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NEWSLETTER

OF THE

NEW ZEALAND MATHEMATICAL SOCIETY

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PUBLISHER'S NOTICE

This newsletter is the official organ of the New Zealand Mathematical Society Inc. This issue was edited by Fabien Montiel and Melissa Tacy. 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 Fabien Montiel (fmontiel@maths.otago.ac.nz) or Melissa Tacy (melissa.tacy@auckland.ac.nz). LaTeX templates are available upon request from the editors.

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EDITORIAL

On Tuesday 11 August we, the editors, met to discuss this newsletter's editorial. Then it seemed clear that we would lead with a discussion of the joys of being back to Level 1. A few hours later we found that we needed update our editorial. We all hope that the current outbreak can be easily contained and we can go back to the freedoms which we have enjoyed for the past three months.

Although our academic lives have greatly been affected and will still be for the foreseeable future, we have found a way to adapt. Online lectures, virtual conferences and webinars, Zoom meetings with colleagues overseas have been part of our everyday lives. The Local News section narrates heartening stories about our resilience and innovative adaptation efforts. This gives us an opportunity to be creative in the way we work together, and establish sustainable and less carbon-intensive approaches that we can carry with us in a post-COVID world. Our society is experimenting with such approaches this year as the 2020 NZMS Colloquium will be held online for the first time. The format of this two-day meeting has been announced with more details in NZMS Notices section of this newsletter.

This year's disruptions have been particularly difficult on early career researchers and the NZMS council is actively seeking ways to help. Melissa (in her role as NZMS council member) is coordinating a ECR Facebook group to connect mathematicians across New Zealand. The link for membership of this group is `www.facebook.com/groups/958031671289554/`. If you would consider yourself an early career researcher please join. In addition to being a place to connect with other ECR members of our community the NZMS will use this group as a place to disseminate resources such as career advice and articles/reports about the effect of COVID on ECRs.

Fabien Montiel and Melissa Tacy

PRESIDENT'S COLUMN

When I wrote my last column for the Newsletter, New Zealand was half-way through its first and, hopefully, only lockdown to deal with COVID-19 [1]. It was an extraordinarily difficult time for many people, and many of the hardships did not fall equitably across society, but elimination of the disease from the country was a remarkable achievement. And, at least for now, life in New Zealand has returned to something like normal. It certainly feels that way at the University of Auckland, where classes resumed with gusto on Monday 27 July. This is so very different from many other parts of the world, where restrictions remain in place and healthcare systems are struggling.

Mathematics has played an important role in putting this country in this almost unique position. Indeed, each of the Te Pūnaha Matatini team who worked most closely on the disease modelling recently received personal letters of thanks from the Prime Minister. This team included Professor Mike Plank (Canterbury), Associate Professor Alex James (Canterbury), Dr Audrey Lustig (Manaaki Whenua), Dr Rachelle Binny (Manaaki Whenua), and Nic Steyn (Canterbury/Auckland). The public health decisions that were made during March, April, and May, were some of the most consequential in New Zealand's history, and the team's work directly supported this. The work was frequently mentioned in daily briefings and was brought up in the COVID-19 select committee. There are few examples as powerful as this of the impact that New Zealand mathematical science can have in the country's future wellbeing and direction, as acknowledged by the Prime Minister in her letter of thanks.

One of the things that made this work so influential was the fact that it was communicated publicly. If New Zealanders had not wanted a lockdown, there is very little the government could have done to enforce it. But the public came to understand what was at stake and what they could do about it, partly because the mathematics that guided the response was made available and accessible to them. There are some important lessons for the science community here, particularly as we line up to tackle even greater problems such as climate change.

The mathematics community has some wonderful communicators, from Jeanette McLeod, Phil Wilson, and their Maths Craft team, through to Dillon Mayhew, who is a regular correspondent on Radio New Zealand Nights. It is perhaps less well known that Robert McLachlan is a regular commentator on climate change policy. In fact, Robert's thoughtful and analytical takes on climate policy have been very influential with policy-makers. While communicating with our peers in international journals is, of course, very important, COVID-19 should serve to remind us how important it is that the rest of New Zealand hear from us as well.

Shaun Hendy

[1] The President's column was recieved by the editors on 31 July 2020

EDUCATION

How did Maths teaching and learning fare during the lockdown? A couple of secondary school teachers share their experience with online teaching below.

Dara Mateeva, Rodney College

My name is Dara Mateeva. I am originally from Bulgaria, living in New Zealand for 15 years now. I have been teaching Mathematics and Statistics for just over 10 years. My current school is Rodney College, a secondary school in Wellsford, Northland, with a school roll of just below 400 students in Years 9–13. Rodney College has a decile rating of 4 and a very diverse population of students, coming from a wide range of backgrounds with about 30% of the students identified as Māori. This year I am teaching a Year 11 Maths class, a Year 12 Stats class, and six groups of MST (Mathematics Support Teacher) students in Years 9 and 10 (36 students altogether).

Lockdown was a surprise and a shock for everyone. As much as it was enjoyable for me as I got to spend so much time with my family, it was also a challenge in terms of having to quickly adapt to online teaching.

If I have to summarise the experience with regards to my students' learning, I would say that the older the students were, the better they adapted to the online learning environment. My Year 12 Stats class was fantastic—they were very regular to all Zoom meetings, all work was completed, we went successfully through an assessment and a couple even requested private Zoom sessions. The students were very active during the sessions, asking questions, discussing and generally being very positive and responsive. Of course, there were a few exceptions but no surprises. The whole process felt very normal since we were using Google Classroom and online resources anyway, and the students were accustomed to more self-directed learning.

My Year 11 Maths class was interesting—the students were very regular to the Zoom meetings like the Year 12s but they stayed muted and invisible all the time, even after being prompted to show and take part in discussions many times. They preferred to ask questions in private messages or emails directly to me. They also completed all assigned work and went successfully through an assignment but did that more individually which meant I had to work with each one of them separately. As with the Year 12s, the few exceptions weren't surprising.

My biggest challenge was exactly those students who did not engage. If we were in school, I would've been able to directly approach them and use different strategies to engage them. However, when they didn't even attend Zoom sessions or didn't even answer emails, I felt completely unable to offer help to them. Ringing parents was unsuccessful as well, as the majority were either not picking up, or the phone numbers were wrong. All of those who I managed to contact promised support but apparently were unsuccessful as nothing changed.

Then there were those students with no Internet access or no device who I felt totally disconnected to. So I felt that the students who generally needed support at school were lost during the lockdown, and did not gain any positives from it in terms of credit collection or preparation for assessments. I was only hoping that they were doing jobs around the house that require application of mathematics so the time was not completely wasted.

Ben Chambers, St. Mary's College

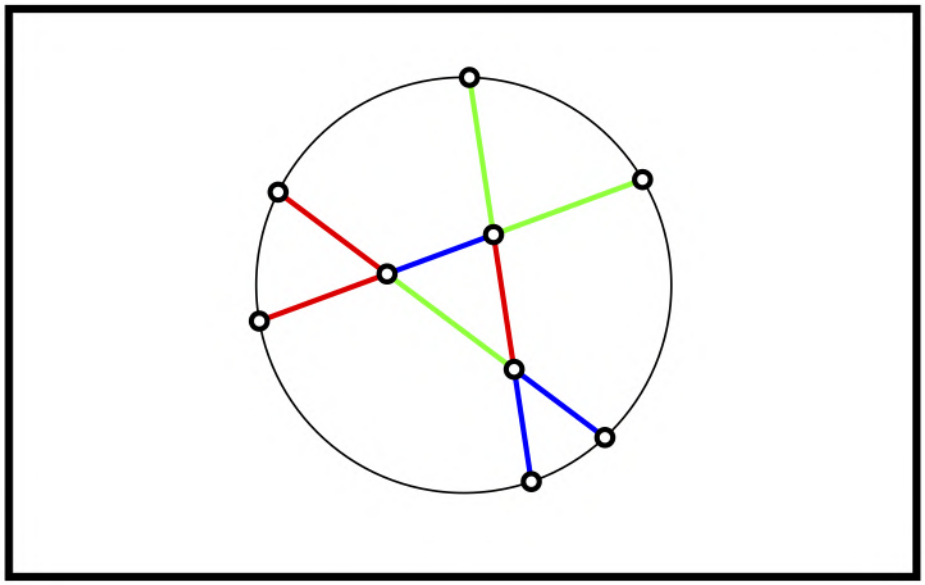
One piece of feedback I received from students was that they found great value in being able to watch recorded lessons multiple times. This allowed them to return to the content later to review concepts that they may not have fully grasped the first time. Students expressed that they greatly appreciated the ability to pause and rewind lessons to progress at their own pace. This is an option that I have tried to continue to make available even after returning to the classroom. While it is not feasible to record my own lessons and upload them, it is perfectly manageable to provide links to relevant YouTube videos created by others. There is a wealth of videos available online that cover virtually every topic that we discuss in the classroom. By providing a link to a video that matches the content of the day, students can continue to review this content at their own pace. This has the added benefit of providing absent students with a greater ability to access content that they may have missed.

