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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 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 nzmsnews@maths.otago.ac.nz. LaTeX templates are available upon request from the editors.

The official address of the Society is:

The New Zealand Mathematical Society,
c/- The Royal Society of New Zealand,
P.O. Box 598, Wellington, New Zealand.

However, correspondence should normally be sent to the Secretary:

Rua Murray
School of Mathematics and Statistics
University of Canterbury
Private Bag 4800
Christchurch 8140
New Zealand
rua.murray@canterbury.ac.nz

NZMS Council and officers

Other positions of responsibility

Correspondents

Web Sites

NZMS homepage: nzmathsoc.org.nz (Webmaster: bbaeumer@maths.otago.ac.nz)

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

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EDITORIAL

At publishing of this newsletter we are just one month from the shocking events at Christchurch on the 15th March 2019. We would like to take this opportunity to express our sympathy for the victims and their friends and family. We express our deepest support to the NZ Muslim community, as well as our colleagues at the University of Canterbury, who have undoubtedly been more affected than most of us. As a society, we stand united against any form of discrimination and we embrace our diversity to the service of mathematical knowledge, education and science.

This is our first newsletter as editors and we would like to begin by offering our thanks to the previous editors, Phil Wilson and Miguel Moyers Gonzalez for their service and for their help and advice as we worked on this issue. We would also like to extend our thanks to our regular contributors and to the local news contributors who have generously donated their time to create the content in this newsletter.

As editors we are open to new ideas and contributors. Is there something you would like to see more of? less of? The newsletter belongs to the society and we encourage society members to be involved in its development. In this issue we have adopted a slight change for the local news, separating out the titles and abstracts for new PhDs and giving them their own section.

The year started off with a number of math-related events in New Zealand, including the annual meeting of our partner organisation ANZIAM, which was held in Nelson on 4–7 February. Despite the infamous Nelson fire which started on day 2 of the conference, the event ran smoothly and showcased the range of applied mathematics conducted in NZ to the wider Australasian community. More details and personal experiences on this meeting are reported in the Events section.

Fabien Montiel and Melissa Tacy

PRESIDENT'S COLUMN

A concern for many in our community is the relatively low participation rates of Māori and Pacific people in mathematics, particularly at post-secondary school level, and the loss of talent and opportunity that this implies. The Council of the NZMS is committed to working to change this situation and would be interested in hearing any ideas you might have for changing this situation. Please tell us about initiatives that you have tried and found successful, or ideas you have that you wish you could try, or initiatives that you have tried but that were not particularly effective. We would also love to hear from you if you wish to be involved in any NZMS work in this area in the future. All contributions are welcome, just email me and I will pass them on the Council.

As you may know, there is to be a Joint Meeting of the American, Australian and NZ Mathematical Societies in 2023. This meeting will be held in Auckland, December 4th-8th, 2023 and will replace the usual Colloquium in that year. I am grateful to Bernd Krauskopf, who has agreed to be the NZ co-chair of the Programme Committee for the meeting. While the meeting is still a long way off, you are welcome to start thinking about how you might be involved in the meeting. In particular, there will be themed special sessions at the meeting and it is not too early to suggest to your international colleagues that they consider joining you in NZ in December 2023 to participate in a special session at the Joint Meeting. More details will be distributed when they become available and, in the meantime, feel free to contact Bernd with comments or questions about the meeting.

What are you doing on May 12th this year? The International Mathematical Union is organising a Celebration of Women in Mathematics on May 12th; the date has been chosen since it is the birthday of Maryam Mirzakhani. Details are light so far on what might be organised by the IMU, but that need not stop you organising something in your own area. If you have some good ideas for activities, I'd be happy to hear about them and to share your ideas with others across NZ. Lastly, I draw your attention to the NZMS Notices at the back of this Newsletter. There you will find calls for nominations for Fellowship of the NZMS, nominations/applications for the NZMS Research Award, applications for the NZMS Early Career Research Award and nominations for the Kalman Prize. Please consider whether any of your colleagues could be encouraged to apply or be nominated for any of these. There is also a call for applications for financial assistance, including student travel grants.

Vivien Kirk

v.kirk@auckland.ac.nz

EDUCATION

Improving the Way WE Teach Maths

First Year in Maths (FYiMaths, see https://fyimaths.org.au/) is a special interest area of the NZMS Education Group and a network of mathematicians teaching in universities in Australia and New Zealand. The goal of the group is to improve outcomes for students in undergraduate mathematics courses. At the NZMS 2018 Colloquium, FYiMaths contributed several parallel sessions. In this article I will recall two of these and challenge you to think about your teaching in 2019.

Julia Novak of the University of Auckland (UoA) and I presented *Renegotiating the Didactic Contract: Understanding and managing student expectations about your teaching and their learning.* The didactic contract is a set of rules, some explicit but most of them implicit, that frame the mathematical practices of both teachers and students. We used research by Birgit Pepin and the results she found in the UK to explore the established norms between students and teachers in mathematics classrooms in NZ.

The most difficult aspect for students in the transition from high school to university are the changes in teaching styles and styles of learning. Pepin's research shows that the support students need most is learning to learn mathematics. Students need academics to clearly and explicitly explain what we mean by practice and mathematical knowledge. What are practical solutions for university lecturers to enable deeper learning without increasing student anxiety and teacher stress? Some of the ideas we discussed:

- Make the hidden curriculum visible. Explain why you do what you do.
- Establish a relationship of trust with your students.
- Give students open-ended problems with low stakes to empower the student.

To make changes to improve student learning, we need to be willing to experiment with our teaching. The article *Professional Learning That Inspires Change* by Katie Martin discusses cultivating a culture of learning focused on teaching (https://tinyurl.com/y22s3vtz). It tackles some of the reasons why teaching practices are not changing. In short, educators need to come together and share what they are trying, even when unsuccessful. If you have a great idea but are afraid to try it because you do not know if it is going to work or you are afraid of what others will say, the status quo will prevail. When innovative practices are celebrated and shared, great learning can spread. If we only tell the stories of the good or gloss over the challenges, we miss the power of the learning process instead of sharing the hurdles that are part of learning. The culture of learning and risk-taking can make great ideas and practices spread.

One example of a great idea was shared at the colloquium: *When on-line pre-lecture quizzes are integrated into a (university maths) course: Exploring the impact of a small-scale change in an instructional model in one large-scale mathematics course* by Tanya Evans and Julia Novak, both of UoA. They addressed the issue of combining face-to-face instruction with online activities to support learning. Pre-lecture quizzes, comprising two multiple-choice questions focusing on the main learning outcomes, were introduced. The implementation of this new resource not only provided instant feedback to students but also enabled teachers to access data prior to every lecture informing them about overall student learning of the material from the previous lecture and afforded opportunity to adjust their lecturing.

What they noted in their own reflections was the simplicity and enjoyment of the quizzes for the students. The effect was also motivational and particularly encouraging for those less able students as they anticipated and experienced satisfying outcomes to the learning task. The majority of students embraced this mode of learning. Having instant feedback and a small reward of 0.25% was galvanising. The surprising effect was the increased attendance at lectures and overall improvement in students engagement with the learning practices. For students, the presence of quizzes as motivational stimulus leads to heighten sense of accountability for their actions in making choices to attend or skip a lecture, and their intent to learn during the lecture. The paper on this research, co-authored with Barbara Kensington-Miller, will be presented at the Psychology of Mathematics Education Conference in South Africa in 2019 (PME 43).

My challenge to you: be brave and trial a teaching innovation in one of your classes. Try new teaching techniques then debrief with a friend and decide on next steps. We would love to hear about your journey, including the muddles and things that go drastically wrong. We will give you a platform to share at the NZMS Colloquium this year at Massey University in Palmerston North.

Cami Sawyer

MATHEMATICAL MINIATURE

MM47: Muses and packages

E. T. W. Hoffmann, the romantic poet, wrote under the name E. T. A. Hoffmann in homage to Wolfgang Amadeus Mozart. He is regarded as one of the founders of fantasy fiction as well as of musical criticism. Some of his stories became the subject of "Les Contes d'Hoffmann", the opera by Jacques Offenbach. After his attempts to find true love had failed, the Muse of poetry claims Hoffmann as her own:
Je t'aime, Hoffmann! Sois à moi!

Is there a muse of Mathematics, and whom does she choose? There are many contenders for the distinction of being the worst poem in the English language and some people think there is also such a thing as bad mathematics. To Paul Halmos it was very simple: "Applied Mathematics is Bad Mathematics." Halmos left a fine mathematical legacy but I don't feel that this assertion is part of that legacy.

Every so often we stumble across LaTeX packages that really help us in typesetting things nicely.

4. If \usepackage{etaremune} is in the preamble, then the environment etaremune, meaning enumerate with the items numbered in reverse order, becomes available.
3. If \usepackage{enumitem} is in the preamble then new options become available in itemize, enumerate and etaremune lists.
2. For example the present list begins with
   \begin{etaremune}[itemindent=-14pt,itemsep=-1pt]
1. The typesetting has to be done at least twice to get the correct reverse numbering

The tabular and array environments allow for vertical and horizontal lines to be inserted. If the package makecell is in the preamble, then the following lines of LaTeX can be used

```
\begin{equation*}
\begin{array}{!{\vrule width1.2pt} r
        !{\vrule width0.3pt} r !{\vrule width1.2pt}}
\Xhline{1.2pt}
\int \cos(x) dx & \sin(x)\\
\Xhline{0.3pt}
\int \sin(x) dx & -\cos(x)\\
\Xhline{1.2pt}
\end{array}
\end{equation*}
```

These give an effect like this:

$\int \cos(x)dx$	$\sin(x)$
$\int \sin(x)dx$	$-\cos(x)$

I have found the package tikz to be very useful for inserting pictures into documents. I will give some examples to show how this works next time.

Are the few packages I have referred to already well-known? I would like to know if this is the case and I would be interested to learn about other useful packages.

I conclude with a puzzle inspired by a discussion with a colleague whom, for reasons of privacy, I will refer to as GW.

Find all values with no common factors, of the trio (a,b,c), such that

$$\begin{bmatrix} a & b & c \end{bmatrix} \begin{bmatrix} 1 & -1 & -1 \\ -1 & 1 & -1 \\ -1 & -1 & 1 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \end{bmatrix}$$

is a perfect square.

I will give my own answer next time, if nobody sends a more interesting one, together with the motivation for the question.

J.C. Butcher

butcher@math.auckland.ac.nz

CYBERMATH

A very short column this time, with only two topics, but each of them fairly important and timely.

After my criticism of the state of the New Zealand Journal of Mathematics in the last column, I have been invited to put my money where my mouth is and do something about it, as a member of the editorial board and the oversight board (the journal is owned jointly by NZMS and the University of Auckland Mathematics Department - I will represent the former). Expect substantial changes in the website (among other things) by the end of 2019. The domain name (not yet live) will change to nzjmath.org.

Not long before the deadline for this column, news came that the University of California had ended negotiations with Elsevier and cancelled all journal subscriptions. UC had been trying for months to achieve a "publish and read" deal by which papers written by their researchers would be made open access. I (and many others) feel that such deals (which have been struck with several publishers by national consortia in the last few years) are far too generous to the large commercial publishers, but apparently Elsevier wanted even more. According to UC, the final straw was that Elsevier communicated directly with UC researchers, omitting key points about the negotiation, in an attempt to influence the negotiations. See https://osc.universityofcalifornia.edu/open-access-at-uc/publisher-negotiations/uc-and-elsevier/ for more information.

