant of the solution of the metrisability equation, and a weight operator. This algebra enables the construction of tangential Laplacian-type operators along the boundary of the Klein manifold. The generalised conformal Yamabe operator and generalised Paneitz operator along the boundary of a Klein manifold are calculated, and it is shown that generalised Graham-Jenne-Mason-Sparling (GJMS) operators can be constructed on the boundary of Klein manifolds more generally. These are conformally invariant Laplacian power operators that include in their coefficients extrinsic embedding data.

Vincent Russell (University of Auckland. 2023)

Title: Statistical Inverse Modelling of Aerosol Size Distributions.

Supervisors: Tom ter Elst and Ruanui Nicholson (both University of Auckland)

Abstract:
In this research, we explore a statistical inversion approach to estimating and quantifying the uncertainty of aerosol size distributions and dynamical parameters from aerosol observations. We consider the state space framework to estimate and quantify the uncertainty of the size distribution, condensation, deposition, and nucleation rates. We apply a combined finite element method to the aerosol general dynamic equation, an integro-partial differential

equation, to model the temporal evolution of the size distribution. Our proposed method applies the discontinuous-Galerkin and collocation methods which obtain similar accuracy at lower computation costs compared to standard approaches. We also demonstrate the feasibility of the Bayesian approximation error approach in improving estimations. This research improves our understanding of aerosol size dynamics, and improves the estimation and uncertainty quantification with lower computational costs compared to previous studies.

Songbao Mo (University of Auckland. 2023)

Title: Classification of Ideal Secret Sharing Schemes.

Supervisors: Arkadii Slinko and Gabriel Verret (both University of Auckland)

Abstract:
This thesis contributes to the characterization of ideal secret sharing schemes and the forensic aspects of secret sharing. We focus on ideal hierarchical secret sharing schemes and find a matroidal characterization of ideal hierarchical access structures. In particular, we show that every ideal hierarchical access structure corresponds to a lattice path matroid. We also give a matroidal characterization for different classes of ideal access structures, including conjunctive hierarchical access structures disjunctive access structures, ideal weighted access structures, and ideal hierarchical roughly weighted access structures. We explore how the seniority of users influences their ability to frame other users. The possibility that the users can be framed is a price we have to pay for using ideal secret sharing schemes, and we find a (non-ideal) frameproof secret sharing scheme for every access structure.

Dibyayoti Dhananjay Jena (University of Canterbury. 2023)

Title: Point Sets in Projective Spaces: Intersection Numbers and Linearity.

Supervisors: G. Van de Voorde (University of Canterbury) and B. De Bruyn (Ghent University)

Abstract:
Chapter 1 of the thesis introduces the basic concepts and sets the notation to be used in the other chapters. Section 2.1 of Chapter 2 gives a brief overview of different types of point sets with few intersection sizes. In particular we look at the work of S. Innamorati and F. Zuanni on the characterization of Baer and unital cones in $\mathrm{PG}(3,q)$, where q is a square. In Section 2.2 of the same chapter, we generalize the result of Innamorati and Zuanni to their higher dimensional analogues. We further prove similar results for hyperoval and maximal arc cones. In all the cases we characterize the geometric object as a point sets with three different intersection numbers.

In Chapter 3 we briefly describe point sets whose intersection sizes are only even/odd numbers, which leads to the concept of pseudo-hyperovals and pseudo-embeddings as defined by B. De Bruyn. We give a brief overview of B. Sherman's classification of odd sets in $\mathrm{PG}(n,4)$ leading to the discovery of all homogeneous pseudo-embeddings of $\mathrm{PG}(n,4)$ and $\mathrm{AG}(n,4)$. We then summarize De Bruyn's classification of pseudo-hyperplanes of all generalized quadrangles of order $(3,t)$ found using the help of the computer programming language GAP. Later in that chapter we study all homogeneous pseudo-embeddings of the generalized quadrangle of order $(3,5)$ in a computer free way. This also allows us to describe all nonisomorphic hyperovals and tight sets of even type in a computer free manner.

Chapter 4 describes my work on linear sets with G. Van de Voorde. In Section 4.1 of the chapter, we give a brief introduction to linear sets and introduce the concept of the (maximum) geometric field of linearity of linear sets. We provide examples describing the significance of this new definition. In Section 4.2 of the chapter, we prove that for certain linear sets with no points of weight one, the geometric field of linearity of the set is a superfield of the usual field of linearity. Finally, in Section 4.3 of the chapter we provide a powerful construction of linear sets attaining the minimum bound as prescribed by De Beule and Van de Voorde. We also generalize the construction to higher dimensional projective spaces. In particular when the dimension of the projective space is 2, we find a new infinite class of linear blocking sets of non-Rédei type of the minimum possible size.