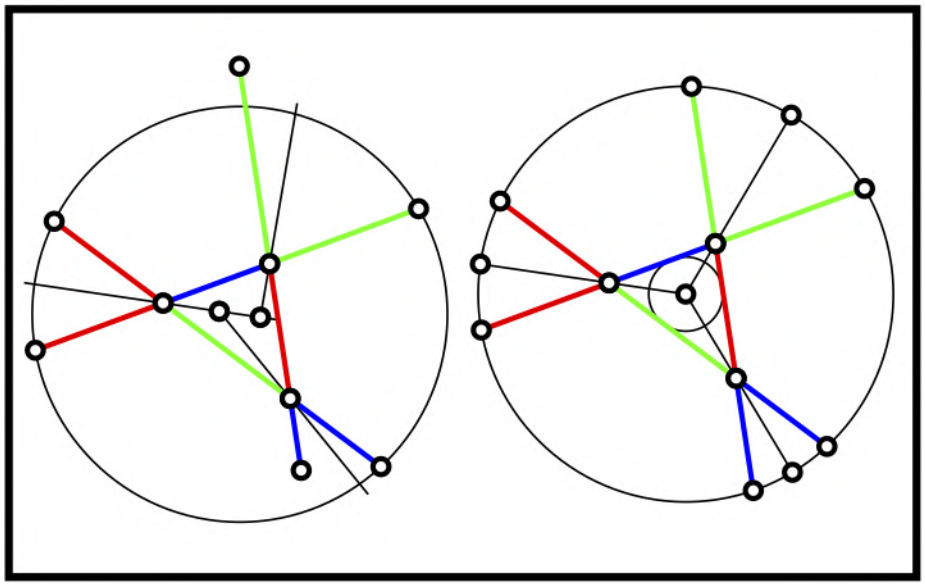
(Ben Chambers is a Maths teacher at St. Mary's College, Ponsonby, a Catholic school for girls from Years 7–13. This year Ben is teaching Maths to Years 7, 11, and 12.)

Sione Ma'u

MATHEMATICAL MINIATURE

MM51: In memoriam John Conway 1937-2020





J.C. Butcher

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MATHEMATICAL MISEPONYMY

L'Hôpital's rule

L'Hôpital's rule is a pretty standard tool for folk wanting to calculate limits, its most basic form being that if f and g are okay functions and $\lim_{x\to a} f(x) = \lim_{x\to a} g(x) = 0$ then $\lim\limits_{x\to a} \dfrac{f(x)}{g(x)} = \lim\limits_{x\to a} \dfrac{f'(x)}{g'(x)}$. Who discovered the rule? Several sources are worth looking at: [3] with its wealth of letters between l'Hôpital and Johann Bernoulli, [4] with a summary of some of that and [1] with some explicit references to the rule itself. Each points to Johann Bernoulli[2].

As far as I can make out the first publication of l'Hôpital's rule appears in [2, pp 145-6], complete with a proof and examples. The first example is interesting for several reasons. Beginning with $\dfrac{\sqrt{2a^3x - x^4} - a\sqrt[3]{a^2x}}{a - \sqrt[4]{ax^3}}$ and noting that numerator and denominator are both 0 when $x = a > 0$, he presents the derivatives of numerator and denominator, evaluates them when $x = a$, and shows that the ratio is $\frac{16}{9}a$.

Back in the 17th and 18th centuries it was common enough for musicians to have rich sponsors; maybe less common for mathematicians. L'Hôpital, Marquis of Saint-Mesme and Montellier, was keen on mathematics and seemingly had spare money, so why not sponsor a mathematician, especially one of the calibre of Johann Bernoulli? Bradley notes at [1, p 18] that Bernoulli met l'Hôpital when the former was visiting Paris in November 1691 and right after that l'Hôpital employed Bernoulli to tutor him in the latest mathematical research, on calculus.

By 1693, l'Hôpital was attempting to calculate the limit of the expression above, which later became his first example of the use of the rule. In a letter to Bernoulli dated 27 June, 1693, quoted at [1, pp 22–23] l'Hôpital argues that setting $x = a$ in the expression yields $\frac{a^2-a^2}{a-a} = \frac{(a+a)(a-a)}{a-a}$ which, on cancelling the expressions $a - a$, gives $2a$ as the answer. It seems that over the next year or so Bernoulli teased l'Hôpital about the correct answer and how he obtained it. Then in a letter dated 17 March 1694 (misprinted as 1794 in [1]) l'Hôpital offered Bernoulli a stipend subject to Bernoulli continuing to give l'Hôpital mathematical lessons and, the kicker, revealing his mathematical discoveries only to l'Hôpital. Partial extracts from that letter are given at both [4, p 199] and [1, p 19]; the full letter, along with many others, is found in [3]. Bernoulli delivered on his contractual obligation regarding the rule in a letter to l'Hôpital on 22 July, 1694, and included both his proof and two examples, including that above.

It is worth saying a bit about [2]. Appearing just 12 years after Leibniz first described his calculus, it was the first textbook on differential calculus. Indeed, in [1], Montucla is quoted as listing five continental mathematicians who in 1696 could use calculus. As part of his tutoring of l'Hôpital, Bernoulli wrote down his lessons and they form the basis of [2]. Interestingly l'Hôpital's name appears nowhere in [2], neither on the title page nor anywhere in the 16-page preface, though apparently it was common enough knowledge that l'Hôpital was the author. By the second edition in 1716 (12 years after his death) his name did appear as author.

References

[1] Robert E Bradley, *De l'Hôpital, Bernoulli, and the genesis of* Analyse des infiniment petits, BSHM Bulletin: Journal of the British Society for the History of Mathematics, 28(2013), 16–24.

[2] Guillaume F. A. l'Hôpital, *Analyse des infiniment petits : pour l'intelligence des lignes courbes*, A Paris : De l'Imprimerie royale, 1696. A scanned copy is available from the Linda Hall Library, Kansas City, Missouri, USA, at http://lhldigital.lindahall.org/cdm/compoundobject/collection/math/id/21037.

[3] O.Speiss (ed) *Der Briefwechsel von Johann I Bernoulli, Vol 1*, Birkhäuser, 1955.

[4] C. Truesdell, *The new Bernoulli edition*, Isis, 49(1958), 54–62.

David Gauld

[2] I expect that quite a few NZ mathematicians can trace their academic ancestry via the website https://www.genealogy.math.ndsu.nodak.edu, alternatively https://www.mathgenealogy.org, to Bernoulli.

PROFILE

Alex James is an Associate Professor in the School of Mathematics and Statistics at the University of Canterbury. She completed her BSc(Hons) in Mathematics at the University of Newcastle-upon-Tyne, followed by a Masters with some of the world's leading experts in nonlinear dynamics at UCL. She did her PhD on combustion theory at the University of Leeds with John Brindley, a global champion of British Applied Mathematics. After finishing her PhD, she was quickly snapped up as a lecturer by Sheffield Hallam University in 2001 before moving to New Zealand to take up her position at UC in 2004.

I first encountered Alex when I was a PhD student at the University of Leeds and I saw Alex, a recent PhD graduate, give a talk with Jon Pitchford at a dynamical systems conference. I still remember this talk 18 years later, partly because Alex and Jon with their references to obscure 1970s British punk are a naturally entertaining combination. But partly because giving a conference talk as a double act seemed, at the time, to be mould-breaking. In the 16 years I have worked alongside Alex at Canterbury, I have come to learn that Alex excels at mould-breaking in numerous areas and is never afraid to think outside the box. Alex's research record is as varied as it is prodigious. She has published over 50 journal papers, including not one but two Letters to Nature. Alex is an incredibly versatile applied mathematician, having worked on seemingly everything from the chemical reactions that take place inside bombardier beetles to the organising principles of complex ecosystems. From optimal foraging theory to the mathematics of invasive species. And from social network analytics to the causes of gender inequity in academia. These are just a few examples that reflect Alex's approach to research, which is innovative yet extremely practical, always grounded in reality and usually based closely on real data. Not one to do research for the sake of doing research, Alex is motivated by enhancing understanding of real-world problems and providing useful answers to important questions.

Alex's ability to talk to people from a range of backgrounds and disciplines means she is able to make connections and communicate the usefulness of mathematics widely in different domains. On several occasions I have been in a meeting where someone (often me!) is trying to explain something mathematical to a non-mathematician. With brows becoming increasingly knitted, Alex will chime in with an analogy or a different way of explaining something and all becomes clear. As a result of this ability, her research has had impact in a range of areas outside academia, including conservation management, child protection services, management of the *Mycoplasma bovis* outbreak, and identifying causes of the gender pay gap. I have recently had the privilege of working closely with Alex on mathematical models to inform New Zealand's response to COVID-19. Without Alex's creativity, modelling expertise, ability to home in on the important question, and knack for extracting insight from messy data, this work would undoubtedly not have had the impact it has.

Alex is a beacon for the benefits that mathematical modelling can bring to policy-makers and managers in industry and government. Alex has long-established research collaborations with scientists at DOC and several CRIs. In her role as Deputy Director of the CoRE Te Pūnaha Matatini, Alex has forged connections with numerous government departments and agencies including MSD, MBIE, MPI, Oranga Tamariki, TEC, and regional councils. Alex played a pivotal role in developing the vision and aims of Te Pūnaha Matatini to deliver internationally recognised cutting-edge research in complex systems, as well as being relevant and useful to New Zealand's economy, ecosystems, and society. This was instrumental to the success of Te Pūnaha Matatini's bid in the 2014 CoRE funding round and the subsequent achievements and impact of the Centre.