It is very clear that large and profit-hungry corporations of this type are simply incompatible with scholarly publishing. My prediction is that after a short transition period no one will miss, or even notice, that they are not subscribed. UC has several contingency plans in place involving fancy inter-library loans. I hope that the money saved (in the tens of millions of dollars per year) will be put to good use, for example by supporting community-controlled infrastructure such as arXiv.org and free journals of the NZ J. Math. type.

I am not holding my breath, but I really hope that the NZ university libraries (who pay tens of millions annually for subscriptions) can follow UC's lead. Such cancellations are becoming increasingly common - see SPARC's list https://sparcopen.org/our-work/big-deal-cancellation-tracking/.

Mark C. Wilson

MATHEMATICAL MISEPONYMY

Bayes's Theorem

It seems much less clear whether there is any miseponymy here than in my previous examples. The evidence for miseponymy seems to be more circumstantial than concrete: the latter may still exist, may have existed and been destroyed or may never have existed.

Recall Bayes's Theorem:

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)},$$

where A and B are two events with respective probabilities $P(A)$ and $P(B)$ while $P(A|B)$ and $P(B|A)$ are conditional probabilities of A given that B is true and vice versa. Bayes's Theorem has many applications, of course, including in a resolution of the Monty Hall problem (which itself is surely a miseponymy!).

There doesn't seem to be much doubt that Thomas Bayes, who lived from about 1701 to 1761, effectively knew of the result that bears his name. A version of it was discussed in papers of his published posthumously after editing by his friend Richard Price [1].

The case for miseponymy is well put by Stephen Stigler, whom I referred to in the introduction to my first *Mathematical Miseponymy* column, in [5]. He presents considerable circumstantial evidence that suggests Nicholas Saunderson, 1682–1739, discovered the theorem some time before Bayes. Saunderson himself was an interesting man: blind from the age of 1 thanks to smallpox, he was appointed as the fourth Lucasian Professor at Cambridge (Newton was the second) a couple of months before his 30$^{\text{th}}$ birthday.

Stigler in [5] presents his case in a way that a detective might approach it, even referring to fictional detectives when he says "[t]his is a whodunit worthy of Hercule Poirot or Nero Wolfe." He draws attention to two books, by Hartley [3] and de Moivre [4]. The former seems to have a statement of Bayes's Theorem conveyed to the author by "an ingenious friend" while the latter conveniently contains a list of subscribers to [4] that might include this ingenious friend. The subscribers to [4] range from names familiar in Mathematics to this day, to dukes and earls and, in particular, Nicolas Sanderson (sic), who had taught Hartley: the list is conveniently reproduced as [5, Figure 2]. Right before Saunderson's name appeared that of one Lady Diana Spencer. For more fun Stigler also discusses a range of other topics attributed to Hartley's ingenious friends, including a 'cure' for kidney stones, an early version of shorthand and a hint of adultery. Stigler rounds out his investigation with a table that uses Bayes's Theorem to estimate the odds that Saunderson discovered Bayes's Theorem versus Bayes discovering it and favours Saunderson 3:1.

Stigler's argument, of course, is not universally accepted, for example [2] attacks Stigler's starting point of the passage from Hartley's book.

References

[1] *An Essay towards solving a Problem in the Doctrine of Chances. By the late Rev, Mr. Bayes, F. R. S. communicated by Mr. Price, in a Letter to John Canton, A. M. F. R. S.*, (Read Dec. 23, 1763), https://royalsocietypublishing.org/doi/pdf/10.1098/rstl.1763.0053

[2] A. W. F. Edwards, *Is the Reference in Hartley (1749) to Bayesian Inference?*, The American Statistician, **40** (1986), 109–110.

[3] David Hartley, *Observations on man, his frame, his duty and his expectations*, Richardson, London, 1749.

[4] Abraham de Moivre, *Miscellanea analytica*, Tonson and Watts, London, 1730.

[5] Stephen M. Stigler, *Who Discovered Bayes's Theorem?*, The American Statistician, **37** (1983), 290–296.

David Gauld

PROFILE

Alona Ben-Tal

Currently an Associate Professor of Mathematics and also Deputy Head of School in the School of Natural and Computational Sciences at Massey University's Albany campus, Alona has a varied scholastic and academic history.

She began with a BSc (cum laude) and an MSc, both in Mechanical Engineering, at the world-renowned Technion Israel Institute of Technology. After 3 years experience as a Research Engineer in the Israel Electric Corporation, Alona moved to NZ (with husband Gadi and then 2-year-old daughter Yael) and pursued a PhD in Mathematics at the University of Auckland from where she graduated in 2001. Following a fixed-term lectureship in the Mathematics Department, she joined the UoA's Bioengineering Institute as a NZ Science & Technology Post-doctoral Fellow. Alona moved to Massey University at Albany in 2005, first as a Lecturer, but was soon promoted to Senior Lecturer, and this year to Associate Professor.

Alona is an established international researcher. Her research is truly interdisciplinary and involves the development and analyses of mathematical models for the study of the cardiorespiratory system.

For example, using several models that vary in complexity and optimal control theory, Alona (in collaboration with Sophie Shamailov and Julian Paton) showed that the acceleration of heart rate during inspiration does not optimize gas exchange as previously thought but instead helps the heart conserve energy while maintaining physiological levels of carbon dioxide in the blood. This work has led to further research into a novel pacemaker that reinstates heart rate variability in people with heart disease (currently being tested on sheep).

Alona has also studied the lungs of birds, which are remarkably different from mammalian lungs. With Emily Harvey she developed and analysed a new discontinuous dynamical model that helps understand how unidirectional flow in birds lungs is generated. Another example demonstrating Alona's wide range of research activities is the numerical technique she developed, based on an Equation Free approach (in collaboration with Yannis Kevrekidis, the founder of this approach) which leads to a better understanding of how neural networks can be simplified.

Apart from Masters, Post-graduate and Post-doctoral Scholarships, Alona's work has attracted significant funding of nearly NZD1 million, through a Marsden Fast Start grant, and for collaborative research from a Marsden Grant (an AI for NZD403k over 3 years), the NIH (a PI for USD210k over 5 years), the HRC (an AI for NZD120k over 3 years) and the Catalyst Seeding Fund (PI for NZD80k over 2 years). These grants show the value that funders place on the work she does.

Alona has more than 20 refereed articles in journals and conference proceedings, mostly with her as principal author. But most are also collaborative works involving NZ and international co-authors, showing recognition that the mathematics she does has an important part to play in cutting-edge physiology studies. She has an extraordinary record of more than 90 presentations of her work at (mostly international) conferences — in the area she works in, Alona's results are disseminated quickly. Alona has given Invited Talks at international conferences in several countries, and most recently (late last year) was a plenary speaker at the NZMS Colloquium in Dunedin.

But this is not all. As a well-rounded academic and researcher, Alona has been a member of degree review panels, but has also taken part in professional organisations. She has been Chair of the NZ Branch of ANZIAM for 3 years, and has also served the branch as Secretary and Treasurer. Alona has been involved with organising several conferences, and has been a member of several judging panels for student talks and posters. She coordinated efforts to establish the ANZIAM-sponsored poster presentations at the annual NZMS Colloquium. Alona has served as a Moderator for MINZ, is an Associate Editor for the ANZIAM Journal, has been a member of a Marsden Fund panel. She is a member of SIAM, ANZIAM, AMS and NZMS; she has been a Fellow of the NZMS since 2016.

As a teacher, Alona has an IIMS Distinguished Teaching Award, and has been nominated for Massey University's Lecturer of the Year many times. She has the 2015 Alexander Aitken Award from the Albany Students' Association for teaching first-year maths (as we all know, this is a real test for a Maths lecturer). Alona has taught across all university levels in Mathematics, and has supervised several postdocs, research assistants and summer students, as well as Project, Masters and PhD students. She is also an experienced examiner of theses.

As might be expected of a someone with a mechanical engineering background, she is a staunch supporter of dual-fuel (electric-petrol) vehicles, one of which she uses to commute from her Mangere Bridge residence to Massey each day.

Among her colleagues, Alona is known to be determined, forthright and gutsy, but also kind and generous. Her views are reasoned, balanced and sane; in the context of the usually rather conservative atmosphere of mathematics academia she is a breath of fresh air! Her multi-disciplinary background has provided her with a view that applications are as important as the theory, and that the former are the way to promote the practicality of mathematics.

Robert McKibbin

LOCAL NEWS

AUCKLAND UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING, COMPUTER AND MATHEMATICAL SCIENCES

Staff news

Dr Michael Lockyer is a newly appointed Lecturer in Mathematics in the Department of Mathematical Sciences at Auckland University of Technology, beginning in January 2019. Michael completed a PhD in Mathematics in 2015 at the University of Auckland, and was a fixed-term lecturer in the Mathematics Department at the University of Auckland during 2017 and 2018. Michael's research interests include topological dynamics, and he is looking forward to developing this background into a more applied area of research. Prior to studying Mathematics, Michael worked as an engineer for several years both in New Zealand and overseas. Michael will initially be involved with developing and teaching Engineering Mathematics papers at AUT.

Dr Victor Miranda-Soberanis is a computational statistician who pursued a PhD at the Department of Statistics, the University of Auckland (2014-2019), after obtaining a Master of Science degree on Mathematics from the National Autonomous University of Mexico (2008) and a BSc in Mathematics from the University of Yucatan, Mexico. At present, his research concentrates on two lines: a) generalized regression using vector generalized linear and additive models (VGLMs/VGAMs), and b) modelling and estimation of time series, and forecasting methods using VGLMs. Dr Miranda-Soberanis is a newly appointed lecturer in the Department of Mathematical Sciences at Auckland University of Technology. Previously he worked for the University of Quintana Roo (2011 - 2014), & the Ibero-American University (2007-2008) in Mexico, as a lecturer in the Departments of Engineering and Mathematics respectively. Between 2014-2018, he worked for the University of Auckland as GTA and as the leader of the course "Business Analytics" in the Masters of Analytics programme (UoA Business School).

Prof Jeffery Hunter and *Dr Alla Shymanska* retired from Department of Mathematical Sciences at Auckland University of Technology. A farewell function was held on 6th December 2018.

Dr Kate Lee resigned from Department of Mathematical Sciences at Auckland University of Technology to take a lecturer position in the University of Auckland.

Figure 1: Dr Michael Lockyer (left) & Dr Victor Miranda-Soberanis (right)

Last year the AUT's Vice-Chancellors Award for Teaching Excellence was won by the Mathematical Sciences "Certificate of Science and Technology" teaching team. The team delivers a high quality programme for students that do not meet the entry requirements for AUT's Mathematics, Engineering, Computer Science and Design Technology degrees. Most of the teaching team are full time teaching pathway lecturers that dedicate their time to paper development and educational scholarship. Some of the noteworthy teaching practices of the team are: utilising teaching teams for developing and delivering papers; using 'teaching squares' to provide feedback on one another's teaching; using lecturers who teach degree level papers as assessment moderators; and including reflective activities in the weekly schedule to encourage students to be reflective learners. The team is lead by Kerri Spooner. Kerri Spooner, Shaun Wason, Jeff Nijsse, Heather Ricketts, Jordan Alexander, Renu Choudhary, Catherine Sweatman, Craig Sole, Fred Furlan, Komala Sagadevan, Asif Rasha, Phil Robbins, Zanhuba Iqbal and Petelo Raass make up the team.

