Number 155 December 2025

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 Florian Lehner. 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 newsletter@nzmathsoc.org.nz. LaTeX templates are available upon request from the editors.

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EDITORIAL

Kia ora koutou

As 2025 draws to an end we reflect on another year of challenges and change. AI is becoming increasingly better at solving assignments, forcing many of us to rethink our assessment strategies, and the Marsden fund as we know it is being discontinued; in light of this, applying in the last-ever Marsden round will be high up on the to-do list for many of us this summer.

On a more pleasant note, the NZMS colloquium took place in Hamilton a few weeks ago. The colloquium featured a range of excellent talks across diverse mathematical areas, the announcements of the NZMS awards (covered on pages 27 – 30), and even song performances at the conference dinner.

Our profile puts the spotlight on Nicolette Rattenbury, whose outstanding contributions to outreach and teaching were recognised with the Gillian Thornley Award and the inaugural Award for Teaching Excellence at the Joint Meeting of the NZMS, AustMS, and AMS last year. The New Zealand mathematics community is very fortunate that her plan to become an airforce pilot did not work out!

We wish you a relaxing summer break and a great and productive start to the new year.

Marie Graff and Florian Lehner

PRESIDENT'S COLUMN

It was very nice to see many of you at the NZMS Colloquium in Hamilton. A big thank you to Nick Cavenagh and his colleagues at Waikato University for organising this event, and for their many efforts to ensure it ran smoothly (including resolving the lack-of-milk crisis). Of course, having the Colloquium now behind us means that we have almost come to the end of the year 2025. So I would like to start by wishing you all the best for the Holidays and a Happy 2026.

As you will know, we had our AGM at the Colloquium (the minutes can be found in this issue of the Newsletter) and there are a few points for me to note here. First of all, Melissa Tacy's terms a VP and Council member came to an end. Thanks again, Melissa, for all that you have done for the NZMS over the years as President and VP. My thanks also to Jeroen Schillewaert for agreeing to be nominated as our next VP, and to Stephen Joe and Priya Subramanian for agreeing to serve on Council. All three were appointed unopposed, and I look forward to working with Jeroen, Stephen and Priya.

In other news, I am happy to report that Mathematics in Industry New Zealand (MINZ) is now a subcommittee of the NZMS, with the primary role to guarantee and oversee the organisation of the annual MINZ workshops. The MINZ group was previously organised, including financially, under the umbrella of KiwiNet. However, this arrangement came to a close, and MINZ is now organisationally a part of the NZMS. In fact, MINZ is the first subcommittee that has been established under clarified and spelled out rules for what it means to be a subcommittee of the NZMS (adopted in connection with revising our constitution and bylaws); specifically, terms of reference are required for a subcommittee and need to be approved by the NZMS Council, as does its membership. I would like to thank Winston Sweatman and Rua Murray for their work on setting up MINZ as an NMZS subcommittee. Unfortunately, we were unable to complete the process of agreeing terms of reference for the Education subcommittee yet. This subcommittee is presently suspended, but Council has agreed on a way forward to (re)establish it under the updated rules, hopefully quite soon.

A high point of the Colloquium is always the dinner where our prizes are awarded. We decided to present the information on the 2025 winners of the different prizes of the NZMS and of the ANZIAM Best Poster prize more prominently elsewhere in this issue of the Newsletter. Congratulations to all Prize winners! It is great to see excellent work being conducted and recognised across different areas of mathematics. Sincere thanks to the nominators and to the members of our Nominating and Prize committees, since quite some work is involved behind the scenes...

Hereby I would like to encourage you all to already consider nominating a colleague for our 2026 prizes. In particular, we did not have any nominations for Fellows of the NZMS, and I hope we'll have some Fellowship nominations next year. Up to date information on how to make nominations can be found on our website at https://nzmathsoc.org.nz/awards. There you will also find information about the Vaughan Jones Lectureship, a new scheme that we established to fund an eminent research mathematician and speaker from overseas to visit New Zealand over a period of four weeks to give public lectures and colloquia at most universities. The Vaughan Jones Lectureship will be awarded in odd year, with the inaugural one in 2027. A call for nominations will go out in early 2026, so please already start thinking about possible candidates.

To finish, I would like to thank all Council members and especially our Secretary Geertrui Van de Voorde, as well as Newsletter editors Marie Graff and Florian Lehner for all their work this year.

Enjoy the summer,

Bernd Krauskopf

LETTER TO THE EDITORS

Mathematical (publishing) malfeasance

I am currently the North American representative on the International Mathematical Union's Committee on Publications (https://www.mathunion.org/cop). A joint committee of IMU and ICIAM, whose membership intersects CoP nontrivially but doesn't include me, recently published a discussion paper and recommendations on the topic of scholarly publication fraud as it relates to mathematics. Apologies in advance to sheltered readers: there is some really bad stuff going on, which predates the widespread use of generative AI but will likely be exacerbated by that technology. The widespread unthinking use of bibliometric indicators for research evaluation, and the acceptance of the "gold" (pay to publish) open access model have made it profitable for many to cheat. Some practices that are on the rise are: bogus gold OA journals, plagiarism, using dodgy institutional affiliations, selling citations, selling authorship credit on a paper, blackmail, identity fraud, non-disclosure of conflicts of interest, subverting the normal peer review process. Although mathematics is highly resistant to some kinds of scientific fraud plaguing other fields (e.g. making up data, as we have seen even from Harvard professors recently), it is peculiarly vulnerable to other forms. In particular, Mathematics was dropped from the Clarivate Highly Cited Researchers list because of the ease of manipulating citation numbers.

I urge readers to check out the reports at the above website (similar versions have been published in Notices of the AMS in October and November 2025), and make their opinions heard to policymakers. These are difficult times worldwide, politically and economically, and it is tempting to think that such issues are not important enough to worry about. I disagree. My opinion is that the entire enterprise of science is in danger of being corrupted past the point where it can be fixed, and that without a properly functioning scientific system, we have no worthwhile future as a species. We must get our own house in order, and then help tackle the political rot that has become all too apparent worldwide in recent years.

Mark C. Wilson

https://markcwilson.site

EDUCATION

As it currently stands, the Mathematics Education group is an informal (mainly online—zoom, discord) discussion group of mathematicians, teachers and others with an interest in mathematics education. It includes both NZMS members and non-members. We are creating a Terms of Reference that formally clarifies the relationship between the group and the NZMS that aligns with subcommittee guidelines.

In short, there will be a subcommittee of the NZMS that deals with Education issues and reports to Council. With the way Mathematics Education has been in the news recently, a formal structure is important if or when the NZMS needs to formulate a position on some issue.

The main work of the subcommittee is to build and maintain relationships with other stakeholders in Mathematics Education (e.g. teachers). Members of the current education group (including teachers and other non-NZMS members) will be an important source of news and feedback for the subcommittee, and will continue to meet as usual to discuss and exchange views. We only had a couple of meetings in 2025, but will hopefully be more active next year.

Primary mathematics

There has been a lot of media coverage of the big changes to the new primary curriculum. Here is a short list of articles online from various points of view:

- A rushed new maths curriculum doesn't add up. The right answer is more time. (The Conversation—Lisa Darragh, David Pomeroy) Link
- New maths curriculum sparks revolt. (The Spinoff) Link
- Better reading, maths results but two new curriculums a massive job - Principals (RNZ) Link
- Kerre Woodham interviews Gaven Martin on calls to pause curriculum rollout Link

The developments in NZ mathematics education are also generating international interest:

https://hechingerreport.org/new-zealand-has-a-problem-with-mathematics-can-a-new-strategy-make-a-difference-for-students/

The direction towards explicit instruction of the basics and more mathematical content is the right one I think. But there are criticisms of the scale and speed of the changes, the amount of new content at each level, and lack of support for teachers and schools.

One task of the Education group and subcommittee next year will be to get feedback on how things are going.

Sione Ma'u

A CHALICE OF SPHERES

Some will know what a chalice or goblet is and others might not. Whichever, it is a bowl shaped drinking vessel that is used commonly to hold liquids, especially wine for consumption on ceremonial occasions. Such vessels can be found also in domestic drink cabinets. In the past, their piece parts - a bowl, a stem and a base (or foot) – were made of precious/semi-precious metals, assembled after manufacture. Cheaper versions made from clay materials thrown on a potter's wheel were also produced. Nowadays they can be moulded as a single piece from glass or plastics. Their shapes can vary in size but there is always a bowl shaped component from which to drink. Attention here is concerned with the design of a very specific shape of goblet, viz., "A Chalice of Spheres", because its piece parts are sections of spheres. Moreover, the proposed design allows for the chalice to be inverted and remain stable, providing thereby the option to sup equal amounts of liquid from whichever end is uppermost. Such a design is of interest also to applied mathematicians and an example is shown in Figure 1 below. The shape is shown here as a 2-D object but the chalice is in fact a 3-D one, formed by rotating the plane shape about its vertical line of symmetry.