Alex does so much to help others on campus, whether they are students, early-career researchers, or department colleagues. Always generous with her time, she is in demand as a supervisor and unfailingly kind and supportive to her students. She has supervised over 18 Masters and PhD students and postdoctoral fellows, including Rachelle Binny, Lisa Hall, Julie Mugford, and Scott Graybill. She is an exceptional teacher of mathematics, especially for students who are combining maths with other subjects. Often some departmental colleagues will be sitting in the tea room debating some point of pedagogy or whether students benefit more from X, Y or Z. The next day, Alex will often come back and say "I know the answer now because I asked my students". This extremely simple but effective approach of actually talking to students and finding out what works for them epitomises Alex's open-mindedness and innovation to different ways of enabling students to become independent learners.

Alex is always keen to promote the public service messages that mathematical modelling can provide. She has given talks and activities for school children on multiple topics including how to reduce spread of an infectious disease. She was given the UC Students' Association "Vaccine Enthusiast Award" in 2019 after a particularly passionate differential equations lecture on herd immunity. Her philosophy is that mathematics should be interesting and it should be useful. Do we really need to make our students learn how to solve THAT differential equation or integrate THAT function? Or can we skip forward a bit to a more exciting topic that will pique their interest and have them coming back for more next year? She has given an invited talk at the NZ Association of Mathematics Teachers conference on this topic.

Alex's achievements have been recognised by numerous awards and accolades. She won the NZMS Research Award in 2018 and has been a Fellow since 2015. She has been an invited plenary speaker at the AustMS conference, Society for Mathematical Biology conference, and more. Her excellence in teaching was recognised in 2008 with a UC Teaching Award. She serves the Applied Mathematics and Science community in various ways. She sits on the NZ Research Information System Stewardship and Oversight Group. She served as NZMS Secretary and Newsletter Editor from 2013 to 2015. She is an Editorial Board member for Letters in Biomathematics and Theoretical Ecology. She has been on many conference organising and invited speakers committees, and has organised special sessions on equity and diversity and early career workshops. She was instrumental in empowering postgraduate students to establish and organise their own conference (initially the South Island Mathematics and Statistics Postgraduate Conference in 2006, now the NZ Mathematics and Statistics Postgraduate Conference). This event has since gone from strength to strength and is now a regular fixture.

I have learned immeasurably from working with Alex for the last 16 years — and not just about teaching and research in mathematics, my knowledge of bicycle maintenance, famous mathematicians and the geographical intricacies of the Lancashire accent would not be the same otherwise! I consider myself very lucky to have Alex as a colleague and a friend.

Mike Plank

LOCAL NEWS

UNIVERSITY OF AUCKLAND

DEPARTMENT OF MATHEMATICS

As with everywhere else, staff have been dedicated to getting through teaching and assessing online (and grappling with distressing processes such as SpeedGrader and "Digital Course Outlines") and most people are pretty exhausted. It's hard to remember that, at the start of the year, many of us had never used zoom or heard of chegg.com. The department was still very quiet most days, with most academic staff choosing to work at home, until it came back to life again for the start of teaching on July 27.

Staffing

We were saddened to hear of the death of our former colleague Robert Chan. This will be reported in greater detail elsewhere in the Newsletter.

Julia Novak has left the department to take a new role at the Learning Design Service (LDS) at the university. As part of this role she is working to assist academics to adapt their teaching to new (and potentially pandemic-proof) modes of delivery.

Melissa Tacy has joined the department from Otago as a Lecturer in Pure Mathematics.

Ofer Marmur has joined the department as a Lecturer in Mathematics Education. He is currently working remotely while continuing to live in Vancouver until international relocation becomes more feasible.

Malia Puloka has accepted a permanent position as a Professional Teaching Fellow in the department.

Lukas Zobernig has started a research fellow position, supervised by Steven Galbraith.

Min-Ah Lee has returned from maternity leave to her role as Academic Services Coordinator. Rajni Herman, who had been covering the role, moves to Statistics.

Four staff (Rod Gover, Eamonn O'Brien, Jeroen Schillewaert, and James Sneyd) who had intended to take research and study leave in semester 2, have deferred their leave to semester 2 of 2021.

Awards and honours

Congratulations to Marston Conder on his award of Officer of the New Zealand Order of Merit (ONZM), for services to mathematics. The list of Maths Department staff to have previously received this honour includes John Butcher, David Gauld and Ivan Reilly.

Other news

Rafal Bogacz (University of Oxford) has spent his sabbatical in the Department, where he was hosted by Hinke Osinga. Rafal's research focuses on modelling neural dynamics, and in particular the oscillations in neural activity that occur in Parkinson's disease. During his stay, he collaborated with the Dynamical System group, and learned new techniques that will be very useful in his work. He has also enjoyed the interactions with other researchers in Auckland.

Steven Galbraith organised (online) the Algorithmic Number Theory Symposium (ANTS-XIV) between June 29 and July 4. This was also followed by a small (online) workshop on Post-Quantum Cryptography.

Tristan Pang, one of our younger graduates who completed his honours degree when he was 18, will be starting a masters in Oxford later in the year.

Nicolette Rattenbury and Jonny Stephenson were featured in a NZ Herald article on MathsJam.

Arkadii Slinko reports that, during lockdown, the Centre for Mathematics in Social Science organised a weekly international seminar on Mathematics of Social Choice. Eight talks have been delivered so far and all future slots until September have been filled. The geographical location of speakers and participants is very diverse, including even participants from Brazil although the local time in Brazil for this seminar is 6am. There have been up to 40 participants so far.

Rachel Passmore is a member of the Auckland Mathematical Association's (AMA) Executive Committee. The AMA's main role is to provide professional development events for secondary school teachers of Mathematics and Statistics in the Auckland region. These events are usually held in person and hosted by the University of Auckland. With COVID-19 this became impossible but the need for professional development grew rather than diminished during this time. Teachers were rapidly trying to upskill in new technologies and find new ways to maintain engagement of students online. So the AMA decided to go #AMAONLINE (https://www.aucklandmaths.org.nz/amaonline/). Normally our participants are from Auckland only, but in the online environment only half were from Auckland, other participants were from all over NZ and even some from Rarotonga. Due to the overwhelming support for this first online event we have decided to continue with the online form of professional development and have already planned another four online events. This format has also allowed us to include Primary teachers as well as Secondary teachers. All sessions are recorded and uploaded to our new website so that they can be shared widely. Thanks to all the presenters for being so generous with their time and expertise and also thanks to Robyn Headifen, our Kaiarahi and Dr Pip Arnold who did an enormous amount of work behind the scenes to make this such a successful event.

Steven Galbraith

UNIVERSITY OF WAIKATO

DEPARTMENT OF MATHEMATICS AND STATISTICS

Lockdown and the aftermath

This has been a challenging and strange time for teaching staff at the University of Waikato. When lockdown was announced they were given a few days to put all of their lectures online. The passage of equipment and resources out of G building during the day prior to lockdown was remarkable.

Lockdown was precisely that: the University including the library and other amenities were closed down, so not even staff could enter buildings. New tasks included producing written materials for posting online and making videos of the lectures they would normally have delivered face-to-face. Following lockdown this requirement has been continued, and will be the case for the rest of this year, at least.

The desire of many, if not most mathematical and computer scientists has been to present material face-to-face, and this has been achieved, to some extent, by replacing some regular lecture sessions with workshops. The new jargon includes Panopto, Wacom tablet, and Zoom. A notion held by some is that the day of the traditional lecture or tutorial, popular from the time of Socrates, is over. Some staff like the idea of pressing a button to deliver their lectures, and save all of that mental exertion associated with live presentations. Other staff have welcomed the opportunity to get their teaching materials into shape to put them online. And some students enjoy the flexibility of being able to take lectures in bed or with pizza. However, many, if not most, students are unhappy and seek face-to-face instruction, and many staff miss that continuous and direct interaction with students, where the extent of student engagement with the process is not in doubt.

The effort involved in making this change has been great and some staff regret the loss of research time. In particular, producing and editing high quality videos is not so easy, and staff are not satisfied with a less than excellent creation. Testing and examining has been a large challenge also, with staff adopting a variety of online methods. The reliability of these approaches overall is unclear, as is their future. One thing is certain, should another lockdown be required, we will be ready!

The situation which applied during lockdown and stages 3 and 2 has now reverted to something more regular. Judy Bowen, the Academic Dean of the Division HECS which we are now in, advises

- Lecture recordings are only required to be made available to those who had to move out of Hamilton due to covid19 and those who are sick (because at level 1, you are still required to stay home even with a minor niggle).
- We are allowed to not put the lecture recordings in the Moodle folder and only make them available by request (to those that satisfy the above criteria).
- Final exam replacement tests can be conducted on campus if they require writing maths equations (or anything else) that makes it difficult to administer online.
- There is no requirement on internal assessment - they can be done in class or however you would normally do.

Thanks to Chaitanya Joshi for obtaining this advice.

Change is in the air

The University has now adopted the "divisional structure" described in a previous newsletter, and the Department of Mathematics and Statistics is now part of the School of Computing and Mathematical Sciences which is in the Division of Health, Engineering, Computing and Science. Head of this division is Geoff Holmes, our previous dean. Annika Hinze is the new Head of School and has undertaken a review of the school structure, with lots of consultation. However, we don't expect much to change in mathematics and statistics other than the creation of a deputy chair position. Stephen Joe has returned to the Department of Mathematics and Statistics, but is still assisting with School administration.

