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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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The newsletter is available at: nzmathsoc.org.nz/?newsletter

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EDITORIAL

Hello there from Marie and Chris.

August's newsletter is jam-packed full of goodies, with heaps of upcoming workshops and conferences advertised, a truckload of successful PhD defenses, information on gender diversity of mathematics and statistics staff throughout NZ and an informative article on how schools can cope with the new NCEA curriculum as it makes an appearance. Our president has written a botanical blurb on co-governance and how it relates to the NZMS society.

Shixiao Wang is profiled this edition and makes an excellent read. We wish him well in his retirement at the end of the year.

It has been great to see staff finally making research trips overseas for in-person conferences and collaborations this semester. This is exemplified locally, with so many conferences and workshops now running in-person, yay!

As asked in the previous edition, if you have any ideas and suggestions on how to improve the newsletter, please let us know; our contact details are on the previous page.

Marie Graff and Chris Stevens

PRESIDENT'S COLUMN

The Loose Vine

Mathematics and Statistics are two strong vines that weave together,
sharing a secure foundation

I found this pearl on Ministry of Education page for NCEA statistics[1]. These pages lay out the big picture, the ideas that underpin and overarch all NCEA standards and curriculums. The botanical imagery continues:

Kei hopu tōu ringa ki te aka tāepa, engari kia mau ki te aka matua
Cling to the main vine, not the loose one

You have to be careful with metaphors around academic mathematicians. We can't resist extending them for great comic effect.

It is tempting to be dismissive of all the figurative and flowery ministry prose. Surely this is something that teachers have to cope with but which has little relevance to the grand tertiary institutions. Wrong. The livelihoods of all academic mathematicians in this country are directly impacted by the text on those webpages and the decisions made now about mathematics in our schools. If year 13 students are discouraged from taking mathematics, our EFTS[2] drop. If our EFTS drop, we lose staff. We've seen this at Otago: between 2003 and 2006 the number of students taking year 13 calculus plummeted by about 35%; in subsequent years the Otago maths EFTS took a dive. Graphs of this have been used repeatedly by our administration to help us accept the drastically reduced mathematics group.

We have no choice but to engage with the metaphors, imagery and semiology of the ministry documents, as if the management-speak from our own administrations is not enough. As mathematicians we think we can stand aloof here. We are the experts in precise language and plain speech. In actuality, our abuse of language is just as severe. Even our core subjects suffer from inconsistent language and notation - try teaching first year calculus!

There are good reasons for inconsistencies in mathematical language and notation. There are also good reasons for widespread use of metaphors, imagery, and parables in discussions of education (and for that matter, science and research). Imagery can succeed in capturing an idea where 'plain' language fails. To my untrained eye, however, it would seem that the biggest driver behind the explosion of parables and metaphors is the challenge and excitement of co-governance.

You may not feel it yet, or even agree with it all, but NZ academia is being transformed by the obligations and opportunities of co-governance. I'm using the term co-governance to mean honouring and expressing the Treaty of Waitangi, righting past wrongs and building a joint future. We have no choice but to engage. These are real issues about real people, and we cannot take refuge in the mathematics education of the past. I'd like to bring your attention to the thought-provoking (and occasionally disturbing) article "Seen but unheard: navigating turbulent waters as Māori and Pacific postgraduate students in STEM"[3]. The article was co-authored by 43 past or present postgraduate students at NZ universities. Many of the stories are hard to listen to, but that is the intention: "we share our stories in an effort to cause a little trouble (Naepi 2021a)[4] with the expectation that universities in New Zealand will hear and listen to how we, as Māori and Pacific people, experience postgraduate education in STEM and will enact the much needed change."

The NZMS will be walking and talking through issues of co-governance during the next few years. We are essentially required to do this because of recent changes in the charitable societies law and our status as a constituent organisation of the Royal Society.

And yes, there will be screw-ups and faux pas, both within the NZMS and for reform of mathematics education nation-wide. At times, even our most august and respected institutions fumble and stumble. Some will throw up the barricades and try and defend our hallowed 1960s-style mathematics education from what is essentially social engineering. My preference would be to take an alternative route, one that is not uncritical of current trends but appreciates the importance and uncertainty of "work in progress".

[1] https://ncea.education.govt.nz/mathematics-and-statistics/statistics?view=learning
[2] equivalent full time students
[3] https://www.tandfonline.com/doi/full/10.1080/03036758.2022.2097710
[4] doi:https://doi.org/10.1080/07294360.2020.1857345

Think what makes a useful collaborator. There are times when you most need a collaborator who can see the holes in your arguments and shoot them down. But there are other times when what you really need is a collaborator who can see past the shortcomings and identify the new and possibly fragile ideas, work with you to get to something quite new. Sometimes you need to hang from a loose vine to swing to another tree. I think that is the situation we face here.

The NZMS has some challenging and important work ahead, both with respect to mathematics education and with respect to the treaty. It may seem that the cleverest strategy to follow is reactionary, but I don't believe that will serve us well in the long term.

David Bryant

EDUCATION

The refresh of the NZ Curriculum and review of NCEA achievement standards continues. One thing to keep in mind is that the NZ Curriculum is a high level document which broadly indicates what students should be learning at each level. It is short on detail. The actual details of what gets taught are sorted out by individual schools.

Teachers and schools need extra support to implement the new curriculum as it rolls out. Last year the Ministry of Education established Curriculum Leads (Kaihautū Marautanga) to provide more support and direction.

We welcome more support for teachers. For maths in particular, support should be standardised and ongoing. The government's new Maths and Literacy Strategy document says, *"...proven effective approaches to maths teaching and learning will build confidence and enjoyment. Curriculum stewardship is also needed to provide guidance on a range of effective and culturally sustaining teaching practices..."* (page 22).

Renu Sikka is a Curriculum Lead and member of the NZMS Education group. She explains what the Curriculum Leads do below.

Sione Ma'u

Kaihautū Marautanga (Curriculum Leads)—a frontline service for Kaiako[5]

The Ministry of Education established Curriculum Leads/Kaihautū Marautanga as a new front line support last year, to assist kaiako in kura, schools, early learning centres, and Te Kōhanga Reo to develop high-quality learning opportunities and experiences for all ākonga[6]. Te Tiriti o Waitangi, Marau ā-kura and indigenous curriculum development form the basis of this mahi[7].

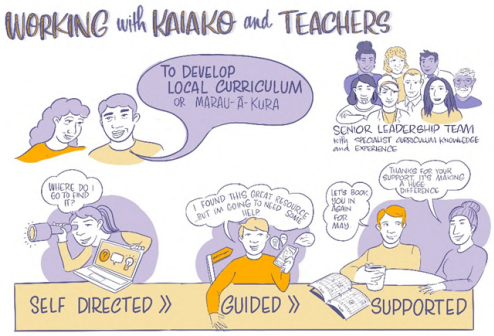
Curriculum Leads enable the entire system to learn collectively with and from each other. Their responsibility is to assist teachers and kaiako in understanding the national curriculum so that they can design meaningful learning experiences for ākonga.

Photo credit: Rawhitiroa Photography (https://www.facebook.com/RawhitiroaPhotography)

With knowledge and expertise in Te Whāriki, Te Whāriki a Te Kōhanga Reo, Te Marautanga o Aotearoa,[8] and the New Zealand Curriculum, our 38 Curriculum Leads work across the motu in all curriculum contexts. Having served as kaiako and leaders they are all passionate about Education with equity, inclusion and excellence. They offer genuine service to make a difference in education and provide kaiako the support they need to design authentic curricula with well-being as an outcome.

Curriculum leads provide different tiers of kaiako support: Self-directed, Guided and Supported.

[5] teachers
[6] students
[7] work
[8] Māori curriculum



Directly linked to Te Poutāhū (The Curriculum Centre)

Our Curriculum Leads can be found providing local knowledge and support across the nation in Te Mahau | Te Tai Raro, Te Mahau | Te Tai Whenua, and Te Mahau | Te Tai Runga (the North, Central, and South). They are directly connected to Te Poutāhū thus allowing the kaiako to have better access to information about changes to curricula and educational policies.

Future-focused: National Curriculum Refresh

Curriculum Leads have started working with kaiako on the Aotearoa New Zealand Histories curriculum, offering several possibilities for them to engage with curriculum materials.