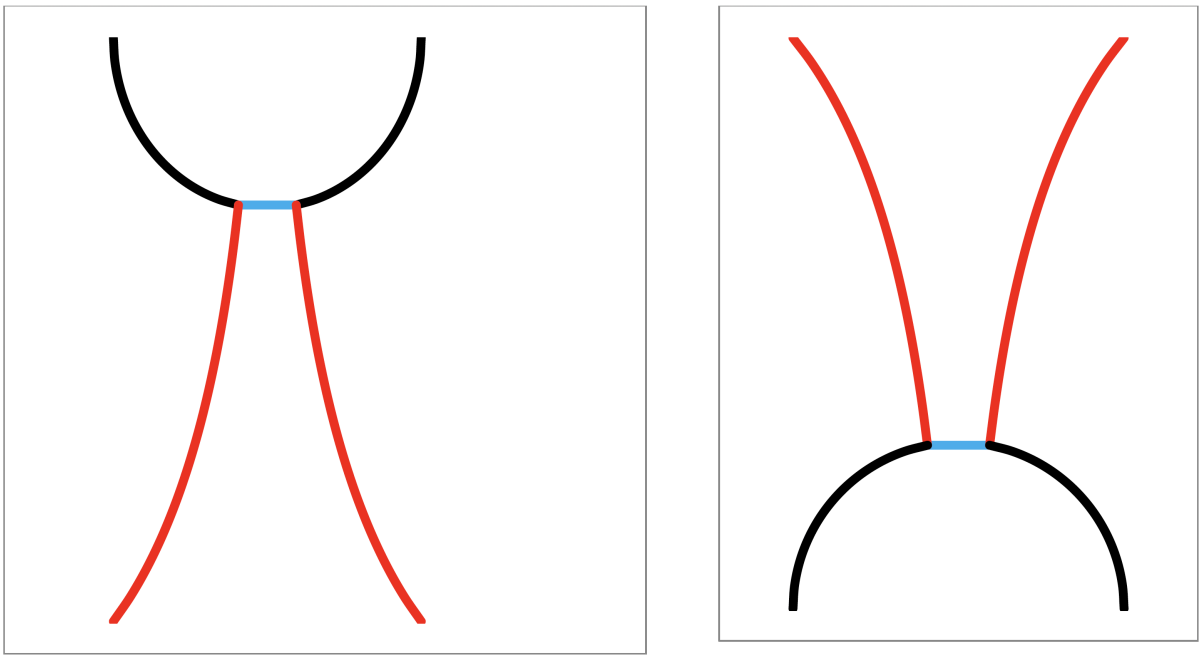

Figure 1: A Chalice of Spheres: (Left) Spherical slice uppermost; (Right) Pseudospherical slice uppermost.

The nomenclature "spherical" is used because the build parts comprise only slices of spheres, joined at a common interface. The uppermost bowl on the left in Figure 1 is such a slice cut, so to speak, from a hemi-spherical shape and it rests likewise on a slice cut from a hemi-pseudospherical one. The rims at the top and bottom of the chalice have been designed to be the same, as too is the volume contained within each slice. The sphere is well known to younger students, it is a surface that has a constant positive curvature. The pseudosphere might not be so well known, but it has a constant curvature, albeit negative. Its history is interesting (Google the names Eugene Beltrami (1868) and Ferdinand Minding (1806 - 1885) to appreciate more). The 3-D shape is known also as a "Tractricoid" or "Tractroid", being the shape obtained on rotation of a 2-D tractrix curve about its asymptote. The mathematical design aspects are discussed briefly below but the fine details in the supporting sums are left for the reader to explore. Before so doing, it will be necessary to provide details regarding formulae etc. for the volumes of a spherical slice and a pseudospherical one, as follows:

(1) The Spherical Slice:
The volume of a spherical slice can be viewed as a volume difference between two spherical caps. With reference to accompanying Figure 2, the volume V of the depicted slice (shown cross hatched) can be derived from first principles or gleaned from the internet in the form

$$V = \frac{\pi}{6}\left((H^3 + 3r_1^2 H) - (h^3 + 3r_2^2 h)\right) \qquad (1)$$

With reference to the diagram, H and h are the respective heights of the two different spherical caps drawn from the same sphere (of radius, R say) and the corresponding chord lengths for each cap are denoted by $2r_1$ and $2r_2$ respectively.

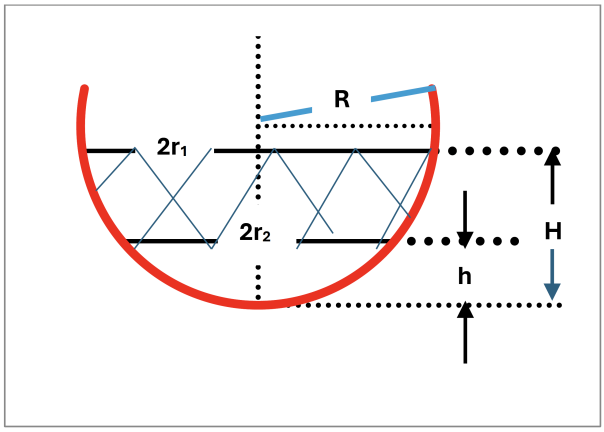

Figure 2: A Spherical Slice

(2) The Pseudo-Spherical Slice:
The volume, W say, of this slice can be viewed also as a volume difference between two pseudospherical caps. With reference to the the tractrix in the adjacent figure, the relevant slice of the pseudosphere is shown shaded. The tractrix extends symmetrically in the vertical direction from minus infinity to plus infinity and here, only the upper half (a hemi-pseudosphere) is shown. If the horizontal axis in the figure is denoted by ρ and if the vertical one is denoted by z, the shape of this upper part is given parametrically by

$$\rho = \pm \text{asec}(u), z = a(u - \tan(u)), 0 \ll u \ll \infty,$$

where a is the radius of the pseudosphere, obtained when the value for the parameter u is zero. It is a straightforward matter to show that the volume, W say, of the slice (shown shaded in Figure 3 between parameter values u_1 and u_2) is given by

$$W = \frac{\pi a^3}{3}\left(\tanh^3(u_2) - \tanh^3(u_1)\right). \qquad (2)$$

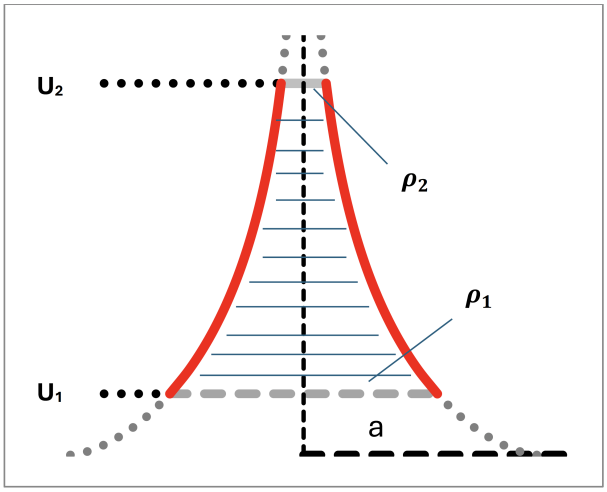

Figure 3: A Pseudo Spherical Slice

(3) Constraint Conditions:
With reference to Figures 2 and 3, the diameter $2\rho_2$ of the pseudosphere at parameter point u_2 is chosen so that the pseudospherical slice marries up exactly to the above spherical slice at their common interface, resulting in the requirement that $\rho_2 = r_2$. There is also another condition that, perforce, relates various parameters of interest. With reference to the geometry in Figure 2, it is simply

$$(R-h)^2 + r_2^2 = R^2 = (R-H)^2 + r_1^2,$$

which implies that $R = (r_1^2 + H^2)/2H = (r_2^2 + h^2)/2h$. As a matter of interest, the parameter h is ideally small and it follows then from this relationship that $h \approx r_2^2/2R$. In the light of comments made above about equal widths, it follows that $r_1 = \rho_1$. Moreover, it will be assumed that the tangent to the rim of the spherical bowl in Figure 2 is vertical, implying $r_1 = \rho_1 = R = H$.

(4) Other input values and design outputs:
To determine design outputs relevant to the above, values for other input parameters are required. Specifically, by measuring the dimensions and volumes of typical wine glasses, the following input was chosen, viz., $r_1 = 4$cm. In addition, the length of the common interface where the two spheres join was chosen to be 1.5cm, so that $r_2(\equiv \rho_2) = 0.75$cm. Equipped with such inputs, it is a straightforward matter to establish first a target value for the volume V from Formula (1) above. It is simply 133.978cm. This must be met by manipulating inputs to the other volume expression given by W in (2). For the as yet undetermined parameter size 'a', select a suitable range and step size on, say, an excel spreadsheet and vary them interactively until a value for W meets the target value V. At each step, the values required for the input parameters u_1 and u_2 are determined from their respective formulations in (2). Of course, it is possible to approach the business in a different way involving the development of a numerical code, in whatever language that suits, to obtain the same end result. In such a way, it can be shown that a value of 'a'$= 6.243$cm will meet the proposed volume requirements and produce the shapes shown for example in Figure 1, with an overall height of 13.043cm, assuming of course that the interface line shown in that figure is infinitely thin.

Conclusion: An interesting problem of designing a Chalice of Spheres has been discussed and it is an example in applied mathematics that is well suited for use, say, at an advanced-school level or early-university level. The parameter values chosen here are not set in stone and the use of other values can be exploited to produce a different looking chalice. It is conceivable that those familiar with the machinations of a 3-D Printer could produce hardware to match a design. However, it is likely that the common interface join for the two chalices will have to be beefed up to avoid a weak point in manufacture. This can be achieved by modifications to the mathematical design process without compromising the requirement for equal volumes, and it is left as a further exercise for the interested practitioner to consider.