Event

On 22-23 November, the Mathematical Science Research Group (MSRG) organized the 2018 AUT Mathematical Sciences Symposium. This is a joint effort of Professors Jiling Cao and Jeffrey Hunter, with the assistance of Drs Kate Lee, Sarah Marshall, Nuttanan Wichitaksorn and Wenjun Zhang. The Symposium focused mainly on some areas in Applied Mathematics and Analytics/Statistics. The main purpose of this event is to develop and promote opportunities for AUT academic staff working on these areas to collaborate with colleagues from other universities. It was an remarkable success with many favorable comments from the external participants.

In February, Auckland University of Technology

(AUT) and the New Zealand Square Kilometre Array (SKA) Alliance hosted the NZ SKA Forum, composed of the Science for SKA (S4SKA) Colloquium (12 & 13 Feb) and the Computing for SKA (C4SKA) Colloquium (14 & 15 Feb). The Forum attracted participants from New Zealand, Australia, and the United Kingdom with its focus on the science and computing challenges and opportunities presented by the SKA, one of the 21st century's biggest and most ambitious science projects. The programme for the S4SKA meeting included 12 presentations that spanned the SKA project, its precursors, and its science drivers; it concluded with a trip to the Warkworth Radio Astronomical Observatory and Ascension Wine Estate. The C4SKA meeting opened with a mihi whakatau and included 24 presentations by SKA project members from academia, industry, research organisations, and the SKA Office. We are grateful to all of the participants for presenting updates on a broad cross-section of the ongoing efforts to develop SKA science and technology, and we look forward to hosting the meeting again in 2020.

Figure 2: Participants of the Computing for SKA Colloquium on AUT's city campus in February

Travel and Conference Participation

Drs Alna van der Merwe, Catherine Sweatman and Wenjun Zhang presented at the NZMS Colloquium, 4-6 December 2018, University of Otago , Dunedin.

Prof Jiling Cao participated in the 2018 QMF conference at UTS, Sydney, where he presented his recent work (joingly with Prof Jeong-Hoon Kim and Dr Wenjun Zhang) on pricing variance swaps.

In February 2019, Dr Nuttanan Wichitaksorn had a research visit to Faculty of Engineering and Graduate School of Commerce at Burapha University in Thailand.

Visitor

In February 2019, Professor Ji-Cheng Hou (Department of Mathematics, Beijing Information Science and Technology University) visited Prof Jiling Cao to do joint research in Mathematical Economics.

Wenjun Zhang

UNIVERSITY OF AUCKLAND

DEPARTMENT OF MATHEMATICS

The new year has brought a new head of department (Steven Galbraith), and a new suite of first year courses (MATHS 120, MATHS 130 and COMPSCI 120) as a result of the Faculty of Science degree restructure. Since we are currently understaffed it means we are all pretty busy right now.

We hosted Martin Bridson (Oxford) as a visiting Hood Fellow. He gave two lectures in our department: "Recognising finite quotients of finitely presented groups" (Groups and Geometry workshop, UoA, Wednesday 16 January) and "Chasing finite shadows of infinite groups" (Mathematics Department Colloquium Lecture, Thursday 17 January). Martin also spoke at Gaven Martin's birthday conference at Massey.

We have also been hosting Victor Flynn (Oxford) who writes: I was delighted to spend my sabbatical leave (for 6 months, from September 2018 to February 2019) at the University of Auckland, kindly hosted by Steven Galbraith. My research during this period mainly emphasised the investigation of possible Tate-Shafarevich groups that can occur for abelian varieties. I also collaborated with one of Steven's PhD students, Yan Bo Ti; this resulted in a joint article on Genus Two Isogeny Cryptography. I gave an Algebra seminar to the Department and very much enjoyed attending the Algebra seminars given by others. A highlight was the November workshop in Number Theory, organised by Steven, which brought together many of the Number Theorists in New Zealand for several days.

A new initiative of the Kalman Trust is to fund five Margaret and John Kalman Trust Teacher Fellows. The scheme was created to develop and promote mathematics and mathematics teaching in the Auckland secondary school community and follows on from the success of the Kalman Teacher Prizes in 2017 and 2018. Five Kalman teacher fellows will be supported every year from 2019 to 2021. The fellowships are worth $\$5,000$ each and cover the costs of releasing fellows from their teaching commitments, as well as a $\$1,000$ honorarium in recognition of their participation in this scheme. The 2019 fellows are: Sam Carroll (Waiheke High School), Jared Hockly (Western Springs College), Shan-I Lee (Auckland Girls Grammar School), Krista

Rabullal (ACG Strathallan), Linda van Zyl (ACG Parnell).

Kim Locke is the 2019 Teaching Fellow. She is a teacher from Rangitoto College, where she teaches the Scholarship Calculus course and is currently the Dean of International Students. She has a BSc majoring in Mathematics and Statistics from Rhodes University, South Africa, and has also lived in the UK.

Our PhD student Elle Musoke was awarded the TM Cherry prize for best student paper presented at the ANZIAM 2019 conference in Nelson. This is the first time a student from the University of Auckland has won the TM Cherry prize (which was established in 1969).

Paddy Bartlett and Nicolette Rattenbury were awarded SEED grant funding of $\$5,000$ for their proposal "Peer-Marked Presentations in Large-Scale Classes". They will be using these funds to implement a new type of assessment in Maths 108 in the coming year.

Marston Conder hosted a number of visitors, including Dr Isabel Hubard (UNAM, Mexico, December), Prof. Martin Bridson FRS (U Oxford, England, Visiting Hood Fellow, January) , Dr Klara Stokes (Maynooth U, Ireland, January), Prof. Alan Reid (U Texas, USA, January), Prof. Jozef Siran (Slovak U Technology, Slovakia, February), Prof. Bill Jackson (U London, England, February).

Tanya Evans hosted Matthew Inglis (Loughborough University) for one month. Matthew gave a seminar on "Five decades of mathematics education research" and a colloquium talk "Understanding and improving students' mathematical reading".

Sina Greenwood is on research and study leave in semester 1.

Distinguished Professor Vaughan Jones gave a lecture Series on "The freakish world of subfactors; designed for everyone to have fun" in January.

Sadly Igor Klep resigned at the end of 2018 to take up a postion in Germany.

Bernd Krauskopf is enjoying a well-deserved one year of research and study leave, after his term as Head of Department.

Igor Kontorovich participated in CERME-11 in Utrecht, the Netherlands (bi-annual Congress of the European Society for Research in Mathematics Education) and RUME-22 in Oklahoma City, OK (annual Research in Undergraduate Mathematics Education conference). He also gave a seminar at the Faculty of Education, Simon Fraser University, BC, Canada.

Eamonn O'Brien and Jeroen Schillewaert were awarded a Seelye Fellowship for Professor Keith Devlin from Stanford, who will visit the department in late March. Jeroen also organised a conference "Groups and geometries 2019" in January with speakers Martin Bridson, Annalisa Conversano, Rod Gover, Pedram Hekmati, Martino Lupini, Gaven Martin, Adam Piggott, Alan Reid, Klara Stokes, Anne Thomas, Geertrui Van de Voorde, Gabriel Verret and James Wilson.

Hinke Osinga was the Hanna Neumann Lecturer at Australian Mathematical Society annual conference in Adelaide in December.

Rachel Passmore is involved in the Tertiary Foundation Certificate restructure and is managing the Kalman trust Teacher Fellows and the Teacher Excellence Awards. She is also doing a part-time PhD on capstone courses.

Warren Moors is on research and study leave and working on completing several books.

Caroline Yoon continues her research and study leave. She had an article selected for the Princeton University press anthology "The Best Writing on Mathematics 2018" (edited by Mircea Pitici).

Steven Galbraith

UNIVERSITY OF WAIKATO

DEPARTMENT OF MATHEMATICS AND STATISTICS

Two PhD completions

Two PhD candidates recently successfully defended their PhD theses. One candidate was Paul Brown with a thesis titled "Computational Bayesian Inference Using Low Discrepany Sequences" and supervised by Stephen Joe and Chaitanya Joshi. He is now working in a continuing position as a Senior Tutor in Statistics at Waikato.

The other candidate was Chris Qin with a thesis titled "Iwasawa Theory Over Solvable Three-dimensional p-adic Lie extensions" and supervised by Daniel Delbourgo and Ian Hawthorn. Chris has a position in the School of Mathematics of Sun Yet-sen University in the Guangdong Provice of South China.

Revisions to the academic structure

Implementation of the new structure at the University is still underway. The Faculty of Computing and Mathematical Sciences has been renamed the School of Computing and Mathematical Sciences and will be one of the four Schools in the new Division of Health, Engineering, Computing, and Science. The division is headed by our former dean Geoff Holmes. The other three Schools are the School of Health, Sport, and Human Perfomance, School of Engineering, and School of Science. Stephen Joe is the Acting Head of the

Figure 3: Dr Paul Brown 2019

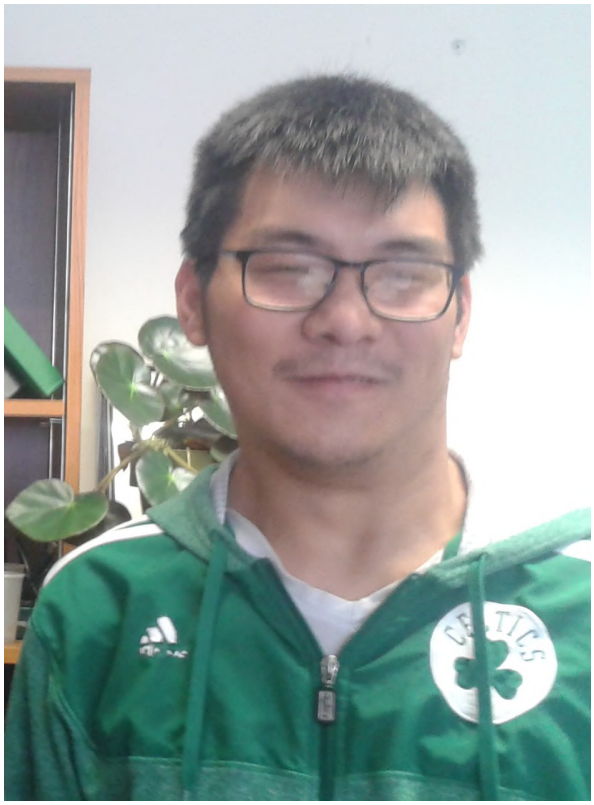


Figure 4: Dr Chris Qin (King) 2019

School of Computing and Mathematical Science until early next year.

Discussions are currently been held on revamping of the first year engineering mathematics papers.

Coming and going

Jacob Heerikhuisen, a former Waikato BCMS, MCMS, and PhD student, will be returning to the university in June as a Senior Lecturer in Applied Mathematics. He is currently at the University of Alabama in Huntsville. His wife is also a former Waikato BCMS and PhD student. Further details will be given once they arrive.

Daniel Delbourgo is on leave in Canada. The image has him taking time out to do some different creative work!