Curriculum Leads assist teachers in identifying their situation and needs. Where necessary, they will quickly direct teachers to appropriate individuals and locations, such as professional development services, networks of knowledge, and subject matter specialists. Your local Ministry office is where one may get in touch with Curriculum Leads.

As Curriculum Leads will be working with local communities and in the regions, they will be able to strengthen and improve parents and whānau understanding of wellbeing, and how they can support their children, their learning, and wellbeing.

Overview of the Curriculum Lead Roles

The Curriculum Leads are a national team and are based regionally. They will:

- Assist in the creation of high-quality learning experiences that embrace the cultures, identities, and languages of all ākonga while putting a strong emphasis on their wellbeing by working with teachers and kaiako.
- Build collaborative networks within communities and actively share local practices.
- Provide frontline support for curriculum design and newly developed curriculum resources, rauemi[9] and guidelines. These include the Wellbeing and Mental Health Teaching Resource for Teachers, the refreshed Relationship and Sexuality Education Guidelines, and the Social and Emotional Learning Resources.
- Create feedback channels connecting Early Learning Services and ngā kōhanga reo, schools and ngā kura, with the Curriculum Teams in the National Office of the Ministry of Education.

Contact for more information: mailto:curriculum.leads@education.govt.nz.

Renu Sikka

[9] materials, resources

2022 HEADCOUNT OF STAFF IN MATHEMATICS AND STATISTICS IN NEW ZEALAND UNIVERSITIES

Summary

In 2018, the NZMS committed to gather and present data on the gender distribution of academic staff in Schools or Departments of Mathematics and/or Statistics in universities in NZ. Below we present 2022 data and compare it to data obtained in 2018 and 2019 (published in the December 2018 and December 2019 Newsletters). There has been a small decline since 2018 in the overall number of staff employed in Mathematics or Statistics across the country. Overall numbers of staff of under-represented genders in Mathematics and Statistics remain low, especially at senior levels.

Methodology

We have retained the same methodology as in 2018 and 2019. That is, we collected data by looking at university webpages, then asked an appropriate person in each Department or School (usually the head of the academic unit) to check the data we had obtained. We used a census date of March 1st, 2022.

Our methodology restricts the type of data we can collect, as follows.

- Our numbers represent a head count rather than taking into account the FTE of each staff member. Fractional numbers in our data represent one person split across multiple roles, e.g., 0.5 in Mathematics and 0.5 in Statistics.
- We have included fixed-term as well as permanent employees. We have not included emeritus staff or those with honorary positions.
- We collected data from the following universities: Massey, Auckland, AUT, Waikato, VUW, Canterbury and Otago. Because Lincoln University does not have a School or Department of Mathematics and/or Statistics, we could not find comparable information for Lincoln University, but this year we were able to get some informal information.

Following NZ regulations on gender, individuals are assigned their self-identified gender of Male (M), Female (F) or Gender Diverse (X). As the number of individual's in the Gender Diverse category is small and they are likely to be as under-represented as those identifying as Female we group these two categories into a single one (F/X).

A weakness in our methodology is that the data we have access to does not identify gender; we continue to record presumed gender. Our hope is that, in the future, universities might be able and willing to share gender data with us. We welcome comments and advice on better methods.

Data

We have collected data in 2018, 2019 and 2022. Our latest data shows interesting changes since 2018, perhaps reflecting hiring and redundancy practices during the pandemic, restructuring at Massey University and threatened restructuring at the University of Otago; see Table 2. Massey University and the University of Otago have seen decreases in headcount in Mathematics (but not Statistics) relative to 2018, of 33% and 38%, respectively; see Table 2. On the other hand, the University of Canterbury has seen an increase in headcount in Mathematics of 26%. To some extent, the improvements in percentage participation rates of females and gender diverse people result from greater retirement and resignation rates by males rather than increased hiring of people of other genders.

2022 data	Female and Gender Diverse, Maths	Male, Maths	Female and Gender Diverse, Statistics	Male, Statistics
Postdocs and research fellows	4 (50%)	4 (50%)	2 (29%)	5 (71%)
Teaching only positions	13.5 (45%)	16.5 (55%)	14.5 (60%)	9.5 (40%)
Lecturers (including fixed term)	4 (40%)	6 (60%)	8 (50%)	8 (50%)
Senior Lecturers	10 (24%)	31 (76%)	9 (29%)	31 (71%)
Associate Professors, Readers	6 (24%)	19 (76%)	4 (33%)	8 (67%)
Professors	5 (15%)	28 (85%)	7 (37%)	12 (63%)
Total	**42.5 (28%)**	**104.5 (71.1%)**	**44.5 (38%)**	**73.5 (62%)**

Table 1: Overall participation rates by gender and academic level.

	Female and Gender Diverse, Maths	Male, Maths	Female and Gender Diverse, Statistics	Male, Statistics
2018 Auckland	15 (33%)	30 (67%)	20 (44%)	25 (56%)
2019 Auckland	15 (35%)	28 (65%)	24 (48%)	26 (52%)
2022 Auckland	**16 (34%)**	**31 (66%)**	**23 (52%)**	**21 (48%)**
2018 AUT	7 (39%)	11 (61%)	4 (44%)	5 (56%)
2019 AUT	4 (29%)	10 (71%)	3 (38%)	5 (62%)
2022 AUT	**6.5 (42%)**	**9 (58%)**	**2.5 (38%)**	**4 (62%)**
2018 Massey	5 (24%)	16 (76%)	3 (20%)	12 (80%)
2019 Massey	5 (25%)	15 (75%)	5 (29%)	12 (71%)
2022 Massey	**3 (21%)**	**11 (79%)**	**5 (33%)**	**10 (67%)**
2018 Waikato	0 (0%)	10 (100%)	1 (25%)	3 (75%)
2019 Waikato	1 (9%)	10 (91%)	1 (25%)	3 (75%)
2022 Waikato	**1 (11%)**	**9 (89%)**	**1 (17%)**	**5 (83%)**
2018 VUW	3 (15%)	17 (85%)	8 (50%)	8 (50%)
2019 VUW	3 (14%)	18 (86%)	8 (47%)	9 (63%)
2022 VUW	**5.5 (26%)**	**16 (74%)**	**5.5 (35%)**	**10 (65%)**
2018 UC	8 (35%)	15 (65%)	5 (29%)	9 (71%)
2019 UC	8.5 (35%)	16 (65%)	4.5 (29%)	11 (71%)
2022 UC	**9.5 (33%)**	**19.5 (67%)**	**3.5 (22%)**	**12.5 (78%)**
2018 Otago	1 (6%)	15 (94%)	4 (25%)	12 (75%)
2019 Otago	2 (13%)	13 (87%)	3 (23%)	10 (77%)
2022 Otago	**1 (10%)**	**9 (90%)**	**4 (27%)**	**11 (73%)**

Table 2: Participation rates by gender and university. Numbers in brackets show the percentage of all staff in the discipline (Maths or Stats) at that university that fall into each gender grouping.

As in 2018 and 2019, the distribution across ranks is significantly different for different genders.