John D Mahony

A Chalice of Spheres (©JDM, ChCh, Oct. 2025)

PROFILE

Nicolette Rattenbury

Nicolette Rattenbury was recognised last year at the Joint Meeting of the NZMS, AustMS and AMS as the 2024 recipient of the Gillian Thornley Award for her "sustained leadership and contributions in Mathematics and Science communication/outreach, her mentoring of students, and also her sustained efforts to support equity/diversity in Science and Mathematics." Most members of the Department of Mathematics at the University of Auckland would have considered such an award a matter of when, not if. Certainly at Auckland, but probably further afield in NZ, Nicolette is synonymous with Mathematics Outreach. Her enthusiasm and phenomenal energy have drawn hundreds of students to mathematics and their appreciation of having Nicolette as lecturer comes close to idolisation. On the day of Nicolette receiving another teaching award, I got the chance to interview her and ask the pressing question: "How do you do it?"

Nicolette's career path to the position of Professional Teaching Fellow in Mathematics has not been easy. In fact, her childhood dream was to become an airforce pilot. Growing up in Taupō, Nicolette was fortunate to have a very inspiring maths teacher in high school. "His name is Jim Hogan and we still get in touch about once a year by email or visit to touch base and catch up." Nicolette's talent in mathematics were discovered early on—she was moved from 3rd to 5th form—when she was placed in the maths class taught by Jim Hogan. "He was very good at pushing you without overwhelming you. He would get you to explore and enjoy mathematics." Nicolette also took physics and computer science and focused on her dream to be selected for the airforce pilot training programme. She does have a vivid memory of an evening playing cards with her mum—"I must have been 15 or so"—when her mum said: "I very much support you going into the airforce, but I can also totally imagine you lecturing at university." Perhaps it is true that mums know best. . . .

A year later, everything changed: Nicolette was not accepted onto the airforce pilot training programme! She took a year out to get over the disappointment and reassess her options. Since she liked maths and physics, she made the decision to enrol for a BSc at the University of Auckland; the terrible experience of her first physics lecture was

the reason she became a maths major. Nicolette thoroughly enjoyed her studies, taking courses in mathematics as well as computer science, and managed to get several research project opportunities: at the end of her second year, she worked on a programming-based summer research project with Philip Sharp; another summer project in her third year saw her working with John Butcher, helping him with his book, which meant learning LaTeX; and she also chose John Butcher as supervisor for her MSc research on *Almost Runge–Kutta methods: A theoretical and practical investigation*. John encouraged her to stay on for PhD research. Under his supervision, Nicolette investigated the appropriate choice of order conditions for higher-order almost Runge–Kutta methods to extend these techniques to stiff problems. To help support her research, Nicolette started lecturing at Manukau Institute of Technology and at the local Queen's Street branch for the foundation year of the University of Woolongong. She also got married to physicist Nicholas Rattenbury who asked her to come with him to Manchester when he started a postdoctoral fellowship there. With 10 months to go, Nicolette ended up writing most of her PhD thesis in Macclesfield, UK.

In 2005, Nicolette was awarded her PhD, and she had to decide what to do next. The inevitable two-body problem meant she restricted her options to opportunities around Manchester. She had enjoyed doing research, but she did not consider taking up a research position at all; she had also very much enjoyed teaching, although she did not want to teach at high school. Nicolette started looking for jobs in financial mathematics. Already at interview stage, she realised this was not for her and that she had to find a job at a university. Initially, she was hired part-time at Manchester Metropolitan University (MMU) to teach mainly foundation mathematics, and she was also contracted to teach part-time at the University of Manchester (UM). It was in this first year as a lecturer that Nicolette discovered how much she is valued as an academic: her SET evaluations were so good that UM asked her to teach the academics how to teach! However, MMU had already offered Nicolette a full-time lectureship, so UM missed out.

As I am sure you are now also wondering: is she a natural? Nicolette explained to me that she had to enrol in a one-year teacher training programme at MMU, which meant taking classes herself every Wednesday afternoon and writing a teaching portfolio. (In my opinion, as someone who took this programme at the University of Exeter, writing a teaching portfolio is like writing a PhD thesis; it is hardly shorter and requires serious time commitment.) Nicolette had to defer submission of her teaching portfolio, because William, her eldest, decided to be born five weeks early. Nicolette's teaching qualification was eventually recognised with her acceptance as a member of the Higher Education Academy, and she was further honoured as Fellow of the Institute for Mathematics and its Applications for her contributions to teaching and outreach.

In the meantime, indeed, Nicolette had started making her name as a maths communicator. She had ventured in this direction after learning about the Pop-Maths initiative from Sheffield Hallam University. Here, 'Pop' stands for 'Popular' and this annual quiz for senior high-school students aims to get them thinking outside the box with maths questions that are designed to be solved relatively quickly. "Sheffield Hallam University encouraged people to copy the idea. They were happy to share question banks and things like that, so I started Pop-Maths at MMU." Around the same time, Nicolette also began giving public talks for the Girl Geek Network. The word got out and in 2012, Nicolette was approached by the BBC for a 5-minute Science segment on the One Show. "They wanted to improve on the world record for the number of times a piece of paper can be folded in half. I was asked to talk through the maths of figuring out how long the strip of paper had to be to add one more fold." Origami specialists will know that a piece of A4 paper can be folded at most 7 times; by making the paper longer, more folds can be achieved. The Guiness World Record for folding a single piece of paper (still) stands at 12 times, established in 2002 by American high-school student Britney Gallivan. The attempt for the BBC One Show was to be filmed in the Manchester shopping mall, until someone realised that to achieve 13 folds, the paper had to be at least 3 km long.... It took another three months to obtain the required length of (super thin) paper and a new venue: a service tunnel underneath the Kielder Dam. Nicolette was to be present again, with the specific request that she wear the same clothes as for the early filming, to make it look like everything was done on the same day; this turned out to be an unsurmountable obstacle, because by now, Nicolette was six months pregnant! (The attentive reader will notice that, yes, this was with Nicolette's second child, her daughter Julia.) This episode of the BBC One Show was aired in May 2013; you can watch it on YouTube (https://www.youtube.com/watch?v=ZQ0QWn7Z-IQ) and decide for yourself why there has been no update on guinnessworldrecords.com.

In 2013, 'Nic and Nick' moved their family back to NZ. "Nick was offered a fantastic position in the Department of Physics and we both agreed it was too good an offer to miss." Nicolette decided to give up her permanent position in Manchester and came along with the positive mindset of wanting to re-define who she wants to be. Nicolette did not just move her family, her entire outreach experience came to NZ with her. At first, she got temporary contracts, in particular to help start the successful Science Scholars programme at the University of Auckland. It took until 2016 before Nicolette was offered a permanent position, when she joined the Mathematics Department as a Professional Teaching Fellow. By now, almost a decade later, she is a Fellow of the NZMS, winner of the 2024 Gillian Thornley Award; and most recently, Nicolette was recognised by the Australia Education Management Group (AEMG) with an 'Outstanding Teaching Visit Teacher Award', for her lectures in China in 2024.

Nicolette loves her job. "I love the flexibility of my job and the variety of it: the teaching, pastoral care, outreach, seeing those 'aha' moments with my students, and the mentoring of junior staff members." As undergraduate adviser in our department, Nicolette does see a lot of variety and has to get through a lot of administrative tasks on a daily basis. She starts work super early so she can be there when her kids come home from school; a very early start also means the first part of the day is not interrupted by the near-constant stream of students asking for her advice. Where did she learn to manage her time so effectively? Nicolette laughs at my question, but honestly, I cannot imagine being in her shoes. (This is my coping mechanism: whenever I feel too stressed about getting stuff done, I think of how busy other colleagues like Nicolette are, and I instantly feel better.) "I have a very supportive husband and we both understand that it is a matter of give and take." Nic and Nick make it work by having a shared calendar recording who is where when, and they hold weekly strategy meetings to coordinate getting everyone to and from their activities. "But I do have hobbies! I always join the team on campus solving the cryptic crossword over the lunch breaks; playing board games every now and then, especially during the holidays; we go to the pub quiz every Tuesday night; and I love cycling, and travelling with my family, in NZ, but also to Europe and other places."

The NZ Branch of ANZIAM just voted in Nicolette as its new Chair at the 2025 AGM; it is clear that the branch will be in good hands!

Hinke Osinga

LOCAL NEWS

AUCKLAND UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING, COMPUTER AND MATHEMATICAL SCIENCES

Events

In November 2025, our Department of Mathematical Sciences and Mathematical Modelling and Analytics Research Centre at AUT organized two major events. The first is the AUT Analytics Mix & Mingle on Tuesday, November 4. This is the sixth time that we've brought together 50 alumni, industry partners, staff members, and current students for networking. The event was opened by Professor Wendy Lawson, Deputy Vice-Chancellor, with a keynote talk by Chris Lowe from Valocity. Then, a panel discussion including Evan Atkinson from SUEZ Digital Solutions, Clarissa Côrtes Pires from Mercury, Helen Wu (alumni) from Amazon, and Toetu Lafoai (alumni) from Auckland Council.