Figure 5: Daniel Delbourgo Canada March 2019

Lyn Hunt has stepped down as Convenor of Statistics and her role has been taken up by Chaitanya Joshi. Lyn was off last year for a period of time due to ill health, but has recovered and is now back at work. Nick Cavenagh was heavily involved in the organisation of the 41st Australasian Conference on Combinatorial Mathematics and Combinatorial Computing held in Rotorua in December. The conference report appears elsewhere in this Newsletter.

Kevin Broughan

MASSEY UNIVERSITY

SCHOOL OF NATURAL AND COMPUTATIONAL SCIENCES

We've had a name change. What used to be the Institute of Natural and Mathematical Sciences is now called the School of Natural and Computational Sciences. The school consists of staff at the Albany campus from biological sciences, computer science and information technology, mathematics and statistics, natural environment, and physical sciences.

Alona Ben-Tal visited Lancaster University, UK, in mid-November. She then attended and presented an invited talk at the workshop "Physics of Biological Oscillators: New Insights into Non-Equilibrium and Non-Autonomous Systems", held at Chicheley Hall, Buckinghamshire, UK.

Shaun Cooper delivered four lectures at a workshop "Analysis and Dynamics in Number Theory" at the Abdus Salam School of Mathematical Sciences at Government College University in Lahore, Pakistan, in December.

Visitor: Prof. Aneta Stefanovska (Lancaster University, UK). Public lecture: "Biological clocks — adjustable time-keeping makes for good health". Hosted by *Alona Ben-Tal.*

Shaun Cooper

VICTORIA UNIVERSITY OF WELLINGTON

SCHOOL OF MATHEMATICS AND STATISTICS

Noam Greenberg and Dan Turetsky, along with Andre Nies from the University of Auckland, were awarded the Society's Kalman Prize for an outstanding and innovative piece of research in the mathematical sciences. This was awarded for their paper with former postdoctoral fellow Laurent Bienvenu, now in Bordeaux, France, and Antonin Kučera of Masaryk University, Czech Republic, titled "Coherent randomness tests and computing the K-trivial sets". Noam accepted the prize on behalf of the authors at the dinner of the NZ Mathematics Colloquium held at the University of Otago in early December. At the same occasion, Fellowships of the NZMS were awarded to Noam, Stephen Marsland and Peter Donelan from this School.

The annual Secondary Teacher Symposium was held in December, with the theme "Keeping up with the Curriculum". It was attended by 41 secondary and tertiary mathematics teachers. Speakers were Dr Cami Sawyer (Massey), John Oldroyd and the NZQA team, Derek Smith (Mathematics Facilitator for Wellington region colleges), Dr Michael Johnston and Dr Bronwyn Wood (School of Education, VUW).

Doctoral student Meenu Jose's presentation at NZMASP was voted the best talk in pure mathematics. Meenu went on to the 41st ACCMCC held in Rotorua in December, where she won the Ann Penfold Street Prize for the best talk by a student. Meenu's supervisor, Dillon Mayhew, won the same prize back in 2001.

In March, Dr Louise McMillan joined the School as a Post-doctoral Fellow in Statistics under the supervision of Ivy Liu and Richard Arnold. Louise graduated from Cambridge University in 2006 with an MMath (1st) and then worked for 5 years as a technical consultant, carrying out data analysis and developing algorithms for a wide range of companies. She moved to New Zealand in July 2012, received a MSc in Statistics from the University of Auckland in 2013 and gained her PhD in statistical ecology in 2018.

Rod Downey completed his nationwide tour, delivering his Rutherford Lecture, "Logic, Mathematics and Modern Society", **twice** to packed houses at the end of March/early April. Rod proved again the ongoing allure of mathematics to the wider public. Rod was also interviewed by Kathryn Ryan for Radio New Zealand's Nine to Noon programme. The interview can be downloaded here.

Mark McGuiness was co-director, with Mike Plank, of the ANZIAM conference held at the Rutherford Hotel in Nelson in the first week of February. There were 225 registrations and 214 presentations, 75 of which were student talks. A Women in Mathematics lunch was well-attended by nearly 100 supporters. An LGBTQI+ morning tea led to some useful discussions on inclusivity at mathematics conferences. The Math Biology Day that followed on the Friday was slightly curtailed when the forest fires nearby led to an evacuation of the area about an hour before the planned ending.

Mark also gave a talk to the Otari Probus Club in Wilton. His talk was titled "Mathematics at Work" and included Mathematics in Industry Study Groups, sorting of alumina in silos, cyclic behaviour of biota and the contaminants they eat underground, and steaming Surtseyan bombs. Yet another general talk on applied mathematics (on fiery volcanoes and frozen southern seas) was to the Kapiti U3A in March.

On the administrative front, Caitlin Warwood has been appointed as our new postgraduate and stakeholder liaison and successor to Kelsey Firmin who will be leaving us at the end of March.

Seminars. Professor Bill Jackson (Queen Mary University of London), "Rigidity of graphs and frameworks"; Professor Graeme Wake (Massey University), "Science and the Law—Mathematical Modelling for Public Environmental Policy"; Associate Professor John Duncan (Emory University), "Moonshine and Arithmetic".

Peter Donelan

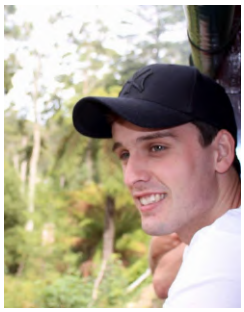
UNIVERSITY OF CANTERBURY

SCHOOL OF MATHEMATICS AND STATISTICS

Congratulations to *Alex James* who jointly received at the NZMS Colloquium in December the NZMS Research Award for 2018 for "her contributions in mathematical modelling ranging from the theoretical, such as Lévy walks and complex ecological systems, to the very applied, such as masting and snail dynamics". Congratulations also to *Clemency Montelle*, *Mike Steel* and *Rua Murray* who were made Fellows of the NZMS in December.

The School welcomed two new continuing staff, *Michael Langton* and *Matt McPherson*. Michael took up a position as a Senior Tutor in December. Michael is well known in the School. He received his PhD from the University of Canterbury in 2009 in applied approximations. Since then he has been tutoring and lecturing in and around the university in a wide variety of courses and roles, all short-term until now.

At the beginning of March Matt joined us as a School Administrator. Matt comes from Airways New Zealand where he worked as both an Intern (through Ara) and as an Administrator. Some of his interests outside of work include reading (especially murder mysteries) and walking/hiking.

Michael Langton (left) and Matt McPherson

In January *Lucia Youn* resigned to take up a position at the Ministry of Business, Innovation and Employment. Lucia had been with us as a School Administrator since March 2016.

In early March the School welcomed Erskine Fellow Glen van Brummelen from Quest University at Squamish, British Columbia. Glen is an eminent Canadian historian of mathematics, specialising in the history of trigonometry and astronomy in ancient Greece and medieval Islam. In 2016 he won the Deborah and Franklin Tepper Haimo Award, the most prestigious teaching award for mathematicians in North America, and in 2017 was one of ten winners of the 3M National Teaching Fellowship, Canada's highest teaching award. Glen is hosted by *Clemency Montelle* and is teaching into MATH380 "Mathematics in Perspective" a course on the History and Philosophy of Mathematics. He stays with us until the end of May. After 2010 and 2017 this is Glen's third visit to the School as an Erskine fellow.

Günter Steinke

UNIVERSITY OF OTAGO

DEPARTMENT OF MATHEMATICS AND STATISTICS

Three new academic staff joined the Department this year: *Timothy Candy*, *Robert Van Gorder*, and *Sarah Wakes*.

Timothy completed his BSc and MSc in Mathematics at the University of Canterbury, and his PhD at the University of Edinburgh. Afterwards he had positions at Imperial College London, John Hopkins University (Baltimore), and Bielefeld University, and finally he has returned to New Zealand. His research interests are in the areas of nonlinear PDEs and harmonic analysis.

Robert obtained his BS and PhD in Mathematics from the University of Central Florida (Orlando). Then he moved to the Mathematical Institute at the University of Oxford. Robert's research focuses on mathematical models for physical, biological, econophysical and engineering systems.

Sarah is the former Director of the Centre for Material Science and Technology at Otago. She completed her BSc in Mathematics and Physics and her PhD in Theoretical Mechanics and Fluid Dynamics at the University of Nottingham. Afterwards she held positions at the Loughborough University of Technology and the University of Hertfordshire, joining the University of Otago in 2002. Sarah's research is on computational and environmental fluid dynamics.

A warm welcome to Timothy, Robert and Sarah!

Our new colleagues Sarah, Robert and Tim.

Congratulations to *Fabien Montiel*, recipient of the NZMS's 2018 Early Career Research Award. The award was instituted in 2006 to foster mathematical research in New Zealand and to recognise excellent research carried out by early-career New Zealand mathematicians. Fabien received the award "for outstanding contributions to the development of mathematical and computational methods in wave scattering theory and his innovative approach to modelling the propagation of ocean waves in ice-covered seas".

Ilija Tolich, our former student, PhD student, Research Fellow and Summer School Lecturer, has taken up a position as Policy Analyst for the Ministry of Business, Innovation & Employment in Wellington. Con-

gratulations on your new position, and all the best for your future, Ilija!

Phillip Wilcox recently led a module on genetics at a Science Wānanga in Te Wairoa near Rotorua. Science Wānanga are three day, hands-on experiences for Māori secondary students, and they seek to positively engage Māori students in science-related topics. The wānanga, which was attended by more than 50 students, was a huge success.

David Fletcher's new book "Model Averaging" was published in SpringerBriefs in Statistics. This series presents concise summaries of cutting-edge research and practical applications. David's monograph provides an accessible overview of model averaging, a common means of allowing for model uncertainty when analysing data. This is used in a wide range of application areas, such as ecology, econometrics, meteorology and pharmacology. The book describes the methods developed in this area, illustrating many of them with examples from the life sciences involving real-world data. Congratulations, David!

Matt Parry, *Florian Beyer*, *Jörg Frauendiener* and *Jörg Hennig* are among the NZ scientist who joined the LISA Consortium earlier this year. LISA — the Laser Interferometer Space Antenna — is a planned European Space Agency mission for the first space-based detection and accurate measurement of gravitational waves, and the Consortium prepares the science and technology for this mission. The NZ group is headed by Renate Meyer (University of Auckland), and Matt is the deputy leader.

The PhD thesis of *Boris Daszuta* on numerical calculations in General Relativity (see the abstract below) has been added to the Division of Sciences' list of Exceptional Thesis. A thesis is of exceptional quality when all three examiners agree that the thesis is of an exceptional standard in every respect and is amongst the top 10% of theses examined. Congratulations, Boris!