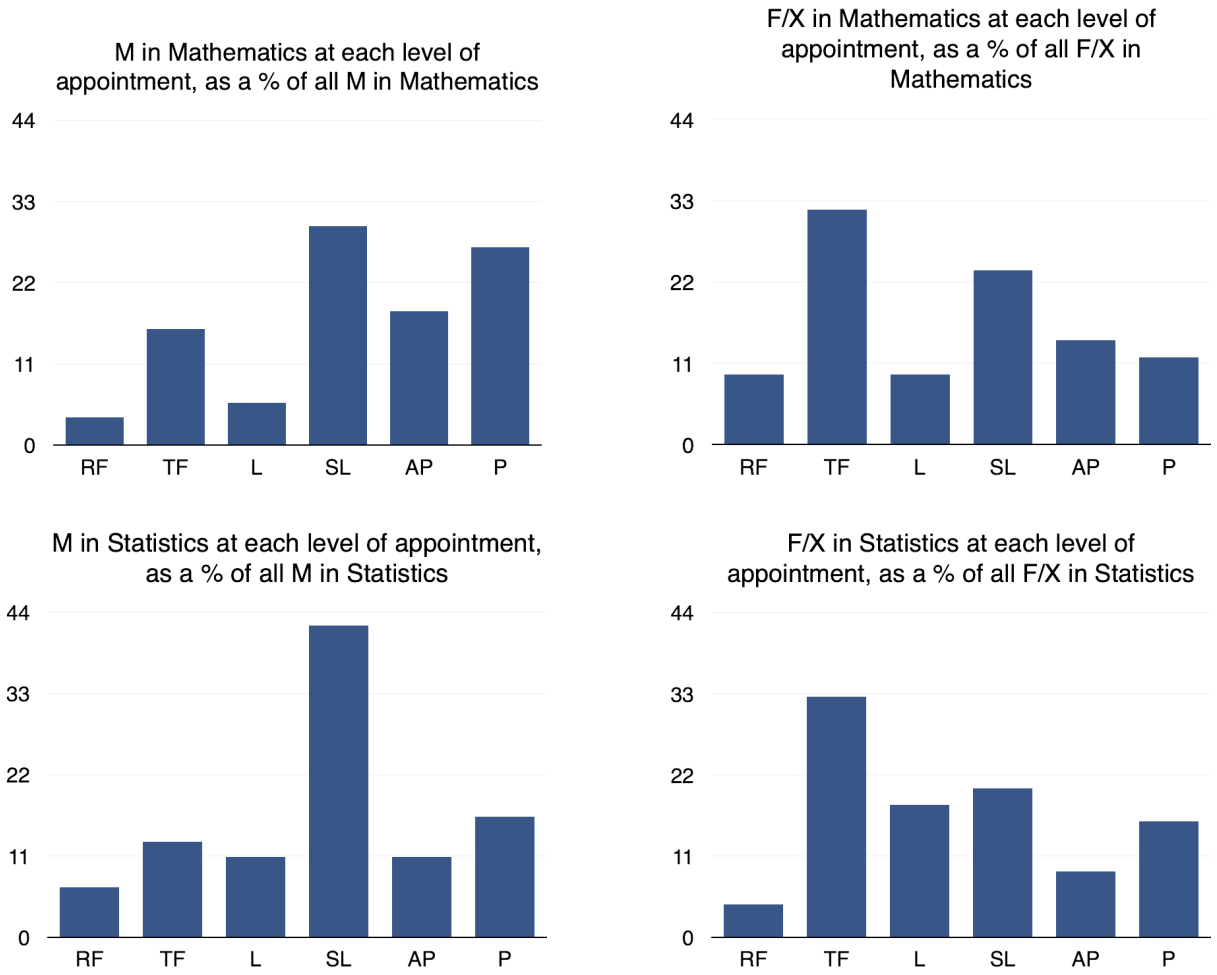


Figure 1: Distribution of genders across the academic grades. RF=Postdocs, Research Fellows and Senior Research Fellows, TF=Teaching only positions, L=Lecturers (including fixed term), SL=Senior Lecturers, AP=Associate Professors and Readers, P=Professors. F=Female, X=Gender Diverse, M=Male

The overall percentages for each gender are heavily influenced by numbers at the University of Auckland. Since Auckland is the biggest university, its relatively high proportion of underrepresented genders partially obscures the lower rates elsewhere; see Table 2. For example, the next table (Table 3) shows that more than 50% of F/X in Statistics are employed by the University of Auckland.

	Female and Gender Diverse, Maths	Male, Maths	Female and Gender Diverse, Statistics	Male, Statistics
2022 Auckland	16	31	23	21
2022 Rest of NZ	26.5	73.5	21.5	52.5
2022 Auckland as a % of NZ total	38%	30%	52%	29%

Table 3: Overall participation rates for the University of Auckland compared with the rest of the NZ universities.

It remains the case that a large proportion of people of underrepresented genders are employed in teaching-only positions.

	Female and Gender Diverse, Maths	Male, Maths	Female and Gender Diverse, Statistics	Male, Statistics
2022 Research required	29 (25%)	88 (75%)	30 (32%)	64 (68%)
2022 Research not required	13.5 (45%)	16.5 (55%)	14.5 (60%)	9.5 (40%)

Table 4: Participation by type of position. Numbers in brackets show the percentage of all staff in the discipline (Maths or Stats) with that job type that fall into each gender grouping.

We note that several universities have introduced new positions called "Lecturer (Teaching)" or something similar; the people in these positions are included in Table 1 under "Teaching only positions" and appear in Figure 1 in the "TF" category. We do not yet have enough data to make a definitive statement, but it appears that these positions may include a higher proportion of males than the teaching-only "Tutor" or "Professional Teaching Fellow" positions elsewhere. We intend to monitor the data over the next few years to look for trends.

Our informal data from Lincoln suggests that there are a number of staff there whose research could be represented in a School or Department of Mathematics and/or Statistics, but at this stage we do not have confidence in our data and we would have to change our methodology to include it.

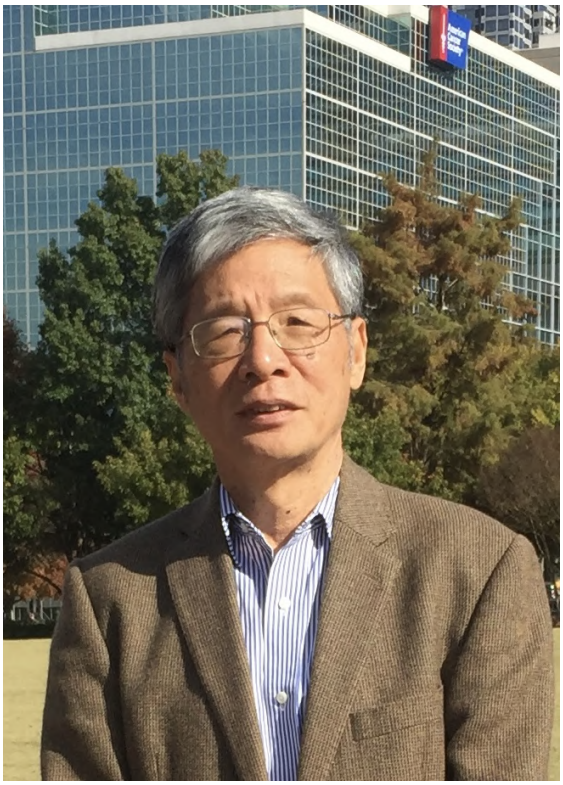
Conclusion

Given the slow progress towards gender equity demonstrated by this data, we call on the NZMS and the Schools and Departments of Mathematics and/or Statistics to review their initiatives to recruit, retain and promote people of underrepresented genders.

Astrid an Huef and Vivien Kirk
July 2022

PROFILE

Shixiao Wang



Dr Shixiao Wang is a Senior Lecturer in the Department of Mathematics at the University of Auckland and is retiring at the end of the year 2022. Before he joined the University of Auckland in 2003, Shixiao's academic journey was far from smooth and straightforward. Let us relate some aspects of it.

Shixiao was born in Shanghai, China, in the 50's. As he turned 13, the Great Cultural Revolution started and Shixiao had to stop going to school. Afterwards, he studied by himself mathematics and physics up to the undergraduate level in only three or four years. Neither schools nor universities were available at the time, Shixiao had to self-educate. Aged 17, Shixiao left Shanghai to move about 1000 km away to a rural place, where he spent six years farming the land.

After the Great Cultural Revolution, universities and schools reopened, and this was an opportunity for Shixiao to join the Northwestern Polytechnical University, Xi'an, China. He studied mathematics and physics, and passed his postgraduate examination within a year, before becoming a lecturer in that same university.

In 1985, after getting a general scholarship for overseas study, Shixiao moved to Paris, France, leaving wife and daughter in his home country, to pursue Ph.D. studies under the supervision of Prof Haïm Brezis. He graduated in 1989 and multiplied post-doctoral positions in the USA afterwards, for instance at Rutger University and Rensselaer Polytechnic Institute New York.

During his years in the States, his family joined him and he had to make a choice about his career to support his family. As a result, from 1997 to 2003, Shixiao worked in industry as a Researcher at General Electric. He designed an aerodynamically high efficiency blower with which he was awarded an USA patent. He also designed the ultra-quiet fan-series for GE refrigerators in 2000 based on cutting-edge aero acoustic technology. Multi-millions units have been manufactured with this fan-series in the past decades.