The 6th AUT Analytics Mix & Mingle

The other one is the 10th AUT Mathematical Modelling and Analytics Symposium, organized on November 24-25. Our symposium attracted approximately 60 registered participants from various universities in multiple countries, such as Australia, China, Korea, Macau, New Zealand, and Thailand. There were 26 presentations, including four invited talks, that involved mathematical sciences in various aspects, ranging from actuarial science, applied mathematics, biology, computer science, engineering, econometrics, finance, health science, social science, and statistics.

The AUT Mathematical Modelling and Analytics Research Centre focuses on research in the areas of mathematical modelling, industrial optimisation and data analytics, and provides a collaborative research environment through regular seminars, and workshops. The next MMARC Symposium is planned for November 2026. We hope to see you there!

The 10th Mathematical Modelling and Analytics (MMARC) Symposium

AUT School of Engineering, Computer and Mathematical Sciences Showcases New Research Centres at 2025 Research Week

The School of Engineering, Computer and Mathematical Sciences at Auckland University of Technology marked a milestone during AUT 2025 Research Week in September with the official launch of five newly established research centres. Each centre was represented by an early career researcher who presented their latest work, highlighting the breadth and impact of AUT's research community.

Dr. Hammed Fatoyinbo, representing the AUT Mathematical Modelling and Analytics Research Centre, presented his recent research on modelling highly pathogenic avian influenza (HPAI). In his presentation, Dr. Fatoyinbo used the illustration of Numeric Islands, the Island of Mathematics and the Island of Statistics, to demonstrate how different perspectives can be applied to better understand the transmission dynamics of HPAI. The launch of these centres underscores the school's commitment to fostering interdisciplinary collaboration and supporting the next generation of researchers in tackling complex global challenges.

Travel and Conference Participation

Dr. Parul Tiwari was an invited Keynote speaker at the international conference on "Women in Innovation, Networking & Global Solutions (IC – WINGS 2025)", Indian Society for Technical Education, 14 – 15 Oct 2025. Parul also presented a research article in The New Zealand Mathematical Society (NZMS) Colloquium 2025, November 26–28, 2025.

Dr Hammed Fatoyinbo presenting his talk at the 2025 AUT Research Week

On 16th October 2025 a lively discussion on science communication was hosted by UoA Scientific. Dr. Cathy Hassell Sweatman represented mathematics on the panel.

In October, Prof. Jiling Cao visited China Jiliang University (CJLU) in Hangzhou, China. In addition to teach the course "Optimization and Operations Research" for the joint Master of Analytics program, he presented a research seminar talk in financial mathematics for staff and students in the College of Science at CJLU. Moreover, he also discussed with the senior leadership team there about the possibility of setting up a joint research lab on data analytics to strengthen the research collaboration between AUT and CJLU.

Dr. Yiming Ma presented his research on detecting short-term slow slip events using GNSS time series at the International Joint Workshop on Slow-to-Fast Earthquakes 2025 in Kochi, Japan. This annual workshop, organised by the Science of Slow-to-Fast Earthquakes project and hosted in different cities across Japan, aims to foster an integrated approach to earthquake research across the full slow-to-fast spectrum. He also presented his work at the 2025 Annual Meeting of Chinese Geoscience Union in Chengdu, China, which attracted more than 4,000 participants from across the geoscience community to share the latest scientific advances. In addition, he attended the 2025 Geoscience Society of New Zealand Conference in Tāmaki Makaurau Auckland, themed "Learning from the Past, Shaping the Future."

Visitor

In December, Professor Hui Zhao from Nankai University visited Prof. Jiling Cao and Dr. Shu Su to do joint research in Mathematical Finance.

PhD completion

In September 2025, Wenqiang Liu successfully defended his PhD theses. The title of Wenqiang's PhD thesis is "Valuation of Financial Derivatives under the 4/2 Stochastic Volatility Model", supervised by Prof. Jiling Cao, Dr. Wenjun Zhang and Assoc. Prof. Wei Qi Yan.

Wenjun Zhang

UNIVERSITY OF AUCKLAND

DEPARTMENT OF MATHEMATICS

Staff News

We congratulate Eamonn O'Brien for being selected as a Fellow of the American Mathematical Society. Forty mathematicians from around the world have been named Fellows of the American Mathematical Society (AMS) for 2026, the programme's fourteenth year. AMS members designated as Fellows of the AMS have made outstanding contributions to the creation, exposition, advancement, communication, and utilization of mathematics.

Our staff and students received a number of awards at the NZMS Colloquium Dinner in Hamilton.

- The Gillian Thornley Award for mathematics research and contributions to mathematics in NZ was awarded to Melissa Tacy.
- The Kalman Prize for Best Paper was awarded to Jeroen Schillewaert for his paper "Braid Groups, Elliptic Curves, and Resolving the Quartic" with Peter Huxford (Math. Annalen 2025).
- The NZMS Award for Teaching Excellence was awarded to Florian Lehner for developing the engagement token system.
- The Aitken Prize for the best contributed talk by a student at the NZMS Colloquium was awarded to Davide Papapicco, with Sam Doak an honorable mention.
- Sam Bolduc was awarded the ANZIAM Prize for Best Poster.

Nicolette Rattenbury was recognised by AEMG (Australia Education Management Group) on 17 November for her Outstanding Teaching Visit in China for 2024. Several members of the department helped celebrate the event.

Nicolette Rattenbury celebrating her award.

PhD student Joe Steele (supervised by Bernd Krauskopf and Neil Broderick) won a Best Presentation award at the 2025 Te Whai Ao — Dodd-Walls Centre Symposium in Wellington from 24 to 27 November.

Congratulations to all of them!

Bernd Krauskopf was invited as one of the keynote speakers at the first International Conference on Experimental Continuation in Nonlinear Dynamics (XCon), held 28-29 August at the University of Liège, Belgium. The aim of XCon is to bring together experts in the fields of experimental continuation and control-based nonlinear vibration testing. Having been the first, with Jan Sieber (University of Exeter, UK) to develop the technique of control-based bifurcation analysis in experiments, Bernd Krauskopf is considered one of the godfathers in this relatively new field. Together with Jan, they gave the 'double-act' presentation "Control-based continuation: tracking unstable phenomena in experiments" to open the conference. The photo taken by (former UoA postdoc) Soizic Terrien (now at Le Mans University, France) shows Bernd and Jan with chair Jens Starke (University of Rostock, Germany):

Bernd Krauskopf giving his keynote lecture at XCon

Jeroen Schillewaert gave invited talks at Hausdorff institute in Bonn, UC San Diego, Irsee (Germany), and contributed talks at Buildings conference in Louvain-la-Neuve, NZMS Colloquium and ACC combinatorics conference in Wellington, during his sabbatical.

Other News

The department had an outstanding result in this year's Marsden, with five grants funded. The recipients are:

- Jurij Volcic, Noncommutative rational functions and their finite dimensional representations (AI M Farkas, mentor Prof R Gover), Fast Start.
- Pedram Hekmati, From knots to manifolds: new techniques and applications, (AIs DP Baraglia, VGB Ramos), Standard.
- Claire Postlethwaite, Exotic behaviour in intransitive competition networks, (AI DJW Simpson), Standard.
- Melissa Tacy, Quantifying energy dependence phenomena for rough scatterers, (AIs SN Chandler-Wilde, J Rowlett), Standard.
- Tom ter Elst, New perspectives on elliptic boundary problems, (AI EM Ouhabaz), Standard.

Bernd Krauskopf hosted international visitors Henk Dijkstra (University of Utrecht), Reyk Börner (University of Utrecht), Tony Humphries (McGill University), Jan

Sieber (University of Exeter), Andrew Keane (University College Cork), and Courtney Quinn (University of Tasmania), who presented at the workshop Climate Dynamics Challenges from 18 to 21 November. Henk Dijkstra has been supported by the Margaret and John Kalman Charitable Trust as a Michael Erceg Senior Fellow, and he presented the Michael Erceg public lecture Complexity of the ENSO phenomenon on 20 November. Moreover, Henk has been this year's ANZIAM speaker at the NZMS Colloquium, where he gave the talk Importance of Conceptual Climate Models to Understand Climate Tipping Phenomena. Reyk Börner, Jan Sieber and Andrew Keane also gave presentations at the Colloquium.

The department hosted several other visitors in the last quarter of the year, including

- Kenny Paterson, ETH Zurich
- Sina Schaeffler, ETH Zurich
- Alan Sun, Rangitoto College
- Stephan Tornier, University of Newcastle
- Jan Slovak, Masaryk University
- Steven Greenwood, Masaryk University
- Georg Sprenger, Masaryk University
- Thomas Leistner, University of Adelaide
- Marc Houben, Inria Bordeaux
- Primož Potočnik, Univ. of Ljubljana, Slovenia

We congratulate Álvaro Menéndez Calzada, Meizheng Fu, Ling Qin, Bradley Windelborn and Darius Young, for successfully defending their PhD theses.

Pedram Hekmati

DEPARTMENT OF ENGINEERING SCIENCE AND BIOMEDICAL ENGINEERING

The department congratulates Peng Du, who was promoted to Professor, John O'Sullivan, who was promoted to Associate Professor, and Maedeh Amirpour, who was awarded the prestigious Yamaguchi Medal from the Asia Pacific Association for Biomechanics (APAB).