People

We celebrated Ernie Kalnins award of professor emeritus in June with a delicious cake provided (and cooked) by Han Gan. Hamish Gilmore and Daniel Delbourgo participated in the Number Theory Online conference NTOC2020 in June. Its URL is https://carma.newcastle.edu.au/meetings/ntoc2020/. Tim Stokes and others have been participating in a range of online international seminars. Three staff have had illnesses which required hospital stays, adding to the the challenges of our time. All are on the mend thankfully. Ian Hawthorn has moved to Tauranga for the remainder of this year where he is providing leadership and content for the mathematics and statistics offering at that uni branch.

Kevin Broughan

MASSEY UNIVERSITY

SCHOOL OF NATURAL AND COMPUTATIONAL SCIENCES

Mick Roberts is taking part in the workshop "Infectious Dynamics of Pandemics: Mathematical and statistical

challenges in understanding the dynamics of infectious disease pandemics" at the Isaac Newton Institute for Mathematical Sciences, University of Cambridge. The meeting is being held virtually, so the time difference is a challenge. Welcome drinks at 3.00 am on Zoom (BYO) were not the same.

Graeme Wake concluded in June, his four year term on the selection panel of the annual Prime Minister's Science Teachers Prize. Competition for this prize is understandably very strong. This valuable prize is worth $150,000 in total for both the winner and his/her school. For the first time in the history of this award it was awarded by Prime Minister Jacinda Ardern on 30th June this year to a Mathematics Teacher: Dr Michelle Dalrymple, Head of Mathematics at Cashmore High School, Christchurch. This served to highlight the welcome inclusion of Mathematics in the group of STEM subjects. A full article on Michelle appears elsewhere in this Newsletter.

Webinar: Mathematics in Industry: Challenges and Frontiers. New Zealand played a lead role in this International webinar on 3rd June to address this fast-developing opportunity world-wide. It was hosted jointly by the University of Baroda, India and the Oxford Centre for Industrial and Applied Mathematics. Graeme Wake was the opening speaker from the Asia-Pacific region of the panel of five international presenters. The live participant audience around the world numbered about 2,500. The unedited live proceedings of around 3 hours can be viewed on the youtube channel: https://www.youtube.com/channel/UCQwf3DPPcNLPb_76ToxTklA

The future of the mathematics group is still unclear after the proposal in February that face-to-face teaching occur in Palmerston North only. Another discussion document is expected to be released in late August.

Carlo Laing

VICTORIA UNIVERSITY OF WELLINGTON

SCHOOL OF MATHEMATICS AND STATISTICS

New staff

We welcome several new staff members. At the beginning of May, Camila Sehnem started a postdoc in Operator Algebra, working primarily with Astrid an Huef. Due to our border being closed, Camila zooms in from Brazil on a regular basis. Camila obtained her PhD in Germany at the University of Göttingen, and then took up a research scholarship at the Universidade Federal de Santa Catarina in Brazil. We hope that she can travel to New Zealand soon.

Brendan Harding started as Lecturer in Mathematics in mid July. He is also working remotely, but from a time-zone-friendly Australia. Brendan completed his PhD in Mathematics at the Australian National University in 2016. He then went on to do a postdoc at the University of Adelaide. Brendan is an applied mathematician, working, in particular, in fluid dynamics.

Nick Brettell is back with us for another postdoc, working with Geoff Whittle. In the meantime, Nick has held postdoctoral positions at Durham University and at Eindhoven University of Technology.

International Statistical Ecology Conference (ISEC)

Shirley Pledger and Louise McMillan attended virtually the International Statistical Ecology Conference 2020, which was run from Sydney by David Warton and Gordana Popovic and many more. They did a fantastic job of organising a virtual conference with 3 months' notice, and it all went astonishingly smoothly.

They had sessions at different times of day to handle multiple time zones, and all the activity was in Slack – so there were channels on Slack to discuss different topics, and the speakers talked via Zoom and were live streamed to videos embedded in Slack, and the audience could post questions and reactions on the thread for each set of talks. It was a strange experience, both giving a talk via Zoom with no access to the audience, and chairing a session via Zoom and relaying questions from Slack to Zoom.

Because the discussion topics were organised in Slack, it was easier to participate in discussions on the topics you were particularly interested in, even if you didn't know anyone at the conference beforehand (it's a biennial conference).

But by far the biggest advantage of the virtual arrangement was that the registration cost dropped from around $350 to $50 AUD, and without the travel and accommodation costs it was much easier for people to attend who usually cannot afford to. The number of participants, usually about 300-350 for previous conferences, went up to about 850 and the diversity of participants was much greater than usual.

This was a shining example of a well-run virtual conference, and the organisers of the next ISEC are already planning a hybrid model to reap some of the benefits of the virtual model.

A lockdown story from Mark McGuiness

Lockdown for me meant a change in how lecture time is used. The prospect of hosting Zoom meetings from my home office felt so different to standing in front of a class in a lecture theatre, that I was receptive to the idea of changing to a more flipped classroom style, an idea floated by Emma Greenbank during discussions about our shared Engineering Math course. So the plan was to allocate reading from the online Lecture Notes each week, and use just the first 10-20 minutes of lecture time to pontificate on some key point in the reading, then ask for questions from students and respond to

those questions during the remainder of the time. Key to this was to be relaxed about not necessarily lecturing on everything in the Notes, rather to be responding to student concerns from the Notes or from the current assignment and tutorial.

I felt good about the chance that lectures would not be very long, if students had no questions. Most students were muted and many chose not to turn on their cameras for Zoom. They used Chat which was set up so that they could not communicate to everyone, only to me, so maintaining anonymity. I also realised the value in this big class of not saying the name of the person asking the question, when I responded to it verbally.

The result was I got heaps of questions from students, arriving via Chat, which I responded to at length, taking up the entire lecture time with some questions remaining unanswered!

Unanswered questions I responded to offline by recording a short video for each.

I'm used to using a document camera to write the mathematics down live as I lecture, old-school chalk on the blackboard style. I found that my phone camera provided excellent resolution when it was pointed at paper on my desk, and could be Shared to students when plugged into my laptop at home. The only problem was how to hold the phone so that it pointed downward. The internet provided an excellent suggestion - use a couple of (full) tin cans, put the phone on top but with the camera sticking out, and another can on top to hold the phone in place.

There was lots of positive feedback from students about the change in lecture style, and I intend to continue it now that we are back in lecture theatres. The challenge will be to monitor the Chat and Zoom on top of what is happening on campus during lectures; students attending in person will be able to choose between using Chat from their device or just putting their hands up if they are feeling brave.

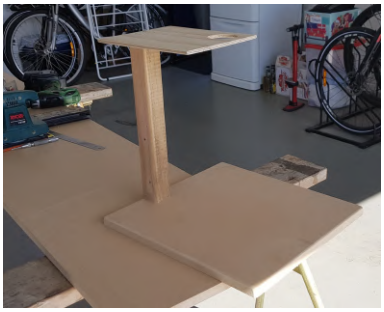
I see three advantages from the extra work to do this - it makes it easier for students to ask questions they might otherwise worry make them appear ignorant, there is less pressure on me to orally cover every detail of the required course content, and material the students are having difficulty with is given more attention.

Astrid an Huef

UNIVERSITY OF CANTERBURY

SCHOOL OF MATHEMATICS AND STATISTICS

The rapidly evolving corona pandemic had a huge impact on universities, their staff and students, how we teach and learn. In mid March the University of Canterbury started to prepare for possible online teaching due to Covid-19. Our IT staff *Paul Brouwers* and *Steve Gourdie* tremendously helped staff in preparing for the change. Paul ran workshops for getting familiar with zoom, how to record and link to LEARN, and how to make a DIY document camera using a mobile phone and some household objects. Later Steve supplied mobile phone stands he built in his garage. I have been told they work really well!



Stand for improvised document camera using mobile phone

On March 20 the university announced the move to fully online teaching from Monday, 23 March for the remainder of the semester. On the afternoon of the Monday when the Prime Minister has announced that the country is at alert level 3 and moves to alert level 4 in two days term 1 ended abruptly that day and the start of term 2 was moved forward by a week. The UC campus was locked down on 25 March from 5pm with no staff access to any buildings. Fortunately, our two Erskine visitors during term 1 made it just in time to get back home before the lockdown took effect. Erskine fellowships have been cancelled for the rest of 2020.

The three week break was to be used to plan and prepare the shape of term 2. A big thank you to each and every one of our staff for their extraordinary efforts in organizing and delivering lectures and tutorials from home, setting and marking online assignments, test and exams.

Huge kudos to *Alex James* and *Mike Plank*, who had been formally seconded to the National Crisis Management Center for their expertise in mathematical modelling. Along with Shaun Hendy (UAuckland), their honours student Nick Steyn, and others in Te Pūnaha Matatini, they provided, and continue to do so, daily reports to the PM's chief science advisor Juliet Gerrard and Director-General of Health Ashley Bloomfield.

Congratulations to *Varvara Vetrova* for her significant role in the TAIAO project (Time-Evolving Data Science/Artificial Intelligence for Advanced Open Environmental Science) which has been awarded an MBIE grant of $13million over the next 7 years. This programme, led by the University of Waikato, is a collaboration between them, and the Universities of Auckland and Canterbury, along with Beca and Metservice and other industry partners.