As his daughter graduated from high school in 2003 and entered adulthood, Shixiao decided to go back to academia and applied at the University of Auckland. At that time, the University of Auckland was seeking applicants for a new lectureship in Industrial Mathematics. Shixiao, with his exceptional academic background,

and experience with industry, got the position. He was welcomed by Prof David Gauld, who was the Head of Department at the time.

A key aspect of Shixiao's research was the development of a novel theory of the instability of rotating fluids (vortex breakdown). The long established linear theory was by Lord Rayleigh in 1917, but this mysteriously disagreed with modern experiments. People had been trying unsuccessfully to explain the discrepancy since the 1960's. Finally, in a series of papers from 1995 to 1997, Shixiao and his collaborator, Zvi Rusak, were able to explain this using nonlinear functional analysis.

Shixiao's early days at Auckland were not without challenges. Having entered the "publish or perish" environment of academia directly from industry, Shixiao, unlike most people starting with a position at a university, had no publications in the pipeline. He worked hard to resolve this situation, but the new perspectives that featured in his work took time to be accepted by the established fluid mechanics community. Shixiao was aware that he needed publications for his position at the University of Auckland, so the delays lead to anxious times.

Shixiao continued his research on stability of rotating flows over the past twenty years at Auckland. He always believed that mathematics and physics should go together to answer applicable questions, with the mathematics used as a tool to reveal the underlying physics. In this sense, Shixiao's Ph.D. with Brezis, which was very much in the area of nonlinear functional analysis, seems to have given Shixiao the power to see things that others have missed. After publishing their original papers, which have since attracted hundreds of citations, Shixiao continued to collaborate mainly with Rusak over this time, until Rusak sadly and unexpectedly passed away in 2020. Shixiao's research is published in highly ranked journals on fluid flow, often with Ph.D. students that he has supervised while at Auckland.

In his spare time, Shixiao plays the violin and is happy to play to his dinner guests.

At the day of our conversation, Shixiao expressed a deep satisfaction with the work achieved and is happily retiring, letting future generations of researchers looking at the subsequent challenges. He now plans to move to New Jersey, where he will be with his daughter and two grand-children. And as a conclusion, Shixiao wishes to acknowledge New Zealand, the University of Auckland and all his colleagues.

Marie Graff and Steve Taylor

LOCAL NEWS

AUCKLAND UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING, COMPUTER AND MATHEMATICAL SCIENCES

New BSc program

The new BSc program in Mathematical Sciences is approved by CUAP. The new program with two BSc majors in Mathematical Sciences: "Mathematical Modelling and Computation" and "Analytics" will start to run from 2023.

ECMS Research Framework Launch Event

A special event on 25 July marked the official launch of ECMS's research entities under the new Research Framework. Over the last year, the School of Engineering, Computer & Mathematical Sciences (ECMS) has undertaken a review of its research framework to establish a future-focused strategic direction. Through collaboration, consultation and feedback processes, a number of research entities have been identified to represent ECMS under the new framework and these are broadly covered by our five core research themes: data science, health technologies, material sciences, energy and intelligent systems. Under the new framework, we seek to improve synergies and collaboratively raise the level of our research performance, quality, visibility and impact. We seek to demonstrate our capability to industry, government, and the broader research community for ECMS and for AUT University.

ECMS research framework launch event.

First meeting of the Mathematics, Modelling and Analytics Research Centre

Following the ECMS research framework launch event, the Mathematics, Modelling and Analytics Research Centre (MMARC) has its first meeting in August to plan the research activities.

External Engagement

Adjunct Professor Graeme Wake has just completed over the last 2 years the first stage of a national project funded through Dairy NZ by the industry group AGMART on developing a workable reliable peer-reviewed algorithm for predicting Nitrogen effluent pollution from the catchment areas of farms. He was part of an interdisciplinary team of eight scientists which included 3 mathematical systems scientists (Graeme Wake, Steve Taylor (University of Auckland), and Tony Pleasants (Massey University's Al Rae Research Centre)). The need has been signalled by government as needed for underpinning decision support to implement regulations governing farm usage and intensification. This development is expected to be ongoing, with an augmented team.

The consolidation of the establishment of the Auckland North Mathematics Olympiad Cluster which Graeme Wake co-founded and managed in 2019 is complete and is now very ably managed by staff at Rangitoto College on Auckland's North Shore. This year's team at the IMO NZ team at Oslo, Norway finally included a Auckland North local James Xu from Kristin College who was awarded the teams only Silver Medal. The whole team results are now on the IMO website https://www.imo-official.org/country_individual_r.aspx?code=NZL.

Travel and Conference Participation

PhD candidate Xi Li is attending the online MathTech Conference in September and will present a talk "Valuation of Barrier Options under Hybrid CEV and Stochastic Volatility". 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-August. 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

Members of the department were greatly saddened by the death of Sue Skelly, who was a professional staff member in the faculty. In recent years Sue was based

in an office in the Maths department and she was very outgoing and well-liked. Rest in peace Sue.

Philip Sharp retired at the end of June after nearly 30 years of service in the department. Here is a photo taken at his retirement party, with John Butcher.

Philip Sharp with John Butcher.

Paddy Bartlett, a professional teaching fellow in the department has left after more than 5 years in the department.

Bartek Ewertowski has been hired as a professional teaching fellow. Bartek is currently finishing his PhD with Rod Gover.

Post-doc Jason Legrow moved to tenure-track academic job at Virginia Tech.

PhD student Kate Riegel and her husband Sam have a baby girl named Zoe.

The Auckland Mathematics Olympiad took place during the week of May 16-23. It was organised by Phil Kane, with questions designed by Arkadii Slinko and his team of assistants (Shai Levin, Yiwei Qi, Oliver Li, David Gauld).

After being re-scheduled multiple times, we held a one-day symposium in celebration of Eamonn O'Brien's 60th birthday. The lecturers were (by zoom) Persi Diaconis (Stanford), Martin Liebeck (Imperial), and Cheryl Praeger (WA), and (in person) Marston Conder and Gaven Martin. Recordings of the talks (except Gaven's, due to technical problems) are available at https://www.math.auckland.ac.nz/conder/EamonnSymposiumTalks.html

We held our annual Student Research Conference in June 2022, with around 15 student talks.

Pedram Hekmati, Arkadii Slinko and Jeroen Schillewaert are on Research and Study Leave.

In addition to organising the one-day symposium for Eamonn O'Brien's 60th, Marston Conder was an invited speaker at the "Groups in Galway meets the Irish Geometry Conference" in Galway (Ireland) in May, and at a workshop of Symmetries of Graphs in Kranjska Gora (Slovenia). Because of some personal family circumstances he had to cancel further travel for conferences in Spain and Alaska in June/July, but he still took part and gave lectures by Zoom in those as well as in the joint AMS-EMS-SMF Conference in Grenoble in July. Jozef Siran visited in the first two weeks of June.

Matthew Conder attended the "Geometry, Arithmetic and Groups" conference at the University of Texas, Austin, in June.

Steven Galbraith issued a press release about some joint work done in 2014 with post-doc Shi Bai about lattice-based digital signature schemes, after a scheme building on this work was selected by the US National Institute of Standards and Technology (NIST) for a standard in Post-Quantum Cryptography. There was an article about it in the NZ Herald on July 13. However, in August one of the main post-quantum cryptosystems that Steven and his students work on (namely the SIDH isogeny-based cryptosystem) was completely broken by researchers in Europe. Steven's blog posts on the topic (in the ellipticnews blog) were quoted in articles in Ars Technica and Wired, and he also spoke with a writer at Quanta who is preparing a future article on the topic.

Sina Greenwood had visitors Lori Alvin (Furman University) and James Kelly (Christopher Newport University). She hosted a Topology Mini-conference on Wednesday 25th May. She also gave an online invited talk "A characterization of a map whose inverse limit is an arc" at The 55th Spring Topology and Dynamical

Systems Conference in March. During her trip to Europe in June she gave an invited talk ”Arcs, circles, finite graphs and inverse limits of set-valued functions on intervals” at the 7th Croatian Mathematical Congress, and an invited seminar ”Arcs, circles, graphs and inverse limits” at the University of Maribor.