6th Symposium of the International Engineering Science Symposium (IESC)

From September 8 to 10, 2025, the Department of Engineering Science and Biomedical Engineering at the University of Auckland hosted the 6th Symposium of the International Engineering Science Consortium. The Symposium started with a student workshop on Time-series Machine Learning taught by Associate Professor Andreas Kempa-Liehr. The following two days featured 16 presentations on Engineering Science Programs and Engineering Science Research, with participating academics and students from Singapore, Japan, Australia, Canada, Sweden, the United Kingdom, the United States of America, and New Zealand.

The student poster session had 11 contributions, with Rodrigo Kunrath winning an award for the best postgraduate poster, and Joseph Storey and Jackson Schofield winning an award for the best undergraduate poster. The social program included a visit to Rocket Lab hosted by Engsci alumni and a dinner at Auckland's Sky Tower. The panel, comprising of senior lecturers Oliver Maclaren and Ru Nicholson, ME student Josephine Greenwood, and EngSci alumnus Lara Collier, exchanged their perspectives on academic and professional careers in Engineering Science with the audience.

The Symposium closed with a management meeting, in which Associate Professor Andreas Kempa-Liehr from the University of Auckland accepted the appointment as Chair of IESC for the next two years.

57th Conference of the Operations Research Society New Zealand

The Department of Engineering Science and Biomedical Engineering, together with colleagues from the Business School, recently hosted the 57th Annual Conference of the Operations Research Society of New Zealand (ORSNZ). The event was a great success and featured a special highlight: ORSNZ President Andrea Raith presented the Lifetime Achievement Award to Professor Michael Saunders, a New Zealander now at Stanford University, renowned internationally for his contributions to optimisation software. The award included a nostalgic touch—a magnetic tape containing his Minos software, which had been in the Engineering Science offices for over 30 years. Engineering Science graduates were well represented among the prize winners. The conference followed a technical workshop on JuMP, a leading open-source optimisation package developed in part by EngSci alumni Oscar Dowson and Iain Dunning. Prize Winners:

Jack Yarndley Young Practitioners' Prize (Best Presentation): Sequential Convex Programming for Multimode Spacecraft Trajectory Optimization (EngSci graduate; now at Te Pūnaha Ātea – Space Institute)

Mahin Panchia Young Practitioners' Prize (Best Presentation): Develop AI Models to Predict Water Levels (EngSci Part IV)

Juliette Foley John A. George Memorial Prize: Optimising Sustainable Meal Planning Under Real-World Constraints (EngSci graduate & Masters student)

Andreas Kempa-Liehr

UNIVERSITY OF WAIKATO

DEPARTMENT OF MATHEMATICS AND DATA ANALYTICS

In November, after an interim of quite a few years, the NZMS Colloquium was again hosted at the University of Waikato. Ably organised by Nick Cavenagh and the committee, the meeting was its usual enjoyable mix of wide-ranging talks, socialising, and networking. Non-talk highlights included after dinner songs(!) by John Butcher and Graeme Wake.

Tori Stanton will be joining us in January 2026 as a lecturer in statistical consulting. She will be coming from the United States, where she recently successfully defended her PhD. Welcome to Tori!

AI, and its roles in mathematics papers, is a topic of repeated discussions and meetings. Not a lot in the way of firm decisions so far.

Sean Oughton

MASSEY UNIVERSITY

SCHOOL OF MATHEMATICAL AND COMPUTATIONAL SCIENCES

David Simpson had success in the latest round of Marsden funding. He is Principal Investigator on the Marsden grant "Empowering research analysts with better mathematical tools for analysing physical phenomena" with Associate Investigators Paul Glendinning (University of Manchester) and Chris Budd (University of Bath). David is also an Associate Investigator on "Understanding complex cycles of competition" led by Claire Postlethwaite (University of Auckland).

Carlo Laing received the 2025 Massey University College of Sciences Research Award – Individual.

Carlo Laing hosted Oleh Omel'chenko (University of Potsdam, Germany) from September 11-21. Oleh gave a seminar entitled "Inverse problems related to pattern formation on coupled oscillator networks".

Winston Sweatman, David Simpson and Graeme Wake spoke at the NZMS Colloquium at the University of Waikato.

The College of Sciences held Research Forums in November. Carlo Laing and David Simpson spoke at the Manawatu forum and Carlo also spoke at the Albany forum.

The move of the Albany mathematics group (along with statistics and computer science) to the Innovation Complex has not yet occurred.

Carlo Laing

VICTORIA UNIVERSITY OF WELLINGTON

SCHOOL OF MATHEMATICS AND STATISTICS

No major news to report from Te Herenga Waka–Victoria University of Wellington:

Our school planning day was held again this year after a long pause, giving us the chance to meet in person, reconnect, and get to know one another better. We also reviewed our strategic direction for the School, including our response to the School Review and the recent Graduating Year Reviews. The day concluded with a lively discussion on the increasingly important role of AI in teaching, supervision, and research.

The year concluded quietly after the examination period. Students and staff are now preparing for the festive season and the summer break. The School of Mathematics and Statistics marked the end of the year with an excellent gathering at Southern Cross Cafe.

The VUW team sends its warmest regards to its colleagues across New Zealand and wishes everyone a happy and prosperous New Year.

Dimitrios Mitsotakis

UNIVERSITY OF CANTERBURY

SCHOOL OF MATHEMATICS AND STATISTICS

Numbers down under

Brendan Creutz, Felipe Voloch and Li Zhao (UNSW) organised this year's Number Theory Down Under conference (NTDU) at UC, August 25-29. This was the largest NTDU ever with 65 participants and the first time held in New Zealand. Alongside the Australian & NZ contingent, we were thrilled to welcome participants from China, Denmark, France, Hungary, India, Italy, Japan, Netherlands, Switzerland, the UK, and the USA. The talks ranged from the deep and serious to the delightfully quirky - think palindromic primes and connections between isogeny volcanoes and chemistry.

Plenary speakers included James Borger (ANU), Steven Galbraith (Auckland), Peng Gao (Beijing University), Harald Helfgott (CNRS), Mumtaz Hussain (La Trobe University), Igor Sparlinksi (UNSW), Alexei Skorobogatov (Imperial College London), Local Thompson (Utrecht University), and Ilaria Viglino (EPFL).

Prizes for best student talks were awarded to Raiza Corpuz (Waikato) and Yiannis Fam (University College London). In a fun twist, the students awarded a prize to Jim Borger (Australian National University) for the best non-student talk.

https://www.math.canterbury.ac.nz/~f.voloch/ntdu2025.html#registration

Number Theory Down Under.

Meridian Energy's Digital Generation Capability Programme (DigiGEN)

We hosted a visit from Meridian Energy's Digital Generation Capability Programme (DigiGEN) team, coordinated by Dr James Williams in collaboration with Dr Yanosh Irani, Meridian's Head of Data and Performance and a UC alumnus who completed both his undergraduate and doctoral studies here.

The visit prompted lively exchanges on how UC and Meridian might strengthen their partnership in data science. Discussions focused on creating direct pathways for students to contribute to real-world projects and on ways to translate data insights into practical solutions for asset management.

Both teams identified strong institutional support and mutual enthusiasm for extending the collaboration, with scope for students to work alongside industry practitioners on active initiatives. The visit drew broad engagement from across the School and Faculty joining to support the discussions.

Dr Irani later reflected on the collaboration in a public post, observing that "when you don't know what you don't know, a university is a great place to start."

MathSoc Halloween Trick-or-Treating event

The UC Mathematics Society (MathSoc) once again hosted its popular Halloween Trick-or-Treating event in the Jack Erskine Building. Now in its third year, the event took place on Friday, 31 October, from 3-5pm, inviting students to visit participating staff offices for a light-hearted afternoon of treats and themed activities. MathSoc provides all materials, including chocolates, signage for participating offices, and short, Halloween-themed information sheets profiling staff research areas, recent teaching, and student supervision opportunities. This year's event also featured family-friendly activities such as lawn games and a cookie-decorating station, with staff encouraged to bring their children or grandchildren along. The initiative continues to be a creative way of fostering engagement between staff and students while celebrating the School's vibrant community culture.

Chris Stevens

UNIVERSITY OF OTAGO

DEPARTMENT OF MATHEMATICS AND STATISTICS

Matt Schofield has been appointed as the new Maths & Stats Head of Department for a 5-year term, starting in January. Congratulations, Matt, and thank you for taking on this difficult position. Best wishes for your term!

We also would like to thank the previous HoD *Sarah Wakes* for her service. She has led the department effectively during her tenure, and she is approachable,

responsive and consistently supportive. Moreover, she fosters a collegial atmosphere and regularly participates in afternoon teas, giving a strong sense of being "one of us" rather than a distant figure of authority. Thank you, Sarah.

Congratulations to *Xun Xiao* for receiving the University's Early Career Award. Xun's research focuses on industrial engineering, and he is developing novel statistical methods to mitigate uncertainty in managing complex networks of infrastructure assets. Well done!

Further congratulations to *Xun Xiao* on his promotion to Senior Lecturer, and to *Tilman Davies* and *Jörg Hennig* on their promotions to Associate Professors, effective from February 2026.