In April the School farewelled two staff members. *Carl Scarrott* resigned to take up a professorship at the National University of Ireland, Galway. His move to Ireland was put in disarray due to the lockdown. Carl arrived here in 2004 soon after obtaining his PhD at Lancaster on extreme value theory.

Rick Beatson retired after a long career at UC. He joined the department as permanent staff in September 1985. His association with UC goes back even further starting as a student here in 1970 and obtaining his PhD in 1978. Rick is kept busy in retirement, being currently back as a casual teaching complex variables and being in the process of building a new house. Rick has been awarded the title Professor Emeritus for his long service and achievements and continuing involvement with UC.

In the current corona environment UC has suspended all recruitment of continuing staff. Fortunately, *Jennifer Wilcock*, who had been on a fixed-term contract as lecturer in statistics, will help fill in the staffing gap and will be with us for another year.

Congratulations to *Michelle Dalrymple* who won the 2019 Prime Minister's Science Teacher Prize for her work to help inspire students in Mathematics and Statistics. She is the first mathematics and statistics teacher to nab the premier teaching award. Michelle is Head of Faculty Mathematics and Statistics at Cashmere High School in Christchurch and an Associate at our School. She also completed her degree at UC. What a magnificent recognition!

Günter Steinke

UNIVERSITY OF OTAGO

DEPARTMENT OF MATHEMATICS AND STATISTICS

For several weeks already, our staff and students are finally able to enjoy in-person lectures and on-campus life again — something that many of us have been looking forward to during semester 1.

Interestingly, the feelings of our lecturers about working from home and giving online lectures were quite mixed. Some enjoyed that they did not have to come in to their offices and that they were very flexible in how they worked (for example, by recording lectures whenever they wanted). Some would even have preferred to continue this work style after we went down the alert levels.

Others, of course, definitely like a clear separation of their work (on campus) and their private lives (at home), and hence were rather depressed by the need to do everything from home. Lecturing by just talking to a computer screen without any reactions from students was something quite unusual, and took time to get used to. In many cases our partners were not in our privileged position to continue working during lockdown, which made it even more difficult, for some of us, to work from home. Finally, just the uncertainty about how the situation might develop and when life might come closer to normality was rather depressing as well.

Nevertheless, homo sapiens is well-known as a very robust species that tends to survive even under a lot of pressure and in the most difficult circumstances. (Otherwise, how would we have arrived at today's terrible overpopulation on this planet?) Therefore, we tried to make the best out of the lockdown by appreciating that everything was a little bit more relaxed, the pace was slower and the air pollution from traffic was reduced. In some cases, the fact that our neighbours were at home too, and they probably decided to use their additional free time for noisy renovations, would have led to occasional unpleasant increase of noise levels.

Still, many of us did enjoy the additional freedom at home. For example, *Tim Jowett* created a lockdown golf course in his garden:

Leanne Kirk did particularly enjoy regular walks with her dog along the Otago harbour:

and *Chris Palmer* made a very nice contribution to the lockdown teddy bear hunt:

Jörg Hennig

PhD SUCCESS

Elias Siguenza (University of Auckland)

Title: Mathematical Physiology: Modelling Parotid Saliva Secretion

Supervisors: James Sneyd and Vinod Suresh (Engineering Science)

Abstract: Although the theory of exocrine gland secretion is comprehensive, numerous questions over the specific molecular mechanisms and signalling pathways associated with the transport of water in salivary gland epithelia persist. This thesis addresses some of these questions by combining new experimental data, along with mathematical modelling.

One such problem involves exploring to what extent do the calcium (Ca2+) signalling heterogeneities, arising from agonist stimulation, impact the way salivary cells transport water. Using a three-dimensional and anatomically accurate mathematical model of secretion, we found that these have no direct effect on their rate of secretion. The result suggests the possibility of modelling cell salivation as a quasi-steady-state function of the cytosolic Ca2+ averaged over the entire cell; effectively ignoring all the dynamic complexities, not only of the fluid secretion mechanism but also of the intracellular heterogeneity of Ca2+ signalling.

We also address how these cells work as a cohort; this is because they form clusters called acini. We assembled an 'in-silico' parotid acinus and investigated the influence its lumen's topology has on the efficiency of fluid secretion. Our simulations demonstrate that a particular luminal topology does not affect secretion efficiency. Furthermore, this type of model may not be necessary when modelling fluid flow rate. Thus, to obtain an acinus, or better yet a gland flow rate estimate, one can multiply the output of a homo-geneous single-cell model by the number of cells in a salivary gland.

Finally, we study new experimental results that revealed a significant potassium (K+) current in the apical pole of acinar cells. These results are controversial, as the concentration of K+ in primary saliva has been observed to be relatively low. To reconcile these observations, with the accepted secretion model, we use a single-cell model along with experimental data to propose a framework in which the luminal K+ is reabsorbed by the cell via apical NaK-ATPases in exchange for intracellular Na+. We show that placing a sizeable K+ current in the apical membrane, along with apical NaK-ATPases, does not lead to a secretion rate that is either increased or decreased. However, the luminal electrolyte concentrations are maintained at physiological levels.

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Nathan Pages (University of Auckland)

Title: Models of Calcium Dynamics: Analysis Using Physiologically Accurate Simulations and Non-Standard Geometric Singular Perturbation Theory

Supervisors: James Sneyd and Vivien Kirk

Abstract: This thesis considers models of intracellular calcium ions (Ca2+). We aim to show how mathematical modelling can help us understand Ca2+ dynamics and how the investigation of Ca2+ dynamics models can motivate the development of new mathematical tools.

The first part of the thesis presents a model of Ca2+ dynamics in parotid acinar cells.This model is simulated using a finite element method on an anatomically accurate reconstruction of a cluster of cells. Parotid acinar cells are exocrine cells; therefore, the Ca2+ model is coupled with a fluid flow model. From simulations, we gathered three main results. Firstly, the structure of the cell determines which of the possible mechanisms can create the observed Ca2+ concentration oscillations. Secondly, a wave propagation mechanism is needed to transport the Ca2+ oscillation from the apical to the basal region; we propose a mechanism based on calcium-induced calcium-release channels. Finally, there is a strong co-dependence between fluid secretion and Ca2+ dynamics; therefore, it is necessary to model fluid secretion alongside Ca2+ dynamics.

Geometric singular perturbation theory (GSPT) in its classical form, which assumes that each variable is associated with a distinct timescale, has previously been used to study Ca2+ dynamics problems with multiple timescales. However, this association is not valid in general and particularly for models of Ca2+ dynamics; instead, a non-standard form of GSPT, which does not rely on the separation of variables by timescale, is more appropriately used for the analysis of Ca2+ models.

We applied non-standard GSPT to a simplied canonical model of Ca2+ dynamics to explain the structure of its relaxation oscillations. We linked timescales to distinct physiological processes underlying dierent terms in the model, making possible a physiological interpretation of the analysis. Our approach overcomes problems that arise when using classical GSPT. Specically, we were able to study models that exhibit more timescales than variables and in which a variable can be characterised as either fast or slow depending on the position in phase space. Our strategy of identifying timescales in a model based on careful consideration of the underlying physiology is quite general and is expected to be useful for other Ca2+ dynamics models or process-based models with multiple timescales.

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Susana Guzman (University of Auckland)

Title: Model Uncertainties and Joint Inversion in Geophysics

Supervisors: Jari Kaipio and Julie Rowland (School of Environment)

Abstract: Solid Earth geophysics is based on different types of data, such as magnetic, gravitational, electrical and seismic generally collected near or at the surface of the Earth, and is used to estimate physical parameters of the subsurface. The related parameter estimation problems are typically characterize as inverse problems. Other types of data may include petrophysical data from borehole (core) drilling. All these types of data are then used to decide, for example, where to carry out further drilling, which is an expensive undertaking. The standard way of modelling different types of data uses oversimplified likelihood models, which can be interpreted as being induced by white noise, zero mean and uncorrelated with the unknowns. The problem is that the use of these trivial likelihood models tends to underestimate the underlying uncertainties of the parameters. However, the so-called Bayesian Approximation Error (BAE) approach has shown that feasible likelihood models are typically non-trivial.

In this thesis, we use the BAE approach to construct feasible likelihood models for the case of different data types and jointly correlated parameters. We show that the associated joint likelihood functions are coupled and that the errors are heavily correlated with the unknowns. We also show that the assimilation of different measurement modalities with properly constructed covariance structures may increase accuracy in the estimates.

As examples, we use linear and non-linear geophysical forward problems, namely, gravity and magnetics, to estimate the large scale representation of the associated physical parameters. As joint prior models we use jointly correlated Whittle-Matern random field models with cross- covariance constructed using statistical constitutive models. We add borehole data which is inherently represented in a smaller spatial scale. We show that straightforward incorporation of the small scale borehole data with the large scale model can underestimate the posterior uncertainty and can render parameter estimates useless.