Rod Gover travelled to Seattle, Davis, Stasbourg and Vienna for conferences and visits to collaborators. He also recently hosted visitor Dmitry Jakobson (McGill).

Bernd Krauskopf had an invited research visit to the Faculty of Mathematics and Computer Science of Jagiellonian University in Kracow, Poland, and participated in the invitation-only workshop ”Applied Mathematics Without Boundaries” at Budapest University of Technology and Economics, Hungary.

Igor’ Kontorovich has been elected as the subprofessorial representative on the Faculty Staffing Committee.

Eamonn O’Brien attended the Isaac Newton Institute (Cambridge) programme on ”Groups, representations and applications: new perspectives”.

Hinke Osinga gave a plenary invited talk ”Phase resetting as a two-point boundary value problem” at the International Conference on Difference Equations and Applications in Paris. She also had a research visit to Maciej Capiński and Piotr Zgliczyński in Kraków, Poland, as a follow-up from a workshop in Poland in June 2022. She also participated in the invitation-only two-day conference ”Applied Mathematics Without Boundaries” in Budapest, Hungary.

Cris Hasan (Cork) is visiting Claire Postlethwaite for 2 months. Claire was elected Program Director 2022-2024 for the SIAM Activity Group on Dynamical Systems, which means that she will be chairing the 2023 ‘Snowbird’ conference (SIAM DS23) that is expected to attract over 1000 participants.

James Sneyd’s textbook ”Mathematics and Statistics for Science” with co-authors Rachel M. Fewster (Statistics) and Duncan McGillivray (Chemistry) has been published by Springer. It is based on the University of Auckland course MATHS 110.

Priya Subramanian’s paper ”Forced symmetry breaking as a mechanism for rogue bursts in a dissipative nonlinear dynamical lattice” with E. Knobloch and P. G. Kevrekidis was selected by the editors of Physical Review E to be an Editors’ Suggestion.

Melissa Tacy is the incoming President of the NZMS. She has also been confirmed as one of the Vice Presidents of the Asia and Oceania Women in Mathematics group. The AOWM lies under the umbrella of the IMU’s Committee for Women in Mathematics. It is intended that this group will build a network of women mathematicians working in Asia and Oceania.

Stephen Taylor participated in a Toha-sponsored mathematics-in-industry-style workshop to explore mechanisms of reducing nitrogen pollution in dairy farming. (Toha is an investment platform for environmental action that was co-founded by former President of the NZMS, Shaun Hendy.)

Tom ter Elst participated in workshops ”Mathematical aspects of the Physics with non-self-Adjoint Operators” at the Banff International Research Station, and ”New Challenges in Operator Semigroups” in Oxford, both in July.

Gabriel Verret gave an invited talk at SIGMAP (Symmetries in Graphs, Maps and Polytopes), University of Alaska, in July.

Steven Galbraith

DEPARTMENT OF ENGINEERING SCIENCE

On 25 July, the Department of Engineering Science held the BHons Mid-year Workshop in Fale Pasifika. The workshop ran from 8 am to 5 pm during which 100 students presented 52 research projects from Engineering Science and Biomedical Engineering. Congratulations to Nicky Dachs and Leah Slack, who won the Best Presentation Award for their project “What really happens with back sleep in pregnancy?” and Sophie Byrne and Natasha Humphries, who won the Best Presentation Award (runner-up) for their project “Assessing ADHD using Multiband MRI”. Many thanks to Maedeh Amirpour, Alys Clark, Richard Clark, Andreas Kempa-Liehr, Oliver Maclaren, Ru Nicholson, Poul Nielsen, Peng Du, and Recep Avci for chairing the sessions.

Andreas Kempa-Liehr

UNIVERSITY OF WAIKATO

DEPARTMENT OF MATHEMATICS AND STATISTICS

In June we said goodbye to Chaitanya Joshi with a dinner at the mediterranean Kitchen, Hamilton Central. He

BHons Mid-year Workshop in Fale Pasifika

is joining the Department of Statistics of the University of Auckland and will be greatly missed. He was at Waikato for 11 years.

Jacob Heerikhuisen and Han Gan are continuing to develop their Covid-19 model as part of a project with the Waikato, Bay of Plenty, Hawkes Bay, Tairawhiti, and Taranaki DHBs. This covers a very wide area and large proportion of the NZ population. The made an application for a government grant to extend their work to all of NZ, but missed out, coming second to Michael Plank's group at the University of Canterbury.

Daniel Delbourgo has finished his period of study leave and back in the saddle as Head of Department. During his leave he and Heiko Knospe discovered some amazing connections written up in a preprint "On Iwasawa λ-invariants for cyclic number fields and random matrix heuristics". Thanks to Tim Stokes for doing such an excellent job in his absence.

This trimester, Nick Cavenagh and Yuri Litvinenko are on study leave. Quite a few members have contacted covid, but none seriously and all have recovered.

The student center to our north is progressively taking shape. A new block has been approved for Engineering and will be built on our western side, so construction noise will be with us for some yet!

Kevin Broughan

MASSEY UNIVERSITY

SCHOOL OF MATHEMATICAL AND COMPUTATIONAL SCIENCES

Semester two saw most courses being taught face to face, after being online in semester one. All courses are now offered in a "blended" format, taught in-person on both campuses and simultaneously by distance, with several staff associated with each course.

Two of our recent PhD graduates have begun postdoctoral fellowships. Hammed Fatoyinbo is working on modelling infectious diseases in humans and animals at the School of Veterinary Science at Massey University, Palmerston North. Sishu Muni is working on theoretical aspects of dynamical systems at the Indian Institute of Science Education and Research in Kolkata, India.

Robert McLachlan is co-winner of the 2022 John Ockendon Prize for best paper published in the European Journal of Applied Mathematics in the previous two years, for the paper "Structure-preserving deep learning".

David Simpson was awarded €800 from the journal Physics Reports for a review article on Hopf-like bifurcations in piecewise-smooth dynamical systems.

Our former colleague Mahyar Amouzegar, who taught operations research at Massey in the 1990s, now divides his time between New Orleans, where is provost at UNO, and Palmerston North. He discussed his fourth novel, The Hubris of an Empty Hand, on Radio New Zealand on 3 August 2022.

Carlo Laing

VICTORIA UNIVERSITY OF WELLINGTON

SCHOOL OF MATHEMATICS AND STATISTICS

We have some news from Te Herenga Waka in Wellington:

Prof. Estate Khmaladze is retiring (from teaching). The road for knowledge is still long for him. He is off to a new adventure; he just signed a contract to write a book. If you do not know Estate:

- Estate is the Fellow of the Institute of Mathematical Statistics, the only one from NZ
- He is best known for his contribution of Khmaladze transformation in statistics
- His name is in the list of Notable Statisticians in Wikipedia
- He is a fellow of Royal Society of New Zealand and foreign member of the National Georgian Academy of Sciences
- Considerable amount of Khmaladze's work is in applications of statistics

Estate we all wish you the best and to enjoy life at any moment!

Internationally renowned scholar and senior university sector leader Professor Nic Smith has been appointed to be the next Vice-Chancellor of Te Herenga Waka—Victoria University of Wellington. The appointment results from a global search after previous Vice-Chancellor Professor Grant Guilford retired in March 2022 after eight years at the helm.

We also have some PhD successes!

Arianna Salili-James, supervised by Stephen Marsland, based at Brunel University, London has successfully defended her PhD thesis with title "Taking Shape: The Data Science of Elastic Shape Analysis with Practical Applications".

Also Alberto de Rosa, supervised by Stephen Marsland and Isabel Castro has successfully defended his PhD thesis with title "On Kiwi (*Apteryx mantelli*) vocal behaviour and activity: Relations to population densities and applications to conservation".

Dimitrios Mitsotakis

UNIVERSITY OF CANTERBURY

SCHOOL OF MATHEMATICS AND STATISTICS

Congratulations to *James Williams* and Laura on the safe arrival of their daughter Bethamy in late February. Bethany has been adjusting well in a busy household and enjoying loads of cuddles and attention from older siblings, and especially grandparents, the School's *Steve* and *Phillipa Gourdie*.

Phillipa Gourdie and granddaughter Bethany

The last three months saw a number of staff changes with two staff leaving and four arriving.