We continue the good news with Marsden Fund success. Firstly, we congratulate *Fabien Montiel* and collaborators from Auckland and overseas on receiving funding for their Marsden project "Reading the waves to map a new polar ice landscape, improving maritime safety and climate science for New Zealand". Secondly, congratulations to PI *Conor Kresin* and AI *Martin Hazelton* on the Fast-start grant "Correlation or causation? Measuring cause-and-effect from complex spatiotemporal data".

Finally, we are also happy about two Otago recipients of NZMS awards, which were presented at the conference dinner during the recent NZMS Colloquium. *Dominic Searles* received an NZMS Early Career Research Award "for his contributions to algebraic combinatorics, in particular developing the combinatorial theory of the ring of polynomials, which has led to greater understanding of polynomial bases with important applications to geometry and representation theory". *Jörg Frauendiener* received the NZMS Research Award "for groundbreaking work in mathematical and numerical relativity, especially his innovative use of conformal methods for the numerical treatment of gravitational systems". Congratulations!

Jörg Hennig

NZMS President Bernd Krauskopf (left) presents Early Career awards to Dominic Searles and Rajko Nenadov (University of Auckland) and (below) the NZMS Research Award to Jörg Frauendiener.

PhD SUCCESSES

Wenqiang Liu (Auckland University of Technology. 2025)

Title: Valuation of Financial Derivatives under the 4/2 Stochastic Volatility Model.
Supervisors: Prof. Jiling Cao, co-supervised by Dr. Wenjun Zhang, Assoc. Prof. Wei Qi Yan

Abstract:
This thesis proposes a new stochastic volatility model, which is called the re-scaled double mean-reverting 4/2 stochastic volatility model, for valuation of European and real options. It is shown that this new model can effectively capture the mean-reverting and volatility features of the underlying asset movements in both short and long terms. An approximate formula for pricing European options is provided via an asymptotic approach, where the leading term is the same as the result from the celebrated Black-Scholes pricing formula and the correction terms are contributed by stochastic volatility. The formula is validated through Monte Carlo simulation and real market data on S&P 500. In the same approach, approximate formulas for pricing a real option and determining its corresponding investment threshold are developed. However, these approximate formulas on real options can only be tested by simulation methods, due to lack of market data. Nevertheless, numerical experiments show their high accuracy for both options. The contribution of this thesis fits in modern quantitative finance on financial derivative pricing and investment analysis. The outcomes provided in this thesis are potentially useful for academic research and financial practice in making trading decisions or managing investment risks.

Álvaro Menéndez Calzada (University of Auckland. 2025)

Title: Dimension of Generalised Inverse Limits
Supervisors: Sina Greenwood and Sione Ma'u

Abstract:
This dissertation studies the dimension of generalized inverse limits (GILs) on separable metric continua. The dimension theory tools used to that end are introduced in the first chapter.

It provides upper bounds for the dimension of the Mahavier product of two functions on arbitrary separable metric continua in terms of the dimensions of the domains and codomains of the functions, the dimensions of their graphs, and the sets $\Delta_i(f)$ and $\Delta_i(f)$ of Definition **??**. It also includes upper bounds for the Mahavier product of finitely many functions in terms of the dimensions of Cartesian products of images and preimages of the functions.

Examples of GILs and Mahavier products on spaces different to intervals as well as some results about one and zero-dimensional GILs are presented. The examples include inverse sequences with oscillating dimension.

The upper bounds for the dimension of GILs on arbitrary metric continua given in works by Nall , Ingram, and Banič et al. are reviewed. Some of them are strengthened and a new bound depending on the dimensions of the graphs of the bonding functions is found. Additionally, the upper bound of Theorem **??** is extended to inverse sequences with oscillating dimension.

The characterisation of the dimension of a GIL on intervals proved by Banič and Greenwood through the notion of weighted sequence is discussed and extended to GILs on graphs. The concept of T-cell is defined and utilised to improve the upper bounds found by Kato for the dimension of a GIL on arbitrary separable metric continua. These new bounds apply to Δ-complete inverse sequences, which is a less restrictive class than that of Kato's and is also defined in the present thesis.

Finally, some questions relating to dimension of GILs are proposed.

Meizheng Fu (University of Auckland. 2025)

Title: Elementary abelian subgroups of classical groups
Supervisors: Eamonn O'Brian, co-supervised by Jianbei An

Abstract:
Many open conjectures in the representation theory of finite groups can be studied by reducing them to related questions about quasi-simple groups. In such studies, p-radical subgroups typically play a critical role. To classify the p-radical subgroups of a finite group, we first classify its elementary abelian p-subgroups and find their local structure. To do this, we conduct the classification in a linear algebraic group G and then transfer the results to the finite group of Lie type G^F. We carry out this program in detail for classical groups of type A. For types B, C or D we either classify the non-toral elementary abelian 2-subgroups of G, or reduce the classification problem to an associated finite frame group.

Ling Qin (University of Auckland. 2025)

Title: Isogeny-Based Cryptographic Protocols with Advanced Functionalities
Supervisors: Steven Galbraith, co-supervised by Jason Legrow and Gabriel Verret.

Abstract:
Advances in quantum computing have heightened concerns about information security in the post-quantum era. While traditional cryptographic schemes rooted in number-theoretic assumptions (e.g., integer factorization, elliptic curve discrete logarithm, and discrete logarithm problems) remain foundational to modern security infrastructures, their vulnerabilities in quantum computing environments have become apparent. To address this, researchers have shifted focus toward quantum-resistant mathematical problems. Among these, isogeny-based cryptography has emerged as a strong candidate within the five primary post-quantum cryptographic approaches, garnering significant academic interest.

Recent progress in isogeny-based cryptographic schemes includes SIDH (though recent cryptanalysis by Castryck and Decru has compromised its security), CSIDH, and SQISign. Despite progress, the inherent structural characteristics of isogenies impose limitations on design flexibility compared to other post-quantum alternatives. The goal of the thesis is to develop isogeny-based cryptographic protocols with advanced functionalities. We develop isogeny-based blind signatures based on techniques from CSIDH, CSI-FiSh, and other works. We also develop ring signature schemes using SQISign. Finally, we develop a verifiable encryption scheme (based on CSIDH) and bit commitment scheme (based on the Charles–Goren–Lauter isogeny-based hash function). For both schemes, we give ways to prove to a verifier that the encrypted/committed bits satisfy a given Boolean equation.

Bradley Windelborn (University of Auckland. 2025)

Title: Characterising Homeomorphisms on Continua
Supervisors: Sina Greenwood, co-supervised by Melissa Tacy

Abstract:
We answer the following question: given a set X and a bijective self-map $f\colon X \to X$, when does there exist a compact connected metric on X making f continuous? This thesis is solely devoted to answering this question and provides a characterisation.

Darius Young (University of Auckland. 2025)

Title: Quotients of triangle groups
Supervisors: Marston Conder, co-supervised by Gabriel Verret and Jeroen Schillewaert

Abstract:
This thesis described a number of new discoveries about the finite quotients of triangle groups, focusing on their asymptotic and collective properties. Darius significantly extended the work of Larsen (2001) and Tucker (2022), by showing that the set of orders of finite quotients of every ordinary triangle group has natural density zero, and he provided explicit bounds on the growth of these sets. He also proved that every triangle group admits smooth finite soluble quotients of derived length three or less, taking a first step towards explaining why so many automorphism groups of regular maps on orientable surfaces are soluble. He also addressed a problem posed by Girondo, González-Diaz and Hidalgo, by constructing the symmetric groups S_{4k} as smooth quotients of ordinary $(2,4,4k)$-triangle groups with one extra relation. Finally, he extended a 1974 theorem of Singerman, by showing that all orientably-regular maps with automorphism group isomorphic to $\mathrm{PGL}(2,q)$ are reflexible.

Mikhael Sayat (University of Auckland. 2025)

Title: Free-Space Continuous Variable Quantum Key Distribution: Towards a Global Quantum Network
Supervisors: John Cater, Nicholas Rattenbury

Abstract:
The aim of this thesis is to develop continuous variable quantum key distribution (CVQKD) for the goal of securing a global quantum network. A numerical tool was developed for comparing different CVQKD protocols and identifying parameter spaces for positive and negative secret key rate (SKR) while taking into account the simultaneous effects of CVQKD parameters. Using the transmittance, excess noise, and amplitude modulation, the tool shows that the M-QAM protocol outperforms M-APSK which outperforms M-PSK. In addition, increasing the number of coherent states for a protocol non-linearly increases the capability of a protocol to produce positive SKRs. The tool also identifies parameters spaces, such as small excess noise regimes, where protocols have the same performance. The tool helps identify appropriate protocols for channels where parameters such as the transmittance and excess noise fluctuate, and can be extended to include more CVQKD parameters. The improvement of CVQKD in turbulent channels, through the use of adaptive optics (AO), was studied by investigating the interferometric visibility between a quantum signal and a local local oscillator in turbulent channels. The results showed that the adaptive optics system was able to increase the interferometric visibility and decrease its fluctuations. In the context of free-space CVQKD, these lead to larger positive and more precise SKRs. The structures of existing QKD networks were analysed and shown how they can be fit into a general three-layer QKD network architecture for the endeavour of a global QKD network architecture. The asymptotic and finite size limit SKRs were calculated for different links CVQKD can be used. The results show that CVQKD achieves longer distances in inter-satellite, satellite-to-ground, fibre, and underwater links in order. In addition, the Gaussian modulated (GM) CVQKD protocol with multidimensional (MD) reconciliation outperforms all other protocols studied by producing positive SKRs for longer link distances. The link capacity, a routing metric for secret key distribution, which considers a dynamic SKR based on dynamic links was developed. Its feasibility in simulated CVQKD networks was presented for the aim of spatiotemporal secret key distribution through a CVQKD network.