GENERAL NOTICES

KOZWavinar #3 – 9 November 2023

The scope of this webinar, designed for the Waves community from Australia, New Zealand and Japan, is to present recent developments of all aspects of waves, from the most theoretical mathematics to numerous applications. More information is available on the website of the webinar

https://kozwaves.github.io/KOZWavinar/.

The third KOZWavinar will take place online on Thursday 9 November 2023 at 3pm-5pm (NZ Time) with three guest speakers from Australia, New Zealand and Japan

- Miro Erkintalo, University of Auckland (New Zealand)
- Nicole Kesissoglou, UNSW (Australia)
- Takahito Iida, Osaka University (Japan)

We look forward to seeing many of you join us!

Luke Bennetts, Amin Chabchoub and Marie Graff

Public Lecture | Canterbury Distinguished Professor Roy Kerr, Black holes turn 60

Professor Kerr's influential discovery is a mathematical solution. It is a core ingredient for understanding the cycles of the life and death of stars, galaxies, of the heavy elements that we ourselves are made of and which we carry as precious metals on our fingers. Life, the Universe and everything.

Professor Kerr will dive into the stories of how he discovered the well-known Kerr metric. He will shed light on its importance in grasping the theoretical properties of the geometry of space. His key insight was that all physical objects collapsing under gravity inevitably rotate. This led to revolutions in more than one way. Combined with Einstein's insight that nothing moves faster than light it is now the mathematical basis for analysing new data, and new fundamental discoveries, now that we can finally observe gravitational waves from colliding black holes and neutron stars.

This is a rare chance to gain insights from a true pioneer in the field. Fundamental discoveries made 60 years ago are defining 21st-century science: the cutting edge for decades and centuries to come. Join us to share a unique piece of history, past, present and future.

https://www.canterbury.ac.nz/uc150/events/roy-kerr-lecture-/

Oceania

MathsJam Gathering

13th-15th October 2023

Koru Lodge, Spencer Park

OMG! Oceania MathsJam Gathering is an informal, weekend long get-together all about mathematical recreations, puzzles and ideas. If you enjoy maths, OMG is for you.

Come along and meet like-minded maths enthusiasts of all abilities and backgrounds!

- **Open Mic Maths**
- **Breakout Sessions**
- **Mathematical Bake-off**
- **Professional Development**
- **Keynote Talk**
- **Puzzles**
- **Board Games**
- **Competitions**

Accommodation is available at Spencer Park or it is only a 25-30 minute drive from Christchurch Central.

Check out mathsjam.nz for more information!

NZMS NOTICES

NZMS Colloquium 2023

We are thrilled to announce the upcoming NZMS Colloquium 2023, set to take place in Wellington from December 3rd to December 6th, 2023.

The event will commence with a reception for attendees on the evening of Sunday, December 3rd, followed by a captivating Colloquium dinner on Tuesday, December 5th, 2023. Additionally, there will be a Math Education Day scheduled for Wednesday, December 6th.

We are privileged to present our esteemed plenary speakers for this year's colloquium:

- Professor Rod Downey (NZMS Lecturer) from Victoria University of Wellington, NZ.
- Professor Frances Kuo (ANZIAM Lecturer) from the University of New South Wales, AU.
- Dr. Brendan Harding (Butcher-Kalman Lecturer) from Victoria University of Wellington, NZ.
- Professor Nicola Gaston (Equity and Diversity Lecturer) from the University of Auckland, NZ.
- Dr. Tanya Evans (NZAMT Lecturer) from the University of Auckland, NZ.
- Dr. Dominic Searles (Colloquium Lecturer) from the University of Otago, NZ.

Registration for the NZMS Colloquium 2023 is now open. To register, submit abstracts, and access further information, please visit our website at https://nzmathsoc.org.nz/colloquium2023/.

Should you have any further questions or concerns, please do not hesitate to contact us.

We eagerly look forward to welcoming you all.

The organizing committee:

Astrid an Huef
Brendan Harding
Dimitrios Mitsotakis (Convener)
Ginny Whatarau
Hung Le Pham
Parus Khoso
Tanya Gvozdeva

New Zealand Mathematics and Statistics postgraduate conference

The New Zealand Mathematics and Statistics postgraduate conference (NZMASP) allows postgraduate students in mathematics and statistics at all New Zealand universities to share their research and build relationships to allow for collaboration.

This year, the conference will be held in Wānaka from the 17th to the 19th of November. All New Zealand-based postgraduate students whose research involves mathematics or statistics are invited to attend. All participants are expected to give a presentation and have the opportunity to win prizes. Registration closes on the 23rd of September. To register, go to https://nzmasp2023.wordpress.com/

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- The ability to nominate two students for free membership

You'll Experience:

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