In June *Matt McPherson* departed our School as Administration Assistant. He had been in the School since March 2019. In this short time Matt had become a much valued member of the team through his positive attitude and continual good cheer. Matt stays at UC though, having accepted a role as Administrator in the Deputy Vice Chancellor-Academic's office support team.

In mid July *Mark Hickman* retired from the university after 34 years. He recalls that far from reduced teaching loads for new staff, he was plunged immediately into teaching engineering mathematics and a 4th year course on PDEs. Due to travel restrictions over the past two years Mark and Doris were NZ bound, but they have some ambitious travel plans in the upcoming years. On the itinerary are Botswana, Nepal, Bhutan, Antarctica, Tibet, and the UK, to name a few.

In early May the School welcomed *Taylor Winter* as a lecturer in statistics. He worked at Stats NZ and obtained his PhD this year from Victoria University of Wellington. His research interests are in Bayesian statistics and the use of a range of longitudinal and momentary datasets with a focus on Bayesian methods and structural equation modelling. Currently, he has a focus on the Integrated Data Infrastructure (IDI) hosted by Stats NZ. A large government database integrating a range of datasets such as tax, health, and Census records. In his spare time Taylor is a co-director of Hammerstone Coffee, a roastery with a focus on equity and sustainability. His good friend and co-director will be competing in the New Zealand Barista Championships using their coffee this August, please wish them luck!

Taylor Winter

At the end of May *Karen Featherstone* took up her new position as the School's Senior Administrator. She had been PA to the Executive Dean of Engineering here at UC. Karen has an extensive administrative background, but she also retrained as a Clinical Nutritionist and spent 12+ years specialising in women's hormonal health and fertility. When Covid hit, Karen decided it was time to go back to her roots in administration. She

is an animal enthusiast, with two rescue dogs and a rescue horse.

Karen Featherstone

The following month *Yolande (Yo) Ruiters* joined the School as Assistant Administrator. Originally from South Africa Yo has lived in the greater Christchurch area for more than 20 years. She already had worked at UC in a different department for several years until eight years ago and now returned to UC. She is a keen gardener and cheese maker.

In early July *John Holmes* took up a lecturer position in statistics. He comes to us from the University of Melbourne where he had been since 2018, first as a post-doc in Statistical Genetics, and more recently as a lecturer in biostatistics. John received his PhD in Statistics from the University of Otago in 2018, with his thesis focusing on the genetic evaluation models in the NZ Sheep Industry, supported by supervisors at Otago and AgResearch. His research interests include linear mixed model methodology, primarily in the context of animal and human genetic/genomic applications, and Bayesian approaches to dimension reduction for non-normal data.

After a 2-year hiatus due to Covid-19 travel restrictions the university's Erskine fellowship programme resumed for the start of semester 2, and the School welcomed two Erskine fellows, who both arrived in early July. Everett Howe is currently an unaffiliated mathematician, after more than two decades doing classified work for the US government (and simultaneously maintaining a robust public research program). He works in Number Theory and Algebraic Geometry, specialising in curves over finite fields. He and his wife are in Christchurch for two months, returning to their home in San Diego at the end of August. Everett is hosted by *Felipe Voloch* and teaches into our 300-level course MATH324 Coding theory and cryptography.

Teodor Burghelea is visiting the School until mid August. He is a Tenured Scientist (Charge de Recherche Classe Normale) at Centre national de la recherche scientifique – Laboratoire de Thérmocinétique de Nantes, France. His research interests are Non-Newtonian Fluid Mechanics, viscoplasticity, elastic turbulence and anything involving a complex fluid. Teo is teaching into our second year course MATH202 Differential Equations. He brings the insight of an experimental physicist to his lectures and we are sure that he will make a lasting impression on the students. Every new section is introduced with a small in-class experiment, something new in our School. Teo is hosted by *Miguel Moyers-Gonzalez*.

Günter Steinke

UNIVERSITY OF OTAGO

DEPARTMENT OF MATHEMATICS AND STATISTICS

Michael Beyer and his parents

Amidst the global challenges of climate change, we are delighted to support our vulnerable environment by consciously attending less conferences as part of the university's "air travel and carbon neutral initiative". In order to ensure that their staff are indeed doing something good and follow these plans, the amount of money available for conference travel to each staff member has been reduced. Unfortunately, some wicked tongues claim that the university might not even care about the environment, but much more so about saving money. Let's ignore such rumours and just welcome every opportunity to make our contribution to saving our planet!

Congratulations to *Florian Beyer* and his wife Kirsten

on the arrival of their third child Michael, born 31 May. Everyone is healthy and happy. Best wishes to the entire family!

Alex Fowler has started his position as a fixed-term Statistics teaching fellow until December next year. Welcome to Otago, Alex!

Congratulations to *Shaun Swain* on his new permanent position as a Client Services Administrator in the Dodd Walls Centre. Shaun has been helping us out as a Department Admin for past few months, and he really was an invaluable, great help. We wish him all the best in his new position.

Jörg Hennig

PhD SUCCESS

Arianna Salili-James (Victoria University of Wellington. 2022)

Title: Taking Shape: The Data Science of Elastic Shape Analysis with Practical Applications.
Supervisors: Stephen Marsland (Brunel University)

Abstract: The shape of an object hosts valuable information that can prove vital in analysis performed on the class of objects. But is the shape of an object enough for classification? In this thesis, we exclusively consider two-dimensional curves. Following Kendall, we define shapes as curves modulo shape-preserving transformations. Hence, our shapes lie on some infinite dimensional Riemannian manifold. One way to define a metric in such a space is via the use of diffeomorphisms. This brings us to the area of elastic shape analysis.

In this thesis, we introduce an anthology of projects, in order to emphasise and understand the potential of elastic shape analysis in practical applications. There are four main projects in this thesis: (i) Classification of objects using outlines and the comparisons between methods of elastic shape analysis, geometric morphometrics, and human experts, with a focus on ancient Greek vases, (ii) Mussel species identification and a demonstration that shape may not be enough, (iii) A novel tool to detect the health of kākāpō chicks, and (iv) Classifying individual kiwi based on acoustic data from their calls.

Alberto de Rosa (Victoria University of Wellington. 2022)

Title: On Kiwi (*Apteryx mantelli*) vocal behaviour and activity: Relations to population densities and applications to conservation.
Supervisors: Stephen Marsland (Brunel University) and Isabel Castro (Massey)

Abstract: Acoustic monitoring has long been employed to document the presence and estimate populations of vocal species for conservation purposes. Determining populations trends without the need of sighting or capturing animals can drastically reduce costs and improve welfare. However, as with many other indirect monitoring practices, acoustic surveys impose a series of assumptions about the detectability of the observed animals and their vocal behaviour. Whereas the variability in detection distances and other observer–induced effects can be minimised using acoustic recorders, enabling the delivery of animal abundances using acoustic monitoring requires detailed knowledge of the target species' behaviours to relate numbers of detected acoustic cues to those of animals in an area. This thesis aimed to investigate North Island Brown Kiwi vocal behaviour and activity to build more objective and accurate acoustic monitoring protocols.

Alastair Lamont (University of Otago. 2022)

Title: Breeding value prediction in partially-genotyped populations.
Supervisors: Matthew Schofield and Richard Barker (Otago)

Abstract: Selecting an animal for breeding requires knowledge of the utility it passes on to its descendants, known as a breeding value. Improvements in technology mean that genetic material can be directly measured, creating what is known as a genotype. The use of these data has improved the accuracy of breeding value prediction, but many of datasets of interest contain a mixture of genotyped and ungenotyped animals. It is challenging to make good use of all available data to best predict breeding values while allowing for missingness. We consider some limitations of present approaches, and propose several approaches intended to improve on these weaknesses.

Samuel Dobson (University of Auckland. 2022)

Title: Key Exchange and Zero-Knowledge Proofs from Isogenies and Hyperelliptic Curves.
Supervisors: Steven Galbraith (Auckland)

Abstract: Cryptography plays a vital role in the modern age of computing and security. Of the many branches of cryptography, we primarily focus on two in this thesis. The first is post-quantum secure key exchange from isogenies. Key exchange protocols are critical for setting up secure communication over the internet. We construct a new initial key agreement protocol to replace the classical extended triple Diffie–Hellman (X3DH) scheme in the Signal Protocol, using Supersingular Isogeny Diffie–Hellman (SIDH) for post-quantum security. As part of this work, we introduce a new model capturing the security properties of Signal X3DH, and within this model prove security of our new scheme (SI-X3DH).