REPORTS ON EVENTS

The First International XCON

Over the past week, I was fortunate enough to attend the First International Conference on Experimental Continuation in Nonlinear Dynamics (or, more simply, XCON), held at the University of Liège, Belgium. "Experimental continuation" refers to a collection of algorithms that trace solution branches of a nonlinear dynamical systems, directly within a physical experiment. Even before the conference began, I immediately knew that XCON was going to be very special. The conference was a celebration of the advancements culminated over 15 years of research into a two-day, single track event.

When I started my Ph.D. in 2021, I kept saying that you could "count the number of institutions actively working on continuation with one hand". This conference was proof that this statement has completely changed. The topic of experimental continuation was the heart of my thesis work; the attendees were a physical embodiment of my literature review (literally!). The conference was attended not only by up-and-coming researchers of today, but also by the 'founding fathers' who developed and popularised the subject matter.

I presented my thesis work on the application of experimental continuation to characterise the dynamic response of a MEMS cantilever. In this presentation I demonstrated the use of control-based continuation to identify the MEMS cantilever's complex dynamic landscape, including multi-valued curves and bifurcations points. Through the use of a stabilising feedback controller, the response against frequency and excitation amplitudes was explored, including those that are naturally unstable. This work holds the record for the fastest timescales recorded for a mechanical experiment of its kind, at just under 100 kHz. The other presentations at XCON ranged from topics in applied mathematics/analyses to real-world engineering applications. Although experimental continuation has been predominantly applied to academic examples of mechanical oscillators, XCON demonstrated promising results for new and exotic applications: the acoustics of musical instruments, dynamics of social systems, various aircraft systems, and the extension of experimental continuation to machine learning.

There were two attendees representing Aotearoa: myself and Prof. Bernd Krauskopf (Auckland). Bernd's attendance was also very special, as he presented the opening keynote alongside long-time colleague Prof. Jan Sieber (Exeter, UK), who detailed the beginning of what we now refer to as experimental continuation. The keynote speakers of the first XCON were specifically chosen for their early contribution to the field, thereby providing a historical perspective on its development.

I has the pleasure of connecting with scholars from around the world who are actively working in this field. Notable examples include: Prof. Jens Starke and Niklas Kruse (Rostock, Germany) who also applied continuation for MEMS; Dr. Ludovic Renson and Nikola Ristic (Imperial, UK), who shared various control strategies; Dr. Robert Melville (Emecon, USA) who gave a refreshing perspective on continuation for electrical circuits; Romain Caron, Dr. Etienne Gourc (LMA, France) and Dr. Soizic Terrien (CNRS, France), whom are pioneering applications for musical instruments; and and the local organising team of Prof. Gaëtan Kerschen, Dr. Ghislain Raze, and Alexander Spits (Liège, Belgium) for sharing derivative-free continuation methodologies.

Overall, attending XCON was an extremely positive experience. In fact, it was the first conference where I found every presentation interesting. Not only was I able to connect with researchers in the field, open avenues for collaboration, but also to represent New Zealand research on the world stage. The success of the conference and the immediate positive feedback has inspired a second iteration! Although the details are yet to be confirmed, it is planned to be held in 2027 at a location "somewhere in Europe". I am eagerly looking forward to it!

Dr. Seigan Hayashi Ph.D. Graduate Department of Mechanical Engineering University of Canterbury September 8, 2025

Dr. Seigan Hayashi
Ph.D. Graduate
Department of Mechanical Engineering
University of Canterbury
September 8, 2025

Finite Geometry, Buildings and Friends – Student report

About Me

Kia ora! My name is Sebastian. I am now close to completing my second year towards a PhD in Mathematics under the supervision of Geertrui Van de Voorde at the University of Canterbury. My main interests are in (finite) geometry, graph theory and algebra. For my PhD I am focusing mostly on *Generalised Hexagons*.

General

In September I was able to go on a trip to multiple conferences in Europe thanks to the financial support of NZMS. I was awarded a total of $1500 coming from the general student travel funding. I did not have any other funding available to me so this support from the NZMS was very crucial for my attendance. The conference organisers did reduce my registration fees.

I first traveled to Irsee, Germany, to attend the seventh Irsee conference on finite geometry[1]. It was great to spend a week together in the Irsee Monastery with so many finite geometers. There were a number of people I recognised from my studies and other conferences and some new faces to go with the names I encountered in my research when reading articles. The talks were generally very accessible and highlighted different intriguing finite structures.

From Irsee, I took the train together with some of the others to Belgium. There, I attended the Buildings conference[2] in Louvain-la-neuve. This conference was dedicated to the 60th birthday of Bernhard Mühlherr. The aim across most presentations here was to link together various patterns and structures by analysing the groups related to their symmetries. Although occasionally a bit harder to follow, this gave a quit different but interesting view on my own research and the algebra it connects to.

The week after, I attended the Finite Geometry and Friends summer school[3] in Brussels. This was a lot more hands on with lectures and exercise sessions. The four invited experts did a great job at teaching us something more about polar spaces, algebraic curves, extremal combinatorics and code equivalence. There was also some time for me and others to present our own work.

During this conference and summer school, I stayed with family and used the train to save on accommodation costs. This was quite tiring but it was also nice to feel at home after the intense days.

The week after FGAF, I spend more time with Hendrik Van Maldeghem who was my supervisor back at Ghent University and is an expert on generalised polygons. We made some great progress on a new project which we can now follow up on remotely.

Below I added some more information about the work I presented at the two conferences and summer school.

Overall I had a great time in Europe. I made some great new connections, got nice updates of what others are working on and was able to share my own research and plans.

[1] https://mlavrauw.github.io/Irsee7/irsee7.html
[2] https://algebra.ugent.be/buildings2025/
[3] https://www.vub.be/en/event/finite-geometry-and-friends-2025

Presentation

I ended up presenting this project at the two conferences and summer school:

Characterising the natural embedding of the twisted triality hexagons

Sebastian Petit

University of Canterbury

(Joint work with Geertrui Van de Voorde)

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 $2n$. Here, we want to focus on generalised hexagons. Up to duality, only two classes of finite thick generalised hexagons are known: the *split Cayley hexagons* of order (q,q) and the *twisted triality hexagons* of order (q^3,q). Thas and Van Maldeghem characterised the natural embedding of the split Cayley hexagons in $\mathrm{PG}(6,q)$ using intersection numbers in 2008. Later, this was improved slightly by Ihringer in 2014.

In this talk we investigate the twisted triality hexagon, learn more about its natural embedding and obtain similar results. In particular we prove the following:

A set of lines satisfies a list of properties (such as for example (Sd) *every solid is incident with either* 0, 1, $q+1$ *or* $2q+1$ *lines of the set*) if and only if it is the set of lines of a naturally embedded twisted triality hexagon.

Budget

An overview of the main costs for this trip:

Description	Cost
Flight ChCh-Münich	\$1267
Flight Brussels-ChCh	\$1689
Irsee registration + accommodation (reduced cost)	\$709
Train travel to Belgium (refunded by Buildings)	\$223
Train travel in Belgium to Buildings (refunded by Buildings)	\$200
Train travel for FGAF	\$200
Total	\$4288

As mentioned earlier,my only general funding for this trip came from the NZMS. As indicated, the buildings conference was able to refund some of my travel costs to attend this conference.

Conclusion

I am very grateful I was able to go on this trip thanks to the support of the NZMS and think it was very helpful for my research.

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Summary of ICHST – Student report

Kia ora koutou! I am Nathan Hartmann, a second year PhD student at the University of Canterbury studying under Clemency Montelle and Glen Van Brummelen in the history of mathematics. Thanks to receiving the $1000 Gloria Olive Prize through NZMS, I was able to attend the 27th International Congress on the History of Science and Technology in Dunedin this past June and July. This report will summarise my time at the congress to thank NZMS for their support.

Though I had attended many maths conference during both my studies in the US and here in NZ, attending the ICHST was my first exposure to an academic setting purely devoted to the history of the sciences. Not only was this event extremely eye-opening to meet other researchers in the history of mathematics and astronomy particularly but this also inspired me in my own research. Of the many impactful talks I heard, the first plenary talk, titled *He wai nō Ruawhetū: The Flow of Knowledge from the Stars*, was particularly compelling. In her talk, Victoria Campbell shared *tātai aroraki* (Māori astronomy, lit. "naming stars") from *Kāi Tahu*. Since my research focusses on medieval Islamicate astronomy and mathematical practices, I was thoroughly enthralled by the discussion. One of the most captivating notions of this talk was how this iwi's calendars are formed from the stars, following a three-year cycle, where the first two years are determined by 12 stars and the third-year tracks 13 to readjust the calendar. The talks I attended were based on astronomical practices of different groups spread across the globe. One of the largest takeaways from the ICHST for me is how different peoples come to understand the scenery/sceneries of the night sky and how it impacts more than just naming conventions of constellations. Additionally, this congress allowed me to increase my academic-social circle, meeting fellow PhD students studying the history of mathematics and astronomy from around the globe, studying in the US, UK, Malaysia, and beyond.