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Michael Philip Hackney (University of Canterbury)

Title: Modelling Cooperative and Competitive Behaviour in the Exploitation of Marine Resources

Supervisors: Mike Plank and Alex James

Abstract: Fish are an extremely important resource worldwide, for nutritional and economic reasons. However, many fish stocks are being exploited at an ecologically unsustainable level. It is thus of importance that fisheries' management strategies can be found which will allow significant amounts of fishing to occur, while protecting these renewable resources for the future. In this thesis we are particularly concerned with situations where individual economic interests and environmental concerns coincide. We use behavioral models of individual fishers to investigate how individual profit motivation leads to aggregate fishing behavior. These are coupled with a variety of fish population models, in order to obtain a picture of how this exploitation impacts the fishery. We pay consideration to the economic value of the fishery, as well as using population abundance as a proxy for ecological health. This approach is viewed through the lens of game theory.

In Chapter 2 we consider a dynamic size spectrum PDE model of a single fish population, which is supported by a producer spectrum of plankton on which the juvenile fish prey. This size spectrum model gives the abundance of the fish population by the size of its constituent members, by tracking the transfer of biomass that occurs throughout the population due to predation, mortality, and reproduction. This size spectrum model is paired with an individual based model of many fishers exploiting the population in a small scale open access fishery. We allow

individual agents to change their own size-selectivity behavior, and to make the choice of whether or not to fish in order to meet profit expectations. We find that the aggregate size-selective harvesting behavior reaches a Nash equilibrium, in which we also observe balanced harvesting of the fish stock. Furthermore, the number of active agents in the fishery converges over time. Results from this chapter have been submitted for publication.

In Chapter 3, we consider the classic Gordon-Schaefer bioeconomic model of a fishery from a non-cooperative game theory perspective. We frame exploitation as a symmetric 2-player game in which fishers take action by selecting a harvesting intensity. For a fish population at equilibrium, we find a level of fishing effort that strictly dominates all other actions, as well as a Pareto optimal frontier where the total exploitation is equivalent to that of a monopolist. Consequently, this game is structurally equivalent to an Iterated Prisoners Dilemma. We extend our analysis to non-equilibrium populations using numerical simulations, and evaluate the relative performance of well-known strategies for an IPD (such as tit-for-tat) in these conditions.

In Chapter 4, we use a Markov decision process framework to find an optimal exploitation policy for a monopolist in a noisy environment. Optimal policies map from the population biomass to the level of fishing effort which will maximise the current and future value of the fish stock. Fish populations were modelled using a Beverton-Holt process to allow for the inclusion of noise in the stock recruitment relationship. Increasing stochasticity in the population was found to reduce the optimal fishing intensity with respect to biomass. This analysis was then extended in Chapter 5 to a Markov game situation in which there are two independent fishers acting to maximize profit. A combination of fishing policies that was a Nash equilibrium was obtained.

The thesis concludes with Chapter 6, where we summarise the thesis and present some directions for future research.

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Louis Warren (University of Canterbury)

Title: Minimal logic and automated proof verification

Supervisors: Hannes Diener and Maarten McKubre-Jordens

Abstract: We implement natural deduction for first order minimal logic in Agda, and verify minimal logic proofs and natural deduction properties in the resulting proof system. We study the implications of adding the drinker paradox and other formula schemata to minimal logic. We show first that these principles are independent of the law of excluded middle and of each other, and second how these schemata relate to other well-known principles, such as Markov's Principle of unbounded search, providing proofs and semantic models where appropriate. We show that Bishop's constructive analysis can be adapted to minimal logic.

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Rodelyn Rosalita Jaksons (University of Canterbury)

Title: Quantifying Environmental Exposures Using Bayesian Statistics

Supervisors: Elena Moltchanova, Beverley Horn (ESR) and Elaine Moriarty (ESR)

Abstract: In statistics, the use of observational data is key in understanding what factors are associated with a change in risk. Often, the data also contains a temporal and spatial structure and needs to be accounted for in the modelling. By doing so, one can understand how risk changes over space and time, and to evaluate areas of increased risk. To adequately deal with the complexities of spatio-temporal and observational data, Bayesian hierarchical models can be used. In this thesis, we use Bayesian statistics in the four case studies to quantify risk to environmental exposures and to identify which variables are associated with the greatest change in risk. The applications deal with predictive modelling for water quality management, spatio-temporal analysis of campylobacteriosis disease risk, estimating the extent of underreporting in epidemiological data, and modelling the emergence dynamics of the western corn rootworm for pest management. The models for each application are explained in detail, and the results discussed in depth. Additionally, we also discuss how the methods used in the applications are relevant to other disciplines.

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Jambugahapitiye Dhammaloka Thero (University of Canterbury)

Title: Śrīpati's arithmetic in the Siddhāntaśekhara and Gaṇitatilakac: edition, translation, and mathematical and historical analysis

Supervisors: Clemency Montelle, Kim Plofker (Union College, USA)

Abstract: The literature on the exact sciences in Sanskrit in the second millennium is significant from a historical point of view because of the emergence of innovative ideas, systematization of the traditional knowledge, advanced technicality, creativity of the scientific writing style, and so on. Śrīpati, a mathematician-astronomer, is the first known writer of exact sciences in this era. He lived in the 11th century most probably in Maharashtra and he wrote in a vast range of subjects from astrology to astronomy. In spite of his prolific writings and influence in the early stages of the second millennium, Śrīpati has been understudied. Śrīpati is the first author who wrote a separate mathematical text while still retaining all the main mathematical rules in theoretical astronomical texts. It is Śrīpati who used different elegant metrical forms in versification of mathematical rules. Most importantly, he invented several rules in arithmetic and provided inspiration for successive mathematicians and astronomers especially Bhāskara II.

In this thesis we provide a critical edition of the 13th chapter of Śrīpati's *Siddhāntaśekhara*, an astronomical work, consulting the published edition and three manuscripts and his *Gaṇitatilaka*, his arithmetic text, based on the published edition. They are followed by the critical translation and the commentary where mathematical analysis of all the rules is given. These mathematical rules, procedures, and executions are compared with that of other preceding and succeeding mathematical authors mainly in identifying Śrīpati's contribution and innovation. We attempt to understand Śrīpati's role in the history of Indian mathematics, how he was influenced by his predecessors, his influence on succeeding mathematicians, and to contextualize the mathematical rules given in both texts. This research will also examine, wherever possible, the use of mathematical rules given in the texts in daily practices, similarity or differences of the same rule in different texts, the characteristics of the executions of rules, and the commentators' approaches to the base texts.

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Meenu Mariya Jose (Victoria University of Wellington)

Title: On matroids that are transversal and cotransversal

Supervisors: Dillon Mayhew

Abstract: There are distinct differences between classes of matroids that are closed under principal extensions and those that are not. Finite-field-representable matroids are not closed under principal extensions and they exhibit attractive properties like well-quasi-ordering and decidable theories (at least for subclasses with bounded branch-width). Infinite-field-representable matroids, on the other hand, are closed under principal extensions and exhibit none of these behaviours. For example, the class of rank-3 real representable matroids is not well-quasi-ordered and has an undecidable theory. The class of matroids that are transversal and cotransversal is not closed under principal extensions or coprincipal coextentions, so we expect it to behave more like the class of finite-field-representable matroids. This thesis is invested in exploring properties in the aforementioned class.

A major idea that has inspired the thesis is the investigation of well-quasi-ordered classes in the world of matroids that are transversal and cotransversal. We conjecture that any minor-closed class with bounded branch-width containing matroids that are transversal and cotransversal is well-quasi-ordered. In Chapter 8 of the thesis, we prove this is true for lattice-path matroids, a well-behaved class that falls in this intersection.

The general class of lattice-path matroids is not well-quasi-ordered as it contains an infinite antichain of so-called 'notch matroids'. The interesting phenomenon that we observe is that this is essentially the only antichain in this class, that is, any minor-closed family of lattice-path matroids that contains only finitely many notch matroids is well-quasi-ordered. This answers a question posed by Jim Geelen.

Another question that drove the research was recognising fundamental transversal matroids, since these matroids are also cotransversal. We prove that this problem in general is in NP and conjecture that it is NP-complete. We later explore this question for the classes of lattice-path and bicircular matroids. We are successful in finding polynomial-time algorithms in both classes that identify fundamental transversal matroids. We end this part by investigating the intersection of bicircular and cobicircular matroids. We define a specific class - whirly-swirls - and conjecture that eventually any matroid in the above mentioned intersection belongs to this class.

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Del Rajan (Victoria University of Wellington)

Title: Quantum Physics Under Unusual Conditions

Supervisors: Matt Visser

Abstract: This doctoral thesis makes a significant and original contribution in the area of quantum information science, which reconceptualises quantum physics in terms of information. Central to this area is the quantum effect of entanglement in space. It can be seen as an interdependence among two or more spatially separated quantum information systems that would be impossible to replicate by classical information systems. Alternatively, an entanglement in space can also be viewed as a resource in quantum information in that it allows the ability to perform information tasks that would impossible or very difficult to do with only classical information. Two such notable applications are quantum communications which can been harnessed for teleportation, and quantum computers which can drastically outperform the best classical supercomputers. In this thesis, we provide one of the first theoretical expositions on an analogous quantum effect known as entanglement in time. It can be viewed as an interdependence of quantum information systems across time, which is stronger than could ever exist between classical information systems. We investigate the manifestation of this temporal effect within quantum information science as well as in its related fields of quantum foundations and relativistic quantum information. In this thesis, we also establish a significant result by designing one of the first novel applications of entanglement in time, namely a quantum block chain. We show that the entanglement in time provides the quantum advantage over a classical block chain. Furthermore, the information encoding procedure of this quantum block chain can be interpreted as non-classically influencing the past, and hence the system can be viewed as a 'quantum time machine'.