The SI-X3DH protocol requires a way of proving knowledge of SIDH secret keys. This brings us to the second primary focus of this thesis: zero-knowledge proofs. As suggested by the name, such schemes allow a statement to be proved without leaking any information other than the validity of the statement. We propose a zero-knowledge proof protocol that fixes a flaw in the security proof of the De Feo–Jao–Plût identification scheme from 2014. We then propose a second protocol that additionally proves correctness of the torsion points in SIDH public keys. These schemes admit the first secure, non-interactive Proofs of Knowledge for SIDH secret keys.

Still in the line of zero-knowledge proofs, we study a primitive used in various classical constructions: unknown-order groups. Our contributions here are threefold. We study the security of recommended parameter sizes for ideal class groups as groups of unknown order, and show that these do not meet their claimed level of security when accounting for Sutherland's primorial steps algorithm in generic groups. In response, we propose new parameters for various levels of security. Secondly, we give a new method of compressing elements of ideal class groups, requiring only 3/4 of their uncompressed size. Finally, we concretely propose a new method of generating groups of unknown order using Jacobians of genus-3 hyperelliptic curves—including an analysis of their security. We show that Jacobians may provide a more efficient choice for unknown-order groups than ideal class groups of imaginary quadratic fields.

Gray Manicom (University of Auckland. 2022)

Title: Memory effects in heteroclinic networks and their use in cognitive modelling.
Supervisors: Claire Postlethwaite and Vivien Kirk (Auckland)

Abstract: In my thesis I investigated heteroclinic networks and their use in modelling cognitive dynamics. In particular, it is known that in the presence of noise heteroclinic networks may be associated with non-Markovian dynamics. However, this is not well-understood, and these properties have not yet been used to model non-Markovian cognitive processes. I investigated this in two ways. First, I constructed a local map of a saddle point in a noisy heteroclinic network. By mapping particular initial distributions onto exit distributions using the local map, I was able to determine conditions under which the non-Markovian dynamics present themselves and a few statistical moments relating to this, in particular, when the initial distribution was not centred on the stable manifold of the saddle. Using these results I was able to construct an algorithm for determining a lower bound for the order of the Markov process associated with arbitrary networks. Secondly, I constructed a model of task-switching using a mixed heteroclinic and excitable network. Task-switching is a good example of a cognitive process whose dynamics are explicitly non-Markovian, since the performance of one task depends on the task which came before. Constructing a return map of this model yielded insight into the model's non-Markovian mechanism for reproducing the switch cost. Of particular interest in this was the dependence of the switch cost on a relatively slow global connection, which is atypical of heteroclinic networks in general.

Gayani Tennakoon (University of Auckland. 2022)

Title: Collective motion with excluded-volume effects.
Supervisors: Steve Taylor (Auckland)

Abstract: Many physical and biological systems consist of individuals with collective behaviour. In reality, these individuals have a finite size, or at least prevent others from interacting or becoming involved; hence, they exclude a volume in space. The individual-based models that model this behaviour become computationally intractable for large systems. Gayani's research aims to replace these expensive simulation models with continuum population-level models based on partial differential equations (PDEs). The diffusion of finite size hard-core interacting particles in one or two dimensions is examined systematically using asymptotic methods. The result is a coupled system of PDEs for the distribution functions of position, velocity and time. Due to size exclusion, the PDEs are nonlinear in the transport term.

George Drummond (University of Canterbury. 2022)

Title: Aspects of Matroid Connectivity and Uniformity.
Supervisors: Charles Semple and Geertrui Van de Voorde (Canterbury)

Abstract: In approaching a combinatorial problem, it is often desirable to be armed with a notion asserting that some objects are more highly structured than others. In particular, focusing on highly structured objects may avoid certain degeneracies and allow for the core of the problem to be addressed. In matroid theory, the principle notion fulfilling this role of "structure" is that of connectivity. This thesis proves a number of results furthering the knowledge of matroid connectivity and also introduces a new structural notion, that of generalised uniformity.

The first part of this thesis considers 3-connected matroids and the presence of elements which may be deleted or contracted without the introduction of any non-minimal 2-separations. Principally, a Wheels-and-Whirls Theorem and then a Splitter Theorem is established, guaranteeing the existence of such elements, provided certain well-behaved structures are not present.

The second part of this thesis generalises the notion of a uniform matroid by way of a 2-parameter property capturing "how uniform" a given matroid is. Initially, attention is focused on matroids representable over some field. In particular, a finiteness result is established and a specific class of binary matroids is completely determined. The concept of generalised uniformity is then considered more broadly by an analysis of its relevance to a number of established matroid notions and settings. Within that analysis, a number of equivalent characterisations of generalised uniformity are obtained.

Lastly, the third part of the thesis considers a highly structured class of matroids whose members are defined by the nature of their circuits. A characterisation is achieved for the regular members of this class and, in general, the infinitely many excluded series minors are determined.

Anthony E. Ciriaco (University of Auckland. 2022)

Title: A Refined Methodology for Quantifying Estimates of Extractable Geothermal Energy.
Supervisors: Sadiq J. Zarrouk, Anthony Downwards, Golbon Zakeri (Auckland)

Abstract: Estimating power potential (MWe) of geothermal resources with higher accuracy remains both a necessity and a challenge confronting the geothermal industry. Reservoir models that underpin resource management and decision making can quantify uncertainties and provide a predictive likelihood of MWe capacity. However, uncertainty quantification of power (MWe) prediction from a geothermal numerical model is time-consuming, and reservoir models do not mesh well with the Monte Carlo simulation. The Monte Carlo method approximates the probability of different outcomes based on the probability distribution of the values of the uncertain parameters.

The present study critically examined all existing resource assessment methodologies and practices for quantifying the power potential of geothermal fields with a particular focus on the volumetric method and reservoir simula-

tion. This work provides more substantial evidence that these two methods are preferred for estimating resource potential and highlights the inevitable difficulty in obtaining accurate predictions.

This study also investigated the use of the Experimental Design (ED) – Response Surface Methodology (RSM) framework as an alternative method for probabilistic resource assessment using a calibrated numerical model. The ED–RSM approach enables uncertainty to be modelled with multiple stochastic parameters, while requiring only a relatively small number of simulation runs. The steps involved are to build a polynomial equation of the numerical model, and apply a Monte Carlo simulation to this polynomial equation, thereby generating a probabilistic estimate expressed in generated power (MWe). In order to construct this polynomial model, it is first necessary to run several versions of the numerical model with key stochastic parameters set based on the chosen Experimental Design (ED) and parameters. The outputs of the model can be fitted to the input parameters by fitting a regression model.

The ED–RSM framework using Full Factorial and Fractional designs were tested and implemented into four numerical models of the Rotorua, Ohaaki and Wairakei geothermal fields in New Zealand and the Leyte geothermal field in the Philippines. These designs are the three–level Full Factorial, two–level Full Factorial, three–level Box-Behnken and two–level Plackett-Burman.

Overall, the ED–RSM framework using the Plackett-Burman fractional design proved to be a practical approach for estimating potential capacity from a calibrated natural–state model.

Ryan Tonkin (University of Auckland. 2022)

Title: Transient Two-Phase Modelling of Multi-Feed Geothermal Wells.