Jörg Hennig

PhD SUCCESS

Farzana Afroz (University of Otago)

Title: Estimating overdispersion in sparse multinomial data

Supervisors: David Fletcher, Matthew Parry

Abstract:

The phenomenon of overdispersion arises when the data are more variable than we expect from the fitted model. This issue often arises when fitting a Poisson or a binomial model. When overdispersion is present, ignoring it may lead to misleading conclusions, with standard errors being underestimated and overly-complex models being selected. In our research we considered overdispersed multinomial data, which arises in a number of research areas. Two approaches can be used to analyse overdispersed multinomial data: (i) the use of quasilikelihood or (ii) explicit modelling of the overdispersion using, for example, a Dirichlet-multinomial (Mosimann n.d.) or finite-mixture distribution. Use of quasilikelihood has the advantage of only requiring specification of the first two moments of the response variable, and is therefore likely to be more robust than use of a specific model for overdispersion. Quasilikelihood is most useful when we can assume that $\text{var}(Y) = \varphi V$, where V is the variance assumed by the multinomial model. We derive a new estimator of the overdispersion parameter φ for multinomial data by generalizing the results of Farrington (1996), Fletcher (2012) and Deng & Paul (2016). We consider six estimators of φ including the new estimator, discuss their theoretical properties and provide simulation results showing their performance in terms of bias, variance and mean squared error. Dirichlet-Multinomial distribution and the nite mixture of Dirichlet-Multinomial distribution were used in simulation study. The new estimator show the lowest level of RMSE (root mean squared error) for increasing level of and sparsity compared to the other estimators when the data are generated by the Dirichlet-Multinomial distribution. For the nite mixture case Farringtons estimator sometimes performed better than the new estimator in terms of RMSE. We derived the new estimator subject to a condition on the third cumulant of the response variable and the condition was satised in the case of Dirichlet-Multinomial distribution. It would be interesting to check the assumption for the mixture of Dirichlet-Multinomial distribution and for the other types of overdispersed multinomial models

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Paul Brown (University of Waikato)

Title: Computational Bayesian inference using low discrepany sequences

Supervisors: Stephen Joe and Chaitanya Joshi

Abstract:

The Integrated Nested Laplace Approximation (INLA) provides fast and accurate Bayesian inference for complex hierarchical models. For INLA, and other deterministic methods, the hyperparameter space is explored and points are laid out in a grid structure. These points are used in some numerical integration scheme for which marginal posterior distributions are computed. The main drawback is that the number of points increase exponentially with the number of hyperparameters. The grid is a type of quasi-Monte Carlo (QMC) point set. Low discrepancy sequences (LDS) are QMC point sets that are well known to have significant advantages over grids in terms of convergence and accuracy, and suffer less from the so-called curse of dimensionality.

This work makes several important contributions. We introduce a new method using LDS to compute marginal posterior distributions for hyperparameters, discuss the convergence properties of the approximations and show that they converge to the true posterior. We also show how these methods can be incorporated into the INLA inference framework, and we outline important extensions that improve the accuracy of our approximations with little extra computational effort needed. Lastly, we build a unique spatio-temporal model of residential crime in Hamilton, using INLAs stochastic partial differential equation approach to a Log-Gaussian Cox Process, and use an LDS to approximate the latent parameters of the model.

Our results show that for a fixed number of points or computational time, LDS methods can outperform general grid-based methods, leading to better marginal posterior approximations. Modifying the method for the purposes of incorporation to INLA, we show that we can outperform INLAs grid with respect to computational speed, and obtain accurate and flexible approximations to the model hyperparameters.

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Boris Daszuta (University of Otago)

Title: Numerical scalar curvature deformation and a gluing construction

Supervisors: Jörg Frauendiener, Florian Beyer, Jörg Hennig

Abstract:

In this work a new numerical technique to prepare Cauchy data for the initial value problem (IVP) formulation of Einsteins field equations (EFE) is presented. Our method is directly inspired by the exterior asymptotic gluing (EAG) result of Corvino [86]. The argument of [86] assumes a moment in time symmetry and allows for a composite, initial data set to be assembled from (a finite subdomain of) a known asymptotically

Euclidean initial data set which is glued (in a controlled manner) over a compact spatial region to an exterior Schwarzschildean representative. We demonstrate how [86] may be directly adapted to a numerical scheme and under the assumption of axisymmetry construct composite Hamiltonian constraint satisfying initial data featuring internal binary black holes (BBH) glued to exterior Schwarzschild initial data in isotropic form. The generality of the method is shown in a comparison of properties of EAG composite initial data sets featuring internal BBHs as modelled by Brill-Lindquist and Misner data.

The underlying geometric analysis character of gluing methods requires work within suitably weighted function spaces, which, together with a technical impediment preventing (Corvino, 2000) from being fully constructive, is the principal difficulty in devising a numerical technique. Thus the single previous attempt by Giulini and Holzegel (2005) (recently implemented by Doulis and Rinne (2016)) sought to avoid this by embedding the result within the well known Lichnerowicz-York conformal framework which required ad-hoc assumptions on solution form and a formal perturbative argument to show that EAG may proceed. In (Giulini and Holzegel, 2005) it was further claimed that judicious engineering of EAG can serve to reduce the presence of spurious gravitational radiation - unfortunately, in line with the general conclusion of (Doulis and Rinne, 2016) our numerical investigation does not appear to indicate that this is the case.

Concretising the sought initial data to be specified with respect to a spatial manifold with underlying topology RS our method exploits a variety of pseudo-spectral (PS) techniques. A combination of the eth-formalism and spin-weighted spherical harmonics together with a novel complex-analytic based numerical approach is utilised. This is enabled by our Python 3 based numerical toolkit allowing for unified just-in-time compiled, distributed calculations with seamless extension to arbitrary precision for problems involving generic, geometric partial differential equations (PDE) as specified by tensorial expressions. Additional features include a layer of abstraction that allows for automatic reduction of indicial (i.e., tensorial) expressions together with grid remapping based on chart specification - hence straight-forward implementation of IVP formulations of the EFE such as ADM-York or ADM-York-NOR is possible. Code-base verification is performed by evolving the polarised Gowdy T space-time with the above formulations utilising high order, explicit time-integrators in the method of lines approach as combined with PS techniques.

As the initial data we prepare has a precise (Schwarzschild) exterior this may be of interest to global evolution schemes that incorporate information from spatial-infinity. Furthermore, our approach may shed light on how more general gluing techniques could potentially be adapted for numerical work. The code-base we have developed may also be of interest in application to other problems involving geometric PDEs.

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Giovanni De Franceschi (University of Auckland)

Title: Centralizers and conjugacy classes in finite classical groups

Supervisor: Eamonn O'Brien

Abstract:

Let G be a classical group defined over a finite field. The aim of this thesis is to obtain a precise and explicit solution to each of the following closely related problems:

- List a representative for each conjugacy class of G.
- Given $x \in G$, describe the centralizer $C_G(x)$ of x in G, by giving its group structure and a generating set.
- Given $x, y \in G$, establish whether x and y are conjugate in G and, if they are, find explicit $z \in G$ such that $z^{-1}xz = y$.

We present comprehensive theoretical solutions to all three problems. Their solution is often a necessary and vital component of algorithms for computational group theory. Hence we seek explicit solutions which can be employed widely. To achieve this outcome, we use our theoretical solutions to formulate practical algorithms to solve the problems. In parallel to our theoretical work, we have developed in MAGMA complete implementations of these algorithms.

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Owen Dillon (University of Auckland)

Title: Probabilistic Approximations of Matrix Decompositions for Inverse Problems

Supervisors: Jari Kaipio and James Sneyd (co-sup)

Abstract:

Inverse problems arise in a wide range of subjects, such as medicine, cosmology, and engineering. These problems are often high dimensional, making them difficult to analyse and solve, particularly in industrial applications where time frames are narrow. The aim of this thesis is to provide broadly applicable methods to reduce the computational costs involved in inverse problems.

I consider solving inverse problems in two stages. The first is the offline phase. This is the stage of modelling and analysing the problem. This is sometimes called the "laboratory" or "research" stage. The second stage is online, where real data is coming in and a corresponding solution is found. Typically, the offline stage requires and can access greater computational resources than the online stage. Methods of reducing computational costs at the offline and online stage are presented in this thesis.

This thesis primarily takes the Bayesian viewpoint of inverse problems. Much of the analysis in this thesis is of linear inverse problems with Gaussian unknowns. Such problems can be expressed in terms of linear algebra, so much of this thesis is concerned with numerical linear algebra. A particular focus is approximate matrix decompositions. This thesis makes use of the Sherman-Morrison-Woodbury formula/matrix inversion lemma, Schur Complements, pseudoinverses, the eigenvalue decomposition, the singular value decomposition, the Cholesky decomposition and particularly the QR decomposition. This thesis presents a methodology of computing the QR decomposition of sample approximations to matrices, and demonstrates applications of such factorisations to inverse problems. This thesis also makes use of probabilistic algorithms for constructing approximate matrix decompositions. A probabilistic method of constructing locally accurate matrix approximations is introduced.

A particular focus of this thesis is the Bayesian approximation error framework, in which simulations are computed at the offline stage in order to reduce computational cost at the on-line stage. The Bayesian approximation error, sample QR factorisation, and locally accurate probabilistic approximations are combined to reduce computational costs.

The methods of this thesis are demonstrated separately, typically on 1D deconvolution. These methods are then combined and applied to the linear problems of 2D deconvolution and x-ray tomography. The methods of this thesis are also applied to the nonlinear simplified conductivity imaging problem.

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Hwan Goh (University of Auckland)

Title: Coupled Elastic-Acoustic Modelling for Quantitative Photoacoustic Tomography

Supervisors: Jari Kaipio and Kasper van Wijk (co-sup, UoA physics).

Abstract:

Quantitative photoacoustic tomography (qPAT) is an emerging imaging technique that estimates chromophore concentrations inside soft biological tissue. Chromophores are light absorbing molecules and are related, for example, to tissue metabolism. These images are formed by combining optical information and ultrasonic wave propagation that results from what is known as the photoacoustic effect. Because of the hybrid nature of this imaging technique, mathematically, this can induce two coupled so-called inverse problems. Specifically, the inverse problem of photoacoustic tomography (PAT) challenges us to estimate the initial pressure distribution using time-resolved measurements of the propagating acoustic pressure waves recorded over the tissue surface. The image obtained from PAT, however, has the disadvantage that it provides a somewhat indirect representation of the spatial variation of the optical coefficients. Quantitative PAT instead estimates the spatial distribution of the absorption coefficient, which provides more direct functional information on metabolism.

An example of a chromophore of interest is haemoglobin. The properties of blood is of great interest because multiwavelength measurements of the absorption of blood has the potential to provide functional information about the tissue through oxygen saturation. With these properties, photoacoustic imaging can be applied to detecting brain hypoxia-ischemia cerebral injury. However, the application of qPAT as a neuroimaging modality is complicated by shear waves that can be produced when ultrasound waves travel from soft tissue to bone. Because of this, the estimation of chromophores distributed near the skull bone can be problematic. To the best of our knowledge, only a few research papers have considered photoacoustic wave propagation in elastic media.