My time at the ICHST was not only spent attending talks of other people, but I also gave a talk on my research into medieval Islamicate shadows, sharing that diagrams of the seemingly innocuous concept of a shadow is rather varied. My abstract read:

> *During the Medieval Islamicate period, the astronomical phenomenon called the "shadow", the darkness created by a light source encountering a gnomon, underwent a significant transformation when mathematicians began to perceive these shadows as an abstracted idea. We see ideas of ẓila (lit. "shadow", often translated to "Tangent") evolve between authors throughout the Medieval Islamicate era, ranging from the empirically-grounded astronomical shadow to an abstracted trigonometric relation. Of these interpretations, we examine three mathematicians, Ḥabash al-Ḥāsib (776CE - after 869), Abū 'l-Wafā' (940 - 998), and al-Bīrūnī (973 - c. 1050), and how their "Shadows" existed within these ideas of the Shadow/Tangent. We specifically look at the diagrams, figures, and models accompanying descriptions of ẓila to gauge each mathematician's conception of what the Shadow was, be it astronomical, trigonometric, neither, or both.*

I was able to present this research to my advisors Clemency Montelle and Glen Van Brummelen as well as an audience of varied backgrounds, all of whom asked compelling questions that have further my research and general insight into the history of mathematics. Without the aid of NZMS and the Gloria Olive Prize, I would not have been able to reap such benefits from the ICHST. I personally want to thank NZMS, for without your assistance, I would have been unable to attend the congress.

Summary of Expenses
Below is the cost of my time[4] in Dunedin, and attached are the receipts of them:

Description	Cost
Registration	$511.97
Accommodation (29 June through 6 July)	$299.25
Food	$137.99
Total	$959.21

Nathan Hartmann
University of Canterbury

[4]Travel to and from Dunedin was covered by my advisor Clemency Montelle, who rented a UC van and drove around 10 attendees total.

NZMS AWARDS 2025

This year, we are launching this new section to celebrate our awardees.

All pictures were provided by Hinke Osinga.

Aitken Prize

The Aitken Prize is awarded for the best contributed talk by a student at the annual New Zealand Mathematics Colloquium.

- Honorable mention: **Sam Doak** (University of Auckland)
  for the talk *Invariant Manifolds and Wild Chaos*
- Winner: **Davide Papapicco** (University of Auckland)
  for the talk *Inferring critical transitions from timeseries*

Aitken Prize: from left to right, Bernd, Sam and Davide

Gillian Thornley Award

The Gillian Thornley award was established in 2020 to recognize outstanding contributions to the cause or profession of mathematics in New Zealand.

- **Melissa Tacy**
  (University of Auckland)
  For her *substantial contributions to Mathematics in New Zealand, and to New Zealand society more broadly*.

Picture on the right: (left) Bernd with Gillan Thornley Awardee, Melissa (right)

Award for Teaching Excellence

This Award was established in 2024 to recognise outstanding teaching practice of mathematics in the NZ tertiary sector.

- **Florian Lehner**
  University of Auckland
  For *leadership in student engagement and, in particular, for developing and implementing an engagement token system — this innovative teaching and assessment approach places active student participation at its core and fosters a student-driven and interactive learning environment in lectures.*

Teaching Excellence award: (left) Bernd with Florian (right)

Kalman Prize for Best Paper

The Kalman Prize for Best Paper was instituted in 2016 to recognise excellence in research carried out by New Zealand mathematicians.

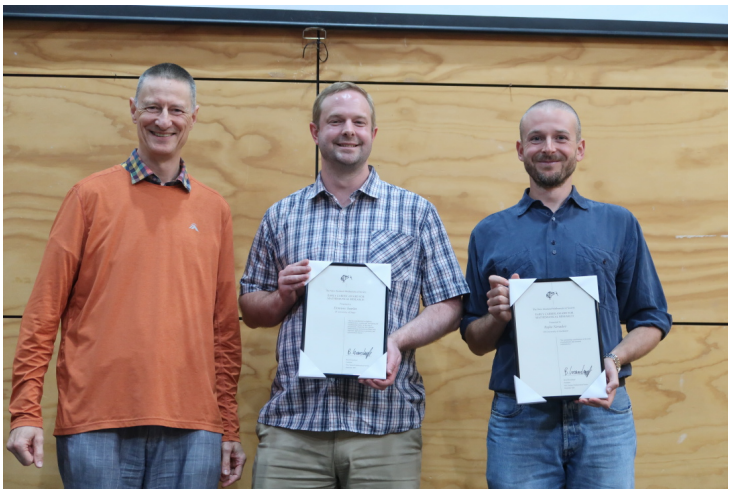
- **Jeroen Schillewaert**
  University of Auckland
  Paper title: *Braid groups, elliptic curves, and resolving the quartic* (by Peter Huxford and Jeroen Schillewaert); published in Mathematische Annalen 391, 4441–4442 (2025).

Picture on the right: (left) Bernd with Kalman Prize recipient, Jeroen (right)

Early Career Award

This award was instituted in 2006 to foster mathematical research in New Zealand and to recognise excellent research carried out by early-career New Zealand mathematicians.

- **Rajko Nenadov**
  University of Auckland
  For his *outstanding contributions in the areas of probabilistic and extremal combinatorics*.
- **Dominic Searles**
  University of Otago
  For his *contributions to algebraic combinatorics, in particular, developing the combinatorial theory of the ring of polynomials, which has led to greater understanding of polynomial bases with important applications to geometry and representation theory.*



Early Career Award: from left to right, Bernd, Dominic and Rajko

Research Award

The NZMS Research Award was instituted in 1990 to foster mathematical excellence in research carried out by mathematicians in New Zealand.

- **Jörg Frauendiener**
  University of Otago
  For *groundbreaking work in mathematical and numerical relativity, especially his innovative use of conformal methods for the numerical treatment of gravitational systems.* *Picture on the right: (left) Bernd with Research Award recipient, Jörg (right)*

ANZIAM Prize for Best Poster

This is the last edition of the ANZIAM Best Poster prize. A new version of the prize celebrating posters will be named after John Butcher from 2026.

- **Samuel Bolduc-St-Aubin** (University of Auckland)

ANZIAM Prize for Best Poster: from left to right, Hinke, Samuel and Brendan

NZMS NOTICES

Draft minutes of the 51th Annual General Meeting of the NZMS

Hamilton, 26 November 2025: 5:10pm-5.35pm

Welcome and apologies.

Apologies: Stephen Joe, James Bartlett, Carlo Laing, Michael Plank

Present: Bernd Krauskopf, Melissa Tacy, Hinke Osinga, Brendan Harding, Steven Galbraith, Jonny Stephenson, Tom ter Elst, Han Gan, Rajko Nenadov, Florian Lehner, Brendan Creutz, Mingfeng Qiu, Marie Graff, Steve Taylor, Catherine Hassell Sweatman, Winston Sweatman, Sean Oughton, Vivien Kirk, Sarah Wakes, John Butcher, David Simpson, Jörg Frauendiener, Joerg Hennig, Dominic Searles, Jeroen Schillewaert, Graeme Wake
Geertrui Van de Voorde (minutes; via Teams)

1. The minutes of the 50th Annual General Meeting were approved.
2. There were no matters arising.
3. President's report
   The President's Report (see Agenda documents, and President's Column) was accepted. A few points were highlighted in the meeting:
   - The president acknowledges the recent changes in the funding landscape and mentioned that NZMS is member of the Save Science Coalition which helps keeping track of those changes.
   - The president draws attention to the two reports by ICU-ICIAM on publishing in the mathematical sciences.
4. Treasurer's report
   The Society is in good financial health.
   Due to the changes in the financial reporting year, there were two treasurer's reports this year.
   Both of the reports were accepted. The proposed subscription of 90NZD (the same as for 2025) was accepted. The council thanks Stephen Joe for his diligent work as treasurer.
5. The membership secretary's report (see Agenda documents) was accepted.
6. The composition of the NZMS Council for 2026 was approved.
   (a) The term of Tammy Lynch ends.
   (b) The term of Melissa Tacy as outgoing vice president ends. The Council expresses their thanks for her continued work for NZMS.
   (c) Bernd Krauskopf remains president.
   (d) Geertrui Van de Voorde remains Secretary.
   (e) Jeroen Schillewaert (already council member) is elected as incoming vice president.
   (f) Stephen Joe is elected to the Council, and appointed as Treasurer.
   (g) Priya Subramanian is elected to the Council.
7. Forthcoming colloquia
   2026: University of Otago, dates to be confirmed.
8. Report on the NZ Journal of Mathematics.
   The report was accepted. The NZMS thanks Charles Semple as chief editor of the journal.
9. Guidelines for subcommittees (see Agenda papers)
   The president presented the guidelines that were adopted by the council

10. Changes to NZMS bylaws
    As a byproduct of the changes in constitution, three of our six bylaws were superfluous.
    The set of three bylaws were brought forwards for formal approval. They were unanimously accepted by the members present at the AGM.

11. The Terms of Reference for the MINZ subcommittee, which were accepted by the council, were presented. The Terms of Reference for the Education Subcommittee are still being finalised.

12. There was no correspondence or general business to report.

The meeting closed at 5:40pm.

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— Carol S. Woodward, SIAM President
Lawrence Livermore National Laboratory

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