Supervisors: Mike O'Sullivan, John O'Sullivan (Auckland)

Abstract: Geothermal wells play a key role in the development, understanding and utilisation of geothermal resources. It is, therefore, important to have a good understanding of the fluid dynamics and thermodynamic processes that occur within geothermal wells. Numerical simulation provides low–cost insight into the transient behaviour of geothermal wells that is difficult or impossible to measure directly. This research discusses the development of a new transient geothermal wellbore simulator that is capable of modelling the complex flows that occur in geothermal wells. Transient geothermal wellbore simulators solve equations describing the conservation of mass, momentum and energy. Our review of the literature found that some forms of these governing equations, used in past simulators, did not correctly conserve momentum or energy. However, we found that the impact of these approximations were relatively small for moderate mass flow rates and wellhead pressures. Despite this finding, we implement a three equation model that correctly conserves mass, momentum and energy. Our numerical formulation of the governing conservation equations is fully–implicit in time. The constitutive model for slip is solved simultaneously with the conservation equations for four primary variables: pressure, temperature (swapped for vapour saturation for two-phase flow), vapour velocity and liquid volume flux. We developed a set of test cases to ensure that our simulator is capable of modelling the diverse range of flow scenarios that are possible within geothermal wells. These included production and injection, and cases where the wellhead is closed. These cases cover liquid, two–phase and vapour conditions, fast and slow transients, and include examples of counter–flow. We have developed a simulator that is capable of modelling counter–flow processes in geothermal wells. This project is the first to report results that show counter–flow occurring due to boiling in geothermal wells and is the first to highlight the importance of these processes in geothermal applications. We found that when boiling occurs within a closed well, counter–flow transports heat to the top of the well, which allows a hightemperature, high–saturation two–phase zone to exist alongside cold formation temperatures. This investigation showed that a geothermal wellbore simulator must be able to model counter–flow processes if it is to be used to simulate the shutting in of wells. We also used our simulator, with an air–water equation of state, to model discharge stimulation methods for non–self–discharging wells. We were able to simulate the successful discharge of a test well with a water level 300 m below the wellhead using air–lifting and air compression.

GENERAL NOTICES

Applied Mathematics vacancy at the University of Canterbury

We invite applications for a continuing position of Lecturer / Senior Lecturer / Associate Professor / Professor to join our dynamic and evolving School. You will contribute to the vibrancy of the School's research culture and teach into the Applied Mathematics programme. Specifically, we are seeking colleagues whose interests and proven research record includes Fluid Mechanics and/or Dynamical systems. You will be required to undertake research and a range of teaching responsibilities for both undergraduate and postgraduate students, as well as supervising research (postgraduate) students. Our School is situated within the Te Kaupeka Pūhanga—Faculty of Engineering; you will be expected to build collaborations and strengthen our connections with the departments within the Faculty.

The closing date for this position is: Monday 12 September, 2022 (Midnight NZ time)

Pēhea te tono mai — How You Apply

Applications for this position must be submitted online through our careers website and should include:

A 'cover letter' of up to four pages. This should be a single document that connects to the evidence on your CV and: (1) introduces yourself and your reasons for applying; (2) outlines your research interests and goals; (3) details your teaching philosophy and how you would contribute to the School's teaching programmes; and (4) articulates a vision of how a successful School of Mathematics and Statistics can have a positive impact on communities. A CV that includes a list of relevant research publications.

Forum "Math-for-Industry" 2022 and Conference: "Statistics and Mathematical Modelling in Combination"

The APCMFI 2022 conferences are welcoming two upcoming linked hybrid events: Forum "Math-for-Industry" 2022 and Conference: "Statistics and Mathematical Modelling in Combination" https://apcmfi.org/event/view/183. Both events are being held in Melbourne and propose a hybrid form. More details below:

Statistics and Mathematical Modelling in Combination

Dates: 16–18 November 2022
Venue: La Trobe University
Web: https://www.mathematics.org.au/sys/public/home.php?conf_id=57

Deterministic modellers and statisticians have a lot to be gained by working as a team in which both types of approaches are used. The combination of statistics and classical dynamics has long been a fertile field, tracing back to statistical mechanics from the end of the 19th century and stochastic differential equations from the 1920s. The need to combine the two modelling approaches has never been greater and neither has the opportunity for affordable high-performance computation. During the COVID-19 pandemic, agreement has been found between agent-based models and differential compartment equations in modelling infection numbers. Each approach gives confidence to the other, and this suggests scope for new hybrid models.

Forum "Math-for-Industry" 2022 -Mathematics of Public Health and Sustainability

Dates: 21 - 24 November 2022
Venue: La Trobe University City Campus (Level 2, 360 Collins Street, Melbourne, Australia)
Web: https://apcmfi.org/fmfi2022/index.html

Winston Sweatman

KOZWavinar #2 – 1 November 2022

Our first edition of the new virtual seminar series KOZWavinar has been a success in June 2022. 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 second KOZWavinar will take place online on Tuesday 1 November 2022 at 3pm-5pm (NZ Time) with three guest speakers from Australia, New Zealand and Japan to be announced.

We look forward to seeing many of you join us!

Luke Bennetts, Amin Chabchoub and Marie Graff

NZMRI Summer School, 9-14 January 2023 in Nelson

The 2023 NZMRI summer meeting "Groups, Geometry and Dynamics" will be held on 9-14 January in Tāhunanui, Nelson. The invited speakers are:

- Ian Agol (UC Berkeley)
- Emmanuel Breuillard (University of Oxford)
- Martin Bridson (University of Oxford)
- Benson Farb (University of Chicago)
- Nicolas Monod (EPFL)
- Anne Thomas (University of Sydney)
- Amie Wilkinson (University of Chicago)

The talks will be targeted towards students, and support is available for all New Zealand based postgraduate students. For further information, including details of how to register, please visit: https://sites.google.com/view/nzmri2023

The registration deadline is Saturday 4 November. If you have any questions, please get in touch with the organisers (Matthew Conder and Jeroen Schillewaert) at NZMRI2023@gmail.com.

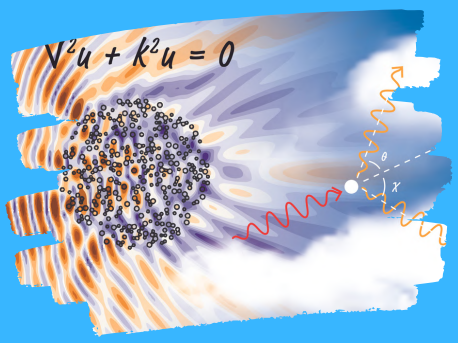
NZMASP 2022 Postgraduate conference, 17-19 November 2022 in Wanaka

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. To register, go to https://nzmaspconference.wordpress.com/nzmasp-2022/

Isaac Newton Institute for Mathematical Sciences

"MATHEMATICAL THEORY AND APPLICATIONS OF MULTIPLE WAVE SCATTERING" PROGRAMME

WINTER SCHOOL



9-13 JANUARY 2023

CAMBRIDGE UK

A meeting for **research students and above***, including **introductory lectures**, **industry applications** and **group projects**.

*funding opportunities available

CONFIRMED SPEAKERS:

Sonia Fliss	**Paul Martin**	**David Abrahams**
ENSTA Paris	Colorado School of Mines	University of Cambridge

APPLY BY 09/09/22:

www.newton.ac.uk/event/mwsw05

NZMS NOTICES

International Mathematical Modeling Challenge

A team from St Andrews College (Christchurch) came first equal in the International Mathematical Modeling Challenge (IM2C). This competition runs every year in 31 countries/regions. The challenge was to use modelling to develop time-effective strategies for plane boarding and disembarking. This is an outstanding achievement. Congratulations to Tom Edwards, Toby Harvie, Corin Simcock, Luke Zhu and their advisor Phil Adams.

I note that mathematical and statistical modelling are looking to become a more significant component of NCEA mathematics and statistics. It would be useful to think about the consequences of this for long term planning for undergraduate universities. At Otago we run a Computational Modelling (COMO) program in the Department of Mathematics and Statistics, which overlaps significantly with papers taught at Auckland, but which is funded at the same level as other sciences (whereas mathematics and statistics are funded at the level of arts).

David Bryant

Asian and Oceanian Women in Mathematics

As president of the NZMS, David Bryant sent a letter of congratulations to the AOWM (Asian and Oceanian Women in Mathematics), which was officially founded on August 1st. The purpose of AOWM is

- to promote activities of all aspects of women in mathematics in Asia and Oceania,
- to foster international scientific communication among women within and across fields in mathematics, and
- to cooperate with other bodies having similar aims.

A person of any gender who supports the goals of AOWM can apply to become a member.

NZMS projects – Help needed

David Bryant needs help on a couple of NZMS projects over the next year or so. He is looking someone who enjoys web design and someone else who would be keen to help him and the NZMS get a research internship program going. Please email directly: david.bryant@otago.ac.nz

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— Randy LeVeque, SIAM Member, Fellow, and Board Member

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