The research conducted in this thesis takes steps towards developing image reconstruction methodologies which attempt to compensate for aberrations of the recorded photoacoustic signals caused by elastic wave propagation. We model the illumination of soft tissue and use the simulated photon distribution to form the initial condition for photoacoustic wave propagation which, in turn, is modelled in a coupled elastic-acoustic medium. With the simulated photoacoustic data, we conduct inversions in a purely fluid domain. Estimation of the posterior density of the absorbed energy density is achieved by inversion under the Bayesian framework. We investigate the statistics of the approximation errors arising from approximating coupled elastic-fluid media by a purely fluid domain. Furthermore, we utilize the Bayesian approximation error approach to marginalise over the elastic layer and improve the estimations. The resulting reconstructions and corresponding uncertainty estimates is then used to estimate the posterior density of the absorption coefficient distribution. We implement a positivity transform to ensure no negative values are present in the absorbed energy density reconstructions; thereby allowing the reconstructions from the acoustic inverse problem to act as the data for the optical inverse problem. However, in doing so, the lin-

earity of the photoacoustic wave operator on the absorbed energy density is lost. Therefore, we employ the adjoint-state method to obtain the search direction for the gradient-based iterative optimization scheme we use to obtain the reconstructions. In the sense of the posterior uncertainty, the results show that the Bayesian approximation error approach yields a more feasible estimate for the posterior model of the absorbed energy density which, in turn, yields a more feasible estimate for the posterior model of the absorption coefficient.

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Purvi Pancholy (University of Canterbury)

Title: Numerical Study of Flow Structure and Pedestrian Level Wind Comfort Inside Urban Street Canyons

Supervisors: Phillip L Wilson, Miguel Moyers Gonzalez, Mark Jermy (UC Mechanical Engineering), Patrick Geoghegan (Aston University), and Kevin Clemens (UC Mechanical Engineering)

Abstract:

The air flow around an individual building or between buildings or groups of buildings is complex. This can introduce high wind speeds at a pedestrian level causing discomfort or even injuries. However, the effect of wind environment around buildings varies from site to site, depending on many factors such as the wind speed, wind direction, height and shape of a building, the neighbouring urban environment and so on. Sometimes a building will create a better urban wind environment and sometimes it may worsen it. When two or more buildings are considered, a recirculating flow can occur in the street canyon between them. These urban flows can impact pedestrians in the building wake or in the recirculating flow in the street canyon.

A three-dimensional numerical study using the steady Reynolds Averaged Navier-Stokes (RANS) of Computational Fluid Dynamics (CFD) has been performed to analyse the flow pattern and pedestrian comfort inside urban street canyons for medium rise buildings inside a thick atmospheric boundary layer. The wind direction considered was perpendicular to the street canyon. CFD validation for a single building has been performed by comparison with previous wind tunnel measurements for two reduced scale models. The near-wall modelling approach with the no-slip boundary condition has been used to model the wall roughness effect.

We initialized our study by analysing the flow structure inside the uniform and non-uniform street canyons. Considered parameters in this study include: the street width, building width and building height. Pedestrian comfort was quantified as the fraction of the street area where the wind speed was about 3 m/s on the extended Land Beaufort Scale at 1.75 m height, was used to compare the cases. This study reveals that for the uniform street canyon cases pedestrian comfort near the downstream building decreases with increasing street width. Whereas, a decrease in the building width decreases pedestrian comfort inside the street canyon. For the non-uniform cases, a step-up street canyon increases the pedestrian comfort inside the canyon whereas a step-down street canyon decreases the pedestrian comfort.

The obtained results for the uniform and non-uniform street canyons revealed that the flow coming from the upstream building roof has an impact on the flow structure and hence on the pedestrian wind comfort inside the street canyon. Hence a study was extended to find the impact of changing roof shapes of both buildings, only the upstream building or only the downstream building on the flow structure and pedestrian comfort inside the street canyon. The street width to the building height ratio S/H = 1 was considered for all studied cases. The results of this study, when compared with the flat-flat roof case, indicate that there is a strong influence of the roof shape change on the flow field and pedestrian comfort in the street canyon. For the pedestrian comfort assessment study using the different roof shapes reveals that for the considered street width, the pedestrian comfort inside the entire street is improved compared to the flat-flat case, in the case of slanted and upwind wedge roof shape of both the buildings, upwind wedge roof shape of only the upstream building and for all types of non-flat roofs on the downstream building.

Finally, finding the impact of adding a panel on the building roof on the flow structure and pedestrian comfort inside the street canyon has been performed. Key parameters considered for this study include: angle of the panel and location of the panel. The obtained results reveal that adding panel at the leading edge of the upstream building roof at an angle of 45° and at the trailing edge of the upstream building roof at angles of 45° and 60° modifies the flow structure inside the street canyon in a way that improves wind comfort at the pedestrian height.

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Chris Qin (University of Waikato)

Title: Iwasawa theory over solvable three-dimensional p-adic Lie extensions

Supervisors: Daniel Delbourgo and Ian Hawthorn

Abstract:

Iwasawa theory is a powerful tool which describes the mysterious relationship between arithmetic objects (motives) and the special values of L-functions. A precise form of this relationship is neatly encoded in the so-called "Iwasawa Main Conjecture". Classically the Main Conjecture (as formulated by Iwasawa himself)

involved the behaviour of ideal class groups over cyclotomic $\mathbb{Z}_p$-extensions, and related this to the Kubota-Leopoldt p-adic zeta-function. During the last two decades, the main conjecture has been greatly generalized to admissible p-adic Lie extensions, and provides a conjectural relationship between L-values of motives and their associated Selmer groups. A key component of the "Non-commutative Iwasawa Main Conjecture" in [CFK$^+$05] predicts the existence of an analytic p-adic L-function $\mathscr{L}_M^{an}$ inside $K_1(\mathbb{Z}_p[[\mathscr{G}_\infty]]_S)$. To establish the existence of such an object, we need to be able to do two things: (1) describe $K_1(\mathbb{Z}_p[[\mathscr{G}_\infty]]_S)$ in terms of the Artin representations factoring through $\mathscr{G}_\infty$ using p-adic congruences, and then (2) show for each motive that the abelian fragments satisfy these congruences. This thesis provides a complete answer to the first task (1), in the specific situation where the pro-p-group $\mathscr{G}_\infty$ has dimension ≤ 3 and is torsion-free. We completely describe $K_1(\mathbb{Z}_p[[\mathscr{G}_\infty]])$ and its localisations by using an infinite family of p-adic congruences, where $\mathscr{G}_\infty$ is any solvable p-adic Lie group of dimension 3. This builds on earlier work of Kato when $\dim(\mathscr{G}_\infty) = 2$, and of Daniel Delbourgo and Lloyd Peters when $\mathscr{G}_\infty \cong \mathbb{Z}_p^\times \times \mathbb{Z}_p^d$ with a scalar action of $Z_p^\times$. The method exploits the classification of 3-dimensional p-adic Lie groups due to González-Snchez and Klopsch, as well as the fundamental ideas of Kakde, Burns, etc. in non-commutative Iwasawa theory. We also undertake a short study of elliptic curves over GL2($\mathbb{F}_p$)-extensions, and compile some numerical evidence in support of the first layer congruences predicted by Kakde [Kak17] for non-CM curves.

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Anand Rampadarth (University of Auckland)

Title: Airway smooth muscle and airway wall couple dynamics: a numerical study using the distribution moment approach

Supervisor: Graham Donovan

Abstract:

Primarily, asthma is a disease of reversible airway constriction which is characterized by airways that constrict too easily and too much. These processes are modulated via a layer of airway smooth muscle (ASM) which surrounds each airway in the lung, wherein its activation leads to airway narrowing and potentially, closure. As a result, understanding the interaction between the ASM and the airway wall is crucial to understanding the reversible airway obstruction central to asthma. Although cross-bridge theory is a well-studied representation of complex smooth muscle dynamics, and can be coupled to the airway wall, this comes at significant computational cost, even for isolated airways. Because many phenomena of interest in pulmonary physiology cannot be adequately understood by studying isolated airways, this presents a significant limitation.

We present a distribution moment (DM) approximation for the coupled system consisting of the ASM and the airway wall. Specifically, we first derive a reduced DM system for the cross-bridge theory which capture the macroscopic characteristics of the original full ASM theory. We then study the validity of the reduced coupled system when the airway is subjected to periodic pressure oscillations and show that in most cases, the DM system is valid. We also explore the region of breakdown. These results show that in many situations within physiological ranges, the DM approximation provides an orders-of-magnitude reduction in computational complexity relative to the full cross-bridge-airway coupled system.

Deep inspirations (DI) are a widely studied topic due to their varied effectiveness as a bronchodilator in asthmatic and non-asthmatic patients. Specifically, it is known to be effective at reversing bronchoconstriction in non-asthmatic patients but may fail to prevent bronchoconstriction in asthmatic patients. Inspired by a recent study on the effect of deep inspirations on the rate of re-narrowing of an isolated airway, we investigate whether latch- bridge dynamics of the cross-bridge theory, coupled with non-linear compliance of the airway wall, can fully account for the reported results. We develop and present length- and pressure-controlled protocols which mimic both the experiments performed in the study, as well as simulate in vivo conditions respectively. The protocols are modelled using the DM approximation and show qualitative agreement with the results reported by the experiments, suggesting that latch-bridge dynamics coupled with airway wall non- compliance is sufficient to explain these results. As a secondary study, we also show thatthe DM approximated method is a suitable method to further investigate DIs on isolated (or branched) airways, as it is both qualitatively and quantitatively similar to the full cross-bridge model under equivalent conditions, and is less computationally intensive than traditional methods.

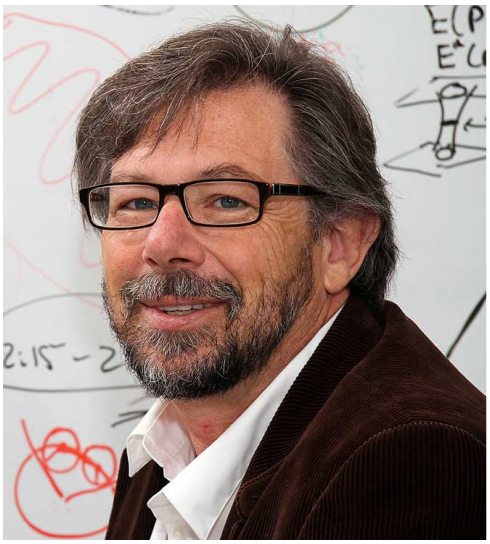
We also study clustered ventilation defects, which are a hallmark of asthma characterized by the emergence of spatially organised regions of hypo- and hyper-ventilated airways. These regions (clusters) can vary from event to event and as such are considered to be partially dynamic rather than purely structural. We investigate these defects by incorporating rich ASM dynamics to systems of symmetrically branched coupled airways via the DM method, and compare the qualitative and quantitative behaviour of this system to a full ASM model, as well as to a simplified ASM model. We study the distribution of clusters of closed airways as a result of randomly perturbed initial airway radii for increasing ASM activation at static pressures. Our results show that the inclusion of rich ASM dynamics via the

DM approximation leads to clustering distributions that are qualitatively similar to the highly simplified model as well as to the full ASM model. We also show that the DM model is less computationally intensive for both large and small numbers of coupled branched airways, and suggests that this model represents a viable option for the inclusion of rich ASM dynamics in whole lung models in future studies.

REPORTS ON EVENTS

Conference in honour of Gaven Martin

A two-day conference "Modern Analysis and Geometry" was held during January 24–25 at Massey University's Albany campus to celebrate Gaven Martin's 60th birthday. The speakers were Kari Astala, Martin Bridson, Marston Conder, Annalisa Conversano, Rod Downey, Rod Gover, Tadeusz Iwaniec, Vaughan Jones, Tim Marshall, Robert McLachlan, Alexander Melnikov, Eamonn O'Brien, Kirsi Peltonen, Alan Reid, Tom ter Elst, Lesley Ward and Tsukasa Yashiro. It was nice to see Gaven's former teachers John Butcher, David Gauld and Ivan Reilly as well as several former PhD students and postdocs. The conference ended with a barbecue at Gaven and Dianne's house on Friday night.