OBITUARIES

Robert Peng Kong Chan, 21 October 1943 – 19 May 2020

Robert Chan

Robert Chan was born in Malaya and migrated to New Zealand in 1959; he began at Auckland Grammar School in 1960, in the 5th form. He then studied for BSc in Physics at the University of Auckland 1963 – 1965, before embarking on a career as a secondary school teacher, first at McAuley High School, and then at Papakura High School, where he taught for the years 1970-1981. He also studied Mathematics extramurally from Massey University,

In 1980 he became a tutor at the University of Auckland, while he was doing an MSc in Mathematics. He then began a PhD under the supervision of Kevin Burrage and John Butcher, which he completed in 1989.

Robert was appointed to a Lectureship in Mathematics at the University of Auckland in 1991 and became the first Mathematics Lecturer at the Tamaki Campus. The campus was designed to be a multidisciplinary hub for research and teaching. It had specialised degrees, such as the Bachelor of Technology (BTech) in Industrial Mathematics, and the BTech in Information Technology, which drew on courses from Mathematics, Computer Science, Statistics, Engineering Science and other areas.

It was in Robert's nature to work with staff from all disciplines and thus he became a central contributor to the culture of the new campus. For the first few years Robert, and two tutors (Alastair McNaughton and Lynne Gilmore), were the only Mathematics staff. More appointments were subsequently made and, by 1996, the lecturing staff included Graeme Wake, Professor of Industrial Mathematics, Paul Bonnington, Stephen Taylor, as well as Robert. There were also Post-Doctoral Fellows and PhD students.

Robert retired in 2016 as a Senior Lecturer.

Robert's research was centred on passive and active extrapolation, in the solution of ordinary differential equations. The idea of smoothing, originality contributed by William Gragg in 1964, had opened the door to the application of Richardson extrapolation, to numerical ODEs. Whereas Gragg's work was confined to the implicit midpoint rule applied to stiff problems and the need to dampen unwanted oscillatory effects, Robert Chan extended these ideas to high order symmetric Runge–Kutta methods, such as Gauss and Lobatto IIIA schemes.

One of his most notable contributions was the study of A-stability barriers, for polynomial extrapolation. He showed that, under mild restrictions, an even order method cannot admit an A-stable extrapolation.

During his academic career, Robert had the opportunity to work with leading scientists at many overseas institutions, including Universities in Toronto, Rennes, Trondheim, Geneva, Trieste, L'Aquilla, Valladolid, Leiden and Nanjing.

Robert supervised many doctoral and masters students, many of whom have gone on to academic careers, in their own right.

Robert is remembered as a kind and patient teacher and a warm-hearted and generous colleague.

Robert was interested in all sports and was a keen follower of the All Blacks. He was with Philip Chartier at Eden Park, for the second Test Match against France on 3 July 1994. Robert was also with Nicola Guglielmi at Stadio Renato Dall'Ara, Bologna, for the Test Match against Italy, on 28 October 1995, and Nicola remembers how Jonah Lomu played with such distinction.

Robert also loved music and wrote, as a postscript to his PhD thesis, "I wish to pay tribute to the following composers whose compositions have been instrumental in smoothing my journey on the long and irregular path to its destination." And at the end of the list of composers he wrote a pseudoTheorem, "Music is the food of life iff Mathematics is its breath."

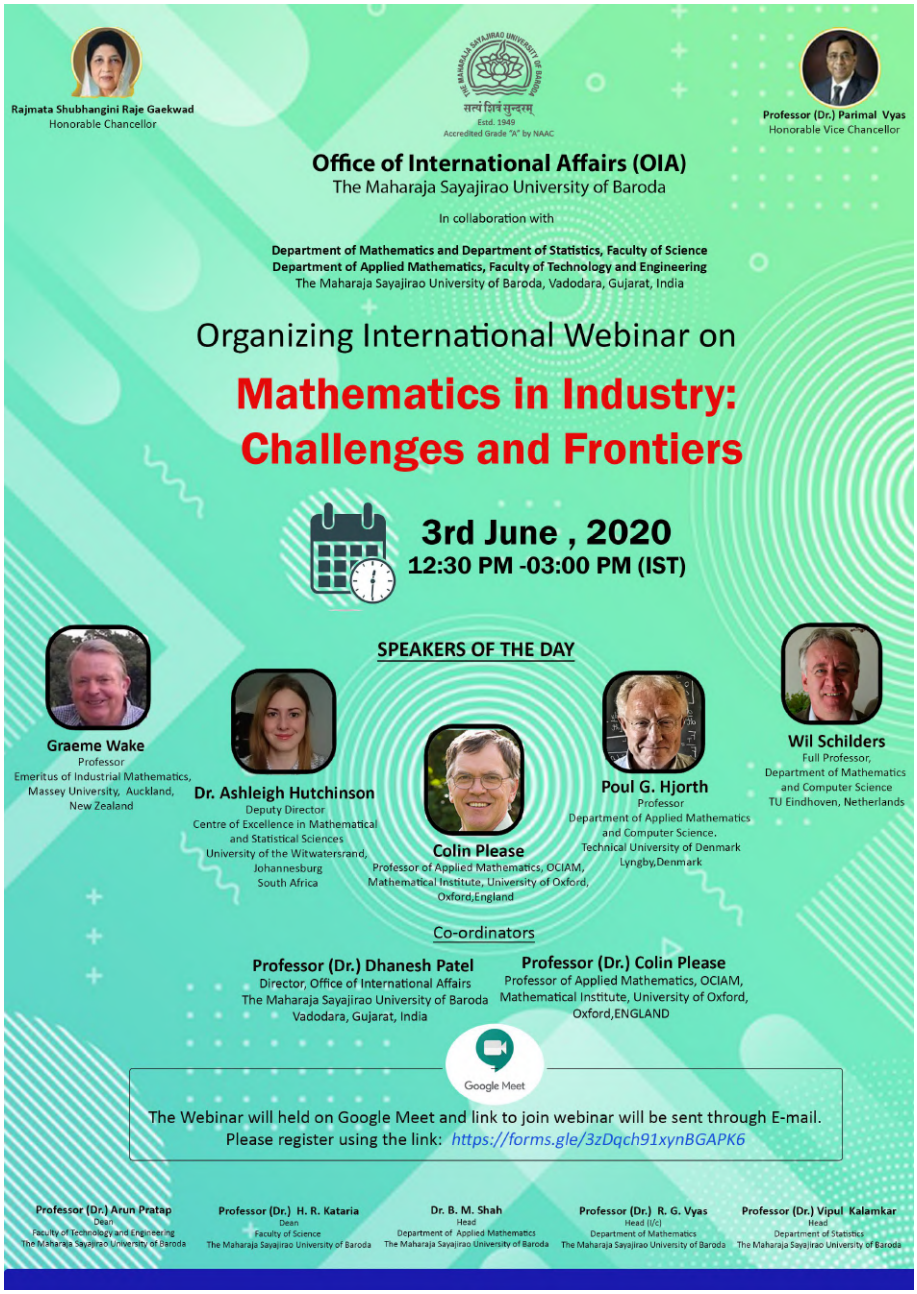
I am grateful to the Chan family, to Stephen Taylor, and to Annie Gorgey, for helping me with some of the details in this tribute to Robert Chan. *John Butcher*

REPORTS ON EVENTS

Mathematics in Industry: Challenges and Frontiers

New Zealand played a lead role in this International webinar on 3rd June to address this fast-developing opportunity world-wide. It was hosted jointly by the University of Baroda, India and the Oxford Centre for Industrial and Applied Mathematics. Graeme Wake of Massey University Auckland was the opening speaker from the Asia-Pacific region (GMT +7 to GMT +12) of the panel of five international presenters. The live participant audience around the world numbered about 2,500. The webinar notice is shown. The unedited live proceedings of around 3 hours can be viewed on the You/Tube channel:

https://www.youtube.com/channel/UCQwf3DPPcNLPb_76ToxTklA

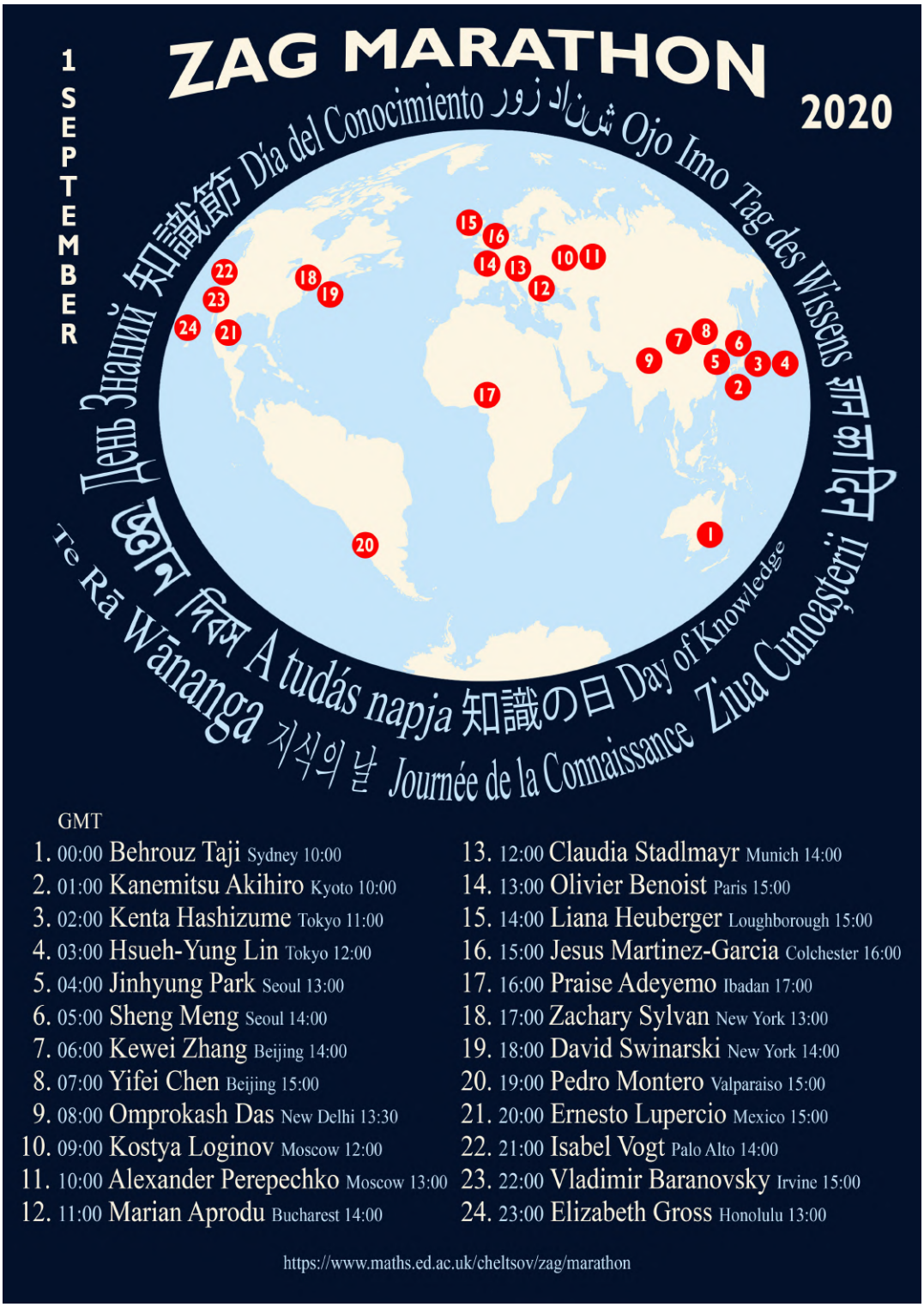


Graeme Wake

GENERAL NOTICES

Zoom Algebraic Geometry Marathon

Tuesday 1 September, 2020 https://www.maths.ed.ac.uk/cheltsov/zag/marathon/index.html



Sione Ma'u

Prime Minister's Science Teachers Prize

Graeme Wake concluded in June, his four year term on the selection panel of the annual Prime Minister's Science Teachers Prize. Competition for this prize is understandably very strong. This valuable prize is worth $150,000 in total for both the winner and his/her School. For the first time in the history of this award it was awarded by Prime Minister Jacinda Ardern on 30th June this year to a Mathematics Teacher: Dr Michelle Dalrymple, Head of Mathematics at Cashmore High School, Christchurch. This served to highlight the welcome inclusion of Mathematics in the group of STEM subjects. A full article on Michelle appears at https://www.pmscienceprizes.org.nz/2019-science-teacher-prize-media-release/.

Graeme Wake

NZMS NOTICES

2020 New Zealand Mathematical Society Colloquium
1-2 December 2020

The 2020 New Zealand Mathematical Society Colloquium will be hosted by the Department of Mathematical Sciences at the Auckland University of Technology over the period of 1-2 December 2020, in a virtual format.

Since COVID-19 has changed our academic delivery dramatically, we have decided that this year's NZMS lecture will run in a theme-based format on the following two themes:
• *COVID modelling*, and
• *Online teaching and learning in the mathematical sciences*
Each theme will have 3 or 4 speakers (each speaker will present a talk for 10-15 minutes), followed by panel discussions.

In addition to the NZMS lectures, this year's colloquium will also include the Butcher–Kalman lecture, organized special sessions and the society's other activities.

Tentative Schedule

Tuesday morning (1 December):

COVID modelling, chaired by Shaun Hendy

Tuesday afternoon (1 December):

Butcher-Kalman Lecture
NZMS Prize-giving
AGM

Tuesday evening (1 December):

Documentary: "*Secrets of the Surface: The Mathematical Vision of Maryam Mirzakhani*"

Wednesday morning (2 December):

Online teaching and learning in the mathematical sciences, chaired by Julia Novak

Wednesday afternoon (2 December):

Special sessions (parallel)

Please note that there will be no general call for contributed talks, but we still have space for more special sessions on Wednesday afternoon (2 December) in parallel format. If you would like to organise one, please contact the following people:

Jiling Cao: jiling.cao@aut.ac.nz

Michael Lockyer: michael.lockyer@aut.ac.nz

Jiling Cao, AUT

Notice of Annual General Meeting

The Society's AGM will be held online, on the afternoon of Tuesday, December 1st 2020 as part of the virtual New Zealand Mathematics Colloquium, hosted by AUT. Please send any potential agenda items to the NZMS Secretary by November 17, 2020 (rua.murray@canterbury.ac.nz).

Reminder about NZMS Awards deadlines

The NZMS Awards all have deadlines of August 31. Full details of criteria and eligibility are on the NZMS webpages: https://nzmathsoc.org.nz/?awards

The awards are:

- NZMS Research Award
- Early Career Research Award (up to 10 years post-PhD)
- Gillian Thornley Award for outstanding contribution to the cause or profession of mathematics
- Kalman Prize for Best Paper (must be published 2015-2019 inclusive)

Please note: the Gillian Thornley Award is new this year, and has very broad criteria. Eligibility is not restricted to research mathematicians, and members are encouraged to think broadly in encouraging nominations.

Call for nominations for NZMS Council positions

Owing to the completion of elected terms, nominations are called for three positions on the New Zealand Mathematical Society Council. At least one vacant position must be filled by a member from the South Island. The term of office of a Council member is three years. Council members may hold office for two (but no more than two) consecutive terms. Please consider the current makeup of the Council and give particular thought to the nomination of candidates who will help maintain a diverse Council that represents the NZ mathematics community (e.g. mix of career stages, areas of mathematics, geographic locations, genders, types of institutes). Existing Council members, and their terms, can be found on the website: http://nzmathsoc.org.nz/?membership

Additionally, nominations are called for the position of Incoming Vice-President. The term of this position is one year, with the Incoming Vice-President then becoming President for a term of two years, followed by a one year term as Immediate Past President. Ordinary members (including existing Councillors) may be nominated for the position of Incoming Vice-President. If an existing Councillor is elected their vacant Council position will be filled by nominations for the vacant Council positions.

Nominations should be put forward by two proposers. The nominee and the two proposers should be current Ordinary members (including Student members) or Honorary members of the New Zealand Mathematical Society. There is no nomination form. Nominations, including the nominee's consent, should be sent by email to the NZMS Secretary, no later than November 3, 2020. The two proposers and the nominee should each send separate messages to the NZMS Secretary.

Applications for Financial Assistance (final deadline for 2020: November 15)

The NZ Mathematical Society has quarterly deadlines for financial assistance applications. Applications must be made well in advance (at least one month before the funded activity, but the earlier the better) and retrospective applications will not be considered. The deadlines for applications for 2020 are: February 15, May 15, August 15, and November 15. You will hear back from the Council within a month of the deadline. The types of grants are as follows.

NZMS Student Travel Grants (for travel commencing at least one month after the application deadline)

The NZMS invites applications from students for financial support for the presentation of research at conferences, attending workshops, and developing new collaborations. Typical grants for travel within NZ and Australia are in the range $200–$600. For travel further overseas, larger grants may be considered. To be eligible, a student must be based at an institution in New Zealand and be active within the New Zealand mathematical community. NZMS Student Travel Grants can contribute to costs including: flights, conference registration, accommodation, and travel-related costs associated with family responsibilities.

NZMS Student Travel Grants are generously supported by an annual grant from the Margaret and John Kalman Charitable Trust.

NZMS Financial Assistance

The NZMS invites applications for financial assistance with the costs of mathematical research-related activity. Any research-related activity will be considered. For example: hosting mathematical visitors; organising conferences, workshops, or outreach activities; and conference attendance, including costs associated with family responsibilities. Further information and application details can be found on the NZMS website: http://nzmathsoc.org.nz/?assistance

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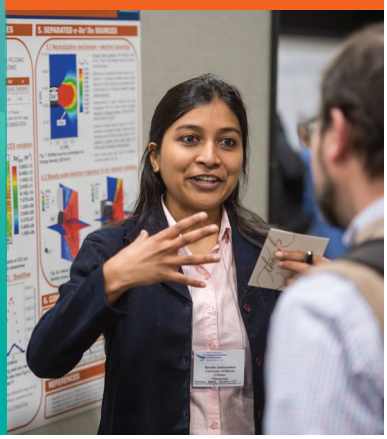
— Lisa Fauci, SIAM President and Professor of Mathematics, Tulane University, U.S.



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