Gavin Martin

Conference participants

Shaun Cooper (Massey-SNCS)

Fluids in New Zealand 2019

The 7th NZ Fluid Mechanics conference, better known as Fluids in New Zealand or FiNZ, was held in Dunedin on 31 January and 1 February 2019. It was the first time since the inaugural event in 2013 that this meeting took place outside of Christchurch or Auckland, and it is fair to say that it was long overdue given the massive participation of Otago-based fluid researchers (17 of the 66 delegates, spread across 5 departments, were affiliated with the host institution). We were further delighted by the significant involvement of the NZ fluid community as a whole, with delegates coming from Auckland, Canterbury, Massey, Waikato and Lincoln universities, as well as Crown Research Institutes (NIWA and Callaghan Innovation), industry (Road Science) and even an overseas institution.

FiNZ provides a forum to facilitate the dissemination of ideas across the different branches of fluid mechanics, and to promote interdisciplinary collaborations between New Zealand scientists. Postgraduate students are especially encouraged to attend and present their research in a friendly environment, at any stage of their project. FiNZ 2019 was successful in attracting a large student crowd (44% of all delegates), thanks to the generous support of the NZMS, which allowed us to keep the student registration fees very low.

Invited speakers Prof. Christina Hulbe (top left), Prof. Shaun Hendy (bottom left), Dr. Ashton Bradley (top right), Dr. Julia Mullarney (bottom right). A beautiful evening at the University of Otago Staff Club (center).

We had a busy two-day event with 41 contributed talks, 4 invited lectures and 6 posters. Our invited speakers were Prof. Christina Hulbe (Otago), Prof. Shaun Hendy (Te Pūnaha Matatini), Dr. Julia Mullarney (Waikato) and Dr. Ashton Bradley (Otago), who gave fascinating talks on topics as varied as ice shelves dynamics, water droplet modelling, hydrodynamics of mangrove forests and quantum turbulence. Contributed talks and poster presentations showcased the far-reaching role of fluid mechanics in many areas of science, with sessions focused on fundamental physics, geophysical fluids, energy and engineering, micro/nanofluidics, biological flows and hydrology.

The first day ended with a general meeting, during which it was decided to broaden the scope of FiNZ in future events, in terms of fields, institutions and diversity of participants, building upon our successful effort to do so at FiNZ 2019. The meeting was followed by a conference BBQ at the Staff Club, during which Dunedin treated us with one its best summer evenings of the year. The overall feedback from delegates was overwhelmingly positive, based on a MBIE/Malatest International survey conducted after the conference. Dr. Emilia Nowak (Massey University) volunteered to organise FiNZ 2020 in Albany next year. We look forward to it!

Fabien Montiel (University of Otago)

ANZIAM 2019: A special event

In the first week of February the ANZ Industrial and Applied Mathematics Conference 2019 was held in Nelson NZ this year, organised jointly by Canterbury University and Victoria of Wellington University. This two-country event has been held every few years in NZ since 1987, when it was at Wairakei. Graeme Wake (Massey University Akl) and Graham Weir (Massey University, PN) convened a half-day session of eight invited talks within the conference in honour of Dr Alex McNabb FRSNZ, who is arguably one of NZ's best-known real-world Applied Mathematicians. The presenters themselves are all well-connected with Alex: Dr John Burnell (GNS), Professor Troy Farrell (QUT), Dr Phillip Laird (University of Wollongong), Professor Robert McKibbin (Massey University, Akl), Professor Mary Myerscough (Sydney University), Professor Bruce van-Brunt (Massey, PN), Professors Graeme Wake and Graham Weir (Massey University). Alex was born coincidentally (and very aptly) in Nelson in 1930 and was present with his wife Yvonne, both as honoured guests. Alex was a Senior Research Fellow in Massey University (PN) for many years in the 1980s and 1990s and much earlier (while in NZ's Department of Scientific and Industrial Research) helped lead the work that ensures our geothermal power system is so sustainable, among many other things. This methodology was subsequently used in other countries who have hydrothermal

systems. He is shown at left exhibiting his gymnastic skills (this appeared, and is reproduced from, The Australian, Higher Education supplement).

Graeme Wake (Massey-SNCS)

Alex McNabb

ANZIAM 2019: student report

This years Australian and New Zealand Industrial and Applied Mathematics Conference was held in Nelson, New Zealand. With the generous help from the NZ Mathematical Society I was able to attend this conference for the first time and spend five wonderful days with about 240 fellow mathematicians from Australia, New Zealand, and a few other countries. I have presented my latest results on the effect of individual heterogeneity in small mammal populations on the success of pest eradications in New Zealand. These results show how introducing different levels of trap-shyness in a pest population affects the predictions for population dynamics during an eradication procedure. My presentation was met with interest and a few insightful questions and remarks.

Attending this conference allowed me to tighten friendship bonds with students and researchers met at previous conferences, as well as to broaden my network of connections to the Australian mathematical community. In particular, I have had a nice chat with Christopher Baker and Matthew Holden from the University of Queensland on population dynamics and pest management. I could also discuss with Thi Hoai Linh Nguyen from Kyushu University about her multi-agent model on swarming movements, as I had worked on a similar project in the past.

I have also attended two special events organised during the ANZIAM Conference:

- The "Women in Mathematics" lunch starred five successful women mathematicians who shared with us their experience and valuable advice on being a woman in this field. Being one myself and at the very beginning of my research career, I was inspired by their words and I am very happy to find that the question of gender equality is taken very seriously in this community. Even though it is an ongoing process, I feel that people women and men alike feel concerned by it and do their best to ensure equal rights and opportunities for all genders;

- The Mathematical Biology Special Interest Group had 6 presentations focused on mathematics applied to different areas of biology. Although the event had to be stopped early because of the fires on Nelsons hills, I was able to hear about applications of spatial models to different areas of biology than mine.

Overall, the Conference was a great experience, especially at this early stage of my research, and I am very grateful to NZMS for sponsoring my attendance.

Giorgia Vattiato (University of Canterbury)

ANZIAM 2019: student report

With the generous support of the NZMS student travel grant I was able to attend the Australian and New Zealand Industrial and Applied Mathematics Conference 2019, held in Nelson, in February this year. I have attended this conference annually during my PhD and this year I was given the opportunity to be part of the organising team, which was a wonderful experience for me.

As I am now in the final year (really last 4 months but I don't want to think about that) of my PhD the chance to present our work is particularly important. The talk I gave on "Modelling Surtseyan Ejecta" was well received and attracted questions as well as feedback during the remainder of the conference.

In general the conference was very enjoyable and it was an excellent chance for networking. As a result of some of the discussions I had during the conference I feel much more confident in my decision to apply for post-doc's after completing my PhD. I am grateful to the New Zealand Mathematical Society for all the generous support I have received over the last 4 years.

Emma Greenbank (Victoria University of Wellington)

Eleventh Congress of the European Society for Research in Mathematics Education (CERME11): student report

With the support of the NZMS Student Travel Grant and Gloria Olive Travel award I was fortunate enough to attend the Eleventh Congress of the European Society for Research in Mathematics Education (CERME11), hosted by Utrecht University, Netherlands. CERME 11 is recognised as a prestigious conference within the mathematics education community. It offers researchers of mathematics education a prime academic environment for sharing knowledge and aims to bring together people active on the field of mathematics education research from all over Europe and beyond. The conference took place on 6th-10th February 2019 and was preceded by a YERME day (5th February) for young researchers. More than 900 international delegates attended this conference (the largest attendance since CERME began). I was one of two representatives from New Zealand and the only New Zealander at YERME.

The YERME day provided a fabulous opportunity for me to meet key European researchers in mathematics education, and learn about their work and methodological approaches. In addition, the YERME Day made it possible to network with young researchers from other countries, pursuing similar and not so similar research issues. Forging international connections with other young researchers enabled me to feel part of an international community in mathematics education research. The programme included several plenary presentations, and allowed for selection from three working groups and three discussion groups. Key scholars in European Mathematics Education led these three-hour group sessions from different academic traditions. During this day I was part of a working group led by Angelika Bikner-Ahsbahs focussing on research tools to think with in research, and I participated in a discussion group led by Gabriel Stylianides focussing on selecting and publishing in journals.

The core part of CERME was participating in a thematic working group. My main research interest is in mathematical proof within the primary school sector. Research in this area is very limited, especially within the New Zealand context. Thematic Group 1 focussing on Argumentation and Proof was therefore an incredible opportunity to both learn about research currently being undertaken in this area, and to be part of productive discussions. Gabriel Styliandes who is internationally renowned for his research within the area of mathematical proof, including task design, chaired this thematic group. The work of Gabriel Styliandes, and that of his brother Andreas Styliandes, has been instrumental in the development of my research interest.

Participating in this conference and being able to discuss my research in this community of international mathematics educators and researchers has enabled me to develop international bridges and relationships. It has been an incredibly insightful experience for me and, I feel, hugely beneficial for my research and career development. I would like to express my gratitude to the New Zealand Society of Mathematics for their financial assistance towards this experience.

Jo Knox (University of Auckland)

Computational Techniques and Applications Conference (CTAC 2018): student report

In November 2018, I had the great experience of attending the Computational Techniques and Applications Conference which was held in Newcastle, NSW Australia. I was fortunate enough to get a financial support from New Zealand Mathematical Society (NZMS) which enabled me to attend that conference and to give a talk presenting my PhD thesis work "Monotone iterative methods for solving nonlinear partial and integro-partial equations". My talk included providing numerical efficient solvers for nonlinear systems of partial differential equations and how to develop those solvers. Many scientists specialized in applied mathematics and postgraduate students from different countries participated in that conference. Most of the recommendations by specialists were about how to create more concert connection between the mathematical society and industry. I really had very fruitful questions and discussions with scientists and postgraduate students. Many thanks go to NZMS for their support and participation towards academic life.

Mohamed Al-Sultani (Massey University)

Joint Mathematics Meetings (JMM): student report

I would like to express my sincere gratitude to New Zealand Mathematical Society and the University of Canterbury for providing their generous travel fund to me to attend Joint Mathematics Meetings (JMM) in Baltimore, United States. JMM is one of the significant mathematics conferences and furnishes an opportunity to build an international network.

It was four days of conference from 16-19 January 2019 with plenty of talks, workshops, exhibitions and poster sessions. I presented my research of title "Integral Means of Univalent functions on an Annulus". My research area is complex analysis and I obtained some results on an annulus. My talk was pretty good and engaging, and I had some positive feedback.

It was honoured to meet various professors and mathematicians around the globe such as Prof. Nasser Dastrange (Buena Vista University), Ass. prof. Lee See Keong (University Sains Malaysia), Ass. prof. Fazal Abbas (Stetson University) and Dr. Laura Munteanu (State University of New York), which opens the doors for future employment and research collaborations. Once again I am thankful to the New Zealand Mathematical Society for the travel grant.

Fareeda Begum (University of Canterbury)

GENERAL NOTICES

Mathematics-In-Industry NZ

24-28 June 2019

University of Auckland

Stay updated at minz.org.nz

42nd Australasian Conference on Combinatorial Mathematics and Combinatorial Computing (42ACCMCC)

The 42nd Australasian Conference on Combinatorial Mathematics and Combinatorial Computing (42ACCMCC) will be held at the University of New South Wales in Sydney, Australia, 9–13 December 2019. The webpage is conferences.maths.unsw.edu.au/e/42accmcc.

ACCMCC is the annual conference of the Combinatorial Mathematics Society of Australasia. The conference covers all areas of combinatorics in mathematics and computer science. The following is a list of confirmed invited speakers.

- Michael Albert, University of Otago
- Joachim Gudmundsson, University of Sydney
- Camilla Hollanti, Aalto University
- Daniel Horsley, Monash University
- Ken-ichi Kawarabayashi, National Institute of Informatics, Japan
- Cheryl Praeger, University of Western Australia
- Wojciech Samotij, Tel Aviv University
- Maya Stein, Universidad de Chile
- Stephan Thomassé, École Normale Supérieure de Lyon

The CMSA Anne Penfold Street Student Prize will be awarded to the best student talk at the conference.

For more information about 42ACCMCC or to be added to a mailing list for future announcements, please contact the organisers at accmcc2019@unsw.edu.au.

Catherine Greenhill

NZMS NOTICES

The 2019 New Zealand Mathematical Society Colloquium will be hosted by Massey University at Palmerston North, Tuesday 3 to Thursday 5 December. For more details visit the conference website: https://nzmathsoc.org.nz/colloquium2019/home.php.

Calls for nominations for NZMS Awards and Fellowships

The NZMS recognises excellence in mathematical research and service to the NZ mathematical community through awards and an accreditation (fellowship) scheme. The Council asks that you all actively encourage eligible colleagues to apply for these awards and/or offer to nominate them, especially women, those of Māori ethnicity, or other members of the NZ mathematical community who are under-represented among past awardees and fellows. Below are calls for nominations for the specific awards and for NZMS fellowships, along with their deadlines. Further details on all the awards, including past recipients, eligibility, and how to nominate someone (or self-nominate), can be found at: http://nzmathsoc.org.nz/?awards. Fellowship information and application forms can be found at: http://nzmathsoc.org.nz/?accreditation.

2019 NZMS Early Career Research Award

This award was instituted in 2006 to foster mathematical research in New Zealand and to recognise excellent research carried out by early-career New Zealand mathematicians. Applicants should be within seven years of confirmation of PhD, but an appropriate adjustment to this time period can be made to take into account an interrupted career pattern. Candidates may contact the NZMS President in confidence for clarification of how the adjustment of time period applies to the their particular circumstances. The candidate will be judged on their best three published research outputs and a two-page CV. Research outputs could include publications in books, journals, other peer-reviewed venues, or other types of high quality mathematical research. To be eligible, the candidate must be a current member of the NZMS, and must have completed a significant part of their research in New Zealand.

All nominations and applications should be sent by email to the NZMS President, Assoc Prof Vivien Kirk (v.kirk@auckland.ac.nz) by 31 August 2019. Submissions should state clearly that they are for the NZMS Early Career Award, and should follow the guidelines at http://nzmathsoc.org.nz/?awards.

2019 NZMS Research Award

This annual Award was instituted in 1990 to foster mathematical research in New Zealand and to recognise excellence in research carried out by mathematicians in New Zealand. This Award is based on mathematical research published in the last five calendar years (2014-2018). This could include research published in books, journals, other peer-reviewed venues, or other types of high quality mathematical research. This assessment period may be adjusted to take into account an interrupted career pattern. Candidates may contact the NZMS President in confidence for clarification of how the adjustment of time period applies to the their particular circumstances. To be eligible for the Award, a candidate must be a current member of the NZMS and must have been a resident of New Zealand for the last three years.

All nominations and applications should be sent by email to the NZMS President, Assoc Prof Vivien Kirk (v.kirk@auckland.ac.nz) by 31 August 2019. Submissions should state clearly that they are for the NZMS Research Award, and should follow the guidelines at http://nzmathsoc.org.nz/?awards.

2019 Kalman Prize for Best Paper

The Kalman Prize for Best Paper was instituted in 2016 to recognise excellence in research carried out by New Zealand mathematicians. The Prize will normally be awarded annually for an outstanding and innovative piece of research in the mathematical sciences published by a member or members of the NZMS. The Prize is for a single publication of original research, which may be an article, monograph or book, having appeared within the last 5 calendar years: 2014-2018. The value of the Prize is $5000. The Prize is generously funded by the Margaret and

John Kalman Charitable Trust, and recognises the significant contributions to mathematics in New Zealand made by Professor John Kalman.

All nominations and applications should be sent by email to the NZMS President, Assoc Prof Vivien Kirk (v.kirk@auckland.ac.nz) by 31 August 2019. Submissions should state clearly that they are for the Kalman Prize for Best Paper, and should follow the guidelines at http://nzmathsoc.org.nz/?awards.

Fellowships of the NZMS

The New Zealand Mathematical Society, like many other societies, has an accreditation scheme. In particular, members may be recognised with the award of Fellowship of the NZMS. The NZMS encourages members to consider applying, and additionally, encourages members to nominate colleagues who meet the criteria. The complete criteria follow, all three of which are to be satisfied.

1. Shall normally have been a Member of the NZMS for a period in excess of three years.
2. Shall have had the qualifications of an Accredited Member for a period in excess of three years (i.e. have completed a postgraduate degree in mathematics at a recognised university or other tertiary institution, or shall have equivalent qualifications, and shall have been employed for the preceding three years in a position requiring the development, application or teaching of mathematics.)
3. Shall have satisfied criteria (3.1 or 3.2 or 3.3 or 3.4) and 3.5:
   - 3.1 have made a substantial and sustained contribution to the mathematical sciences;
   - 3.2 have made a substantial and sustained contribution to the profession of mathematical scientist;
   - 3.3 have made a substantial and sustained contribution to the teaching and learning of the mathematical sciences;
   - 3.4 have made a substantial and sustained contribution to the application of the mathematical sciences;?
   - 3.5 have made a substantial and sustained to the New Zealand mathematics community.

Members' applications are encouraged before 1 June 2019.

Next deadline for applications for Financial Assistance – 15 May (for travel commencing after June 15, 2019)

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 2019 are: 15 February, 15 May, 15 August, and 15 November. You will hear back from the Council within a month of the deadline. The types of grants are as follows.

NZMS Student Travel Grants

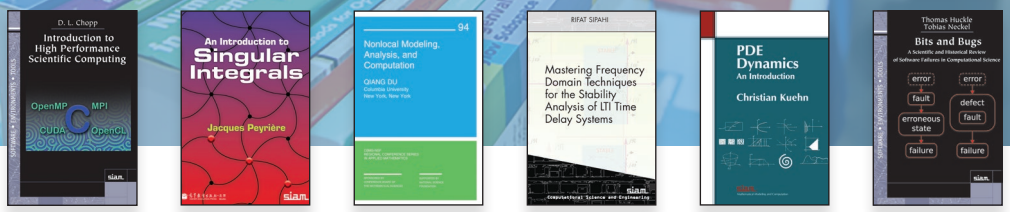
The NZMS invites applications from students for financial support for the presentation of research at conferences, attending workshops, and developing new collaborations. Typical grants for travel within NZ and Australia are in the range $200-$600. For travel further overseas, larger grants may be considered. 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.

SIAM Books



Introduction to High Performance Scientific Computing

David L. Chopp

This book introduces methods for adding parallelism to numerical methods for solving differential equations. It contains exercises and programming projects that facilitate learning as well as examples and discussions based on the C programming language, with additional comments for those already familiar with C++. Based on a course developed by the author, the text provides an overview of concepts and algorithmic techniques for modern scientific computing and is divided into six self-contained parts that can be assembled in any order to create an introductory course using available computer hardware.

2019 • xiv + 453 pages • Softcover • 978-1-611975-63-5
List $89.00 • SIAM Member $62.30 • SE30

An Introduction to Singular Integrals

Jacques Peyrière

In just over 100 pages, this book provides basic, essential knowledge of some of the tools of real analysis: the Hardy–Littlewood maximal operator, the Calderón–Zygmund theory, the Littlewood–Paley theory, interpolation of spaces and operators, and the basics of H1 and BMO spaces. This concise text offers brief proofs and exercises of various difficulties designed to challenge and engage students.

2018 • viii + 115 pages • Softcover • 978-1-611975-41-3
List $59.00 • SIAM Member $41.30 • OT159

Nonlocal Modeling, Analysis, and Computation

Qiang Du

Studies of complexity, singularity, and anomaly using nonlocal continuum models are steadily gaining popularity. This monograph provides an introduction to basic analytical, computational, and modeling issues and to some of the latest developments in these areas. It includes motivational examples of nonlocal models, basic building blocks of nonlocal vector calculus, elements of theory for well-posedness and nonlocal spaces, connections to and coupling with local models, convergence and compatibility of numerical approximations, and various applications. A particular focus is on nonlocal systems with a finite range of interaction to illustrate their connection to local partial differential equations and fractional PDEs.

March 2019 • Approx. xiv + 166 pages • Softcover • 978-1-611975-61-1
List $59.00 • SIAM Member $41.30 • CB94

Mastering Frequency Domain Techniques for the Stability Analysis of LTI Time Delay Systems

Rifat Sipahi

This multipurpose book addresses the following questions for linear time-invariant (LTI) systems with an eigenvalue-based approach that is built upon frequency domain techniques: the fundamental question of how to study the stability of dynamical systems influenced by time delays; the related issues of how much time delay the system can withstand without becoming unstable; and how to change parameters to render improved dynamic characteristics, utilize or tune delay to improve dynamical behavior, and assess the stability and speed of response of the dynamics. Readers will find key results from the literature, step-by-step demonstrations of all implementations, and MAPLE and MATLAB code that is available from the author's website.

2019 • xviii + 174 pages • Softcover • 978-1-611975-71-0
List $74.00 • SIAM Member $51.80 • CS20

PDE Dynamics: An Introduction

Christian Kuehn

This book provides an overview of the myriad methods for applying dynamical systems techniques to PDEs and highlights the impact of PDE methods on dynamical systems. Also included are many nonlinear evolution equations, which have been benchmark models across the sciences, and examples and techniques to strengthen preparation for research.

May 2019 • xiv + 245 pages • Softcover • 978-1-611974-65-9
List $69.00 • SIAM Member $48.30 • MM23

Bits and Bugs: A Scientific and Historical Review of Software Failures in Computational Science

Thomas Huckle and Tobias Neckel

In scientific computing (also known as computational science), advanced computing capabilities are used to solve complex problems. This self-contained book describes and analyzes reported software failures related to the major topics within scientific computing: mathematical modeling of phenomena; numerical analysis; mathematical aspects and complexity of algorithms, systems, or software; concurrent computing; and numerical data. Readers will find lists of related, interesting bugs, MATLAB examples, and "excursions" that provide necessary background, as well as an in-depth analysis of various aspects of the selected bugs. Illustrative examples of numerical principles such as machine numbers, rounding errors, condition numbers, and complexity are also included.

2019 • xii + 251 pages • Softcover • 978-1-611975-55-0
List $44.00 • SIAM Member $30.80 • SE29

Order online at bookstore.siam.org

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