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NEWSLETTER

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PUBLISHER'S NOTICE

This newsletter is the official organ of the New Zealand Mathematical Society Inc. This issue was edited by Mark C. Wilson with paid proofreader assistance. 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 mcw@cs.auckland.ac.nz.

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EDITORIAL

Welcome to 2015.

We continue to present invited articles by recent NZMS prizewinners, this time Steven Galbraith. The untimely death of Judy Paterson is mentioned in several places, and she is featured in the Profile. We continue to publish abstracts of NZ PhD theses in mathematics — supervisors are encouraged to send theirs to their local news correspondent. Local news has been falling off recently. If you belong to a department not mentioned in this issue, consider volunteering to take over the job of correspondent. For example, VUW is in sore need of a new correspondent.

Book reviews are an important feature of this newsletter, and again we have none in this issue. As always, such a newsletter can only work if there is a constant stream of interesting content. I urge members to suggest books for review, and to provide reviews, to the book review editor. Also, letters to the editor are welcome.

In general, there is far too little community involvement in this newsletter. I am not aware of any standardized forum, electronic of otherwise, in which substantial discussion takes place among members of our far-flung and relatively poorly supported community. Trends in government policy in recent years seem to me to be evern more reason for discussion. Message to readers: spend a little time writing, as well as reading (quite the opposite advice should be given to some researchers with respect to research articles, but that is another story).

All that being said, I thank yet again those who have contributed over many issues. Your help is greatly appreciated.

This marks the 6th issue since I took over. Now that the newsletter has been restored to a reasonable state after some time of neglect, I am considering moving on to other activities by the end of the year. Anyone interested in taking over the job of editor should contact me directly in order to ensure a smooth transition.

Mark C. Wilson

PRESIDENT'S COLUMN

As I write, Endre Süli's Forder Lecture tour is underway. In Albany, we enjoyed meeting him and seeing his presentation last week. Many thanks to Tom ter Elst for his great job of planning and coordination of the tour.

There are several other events to look forward to during the year. In September, Ingrid Daubechies from Duke University will visit as the 2015 Maclaurin Lecturer. Florian Beyer is coordinating her tour.

The NZMS Colloquium this year will be at University of Canterbury (1st-3rd December). It will good to return to Christchurch for this event. Rua Murray is conference director.

The New Zealand Mathematics and Statistics Postgraduate Conference is being coordinated by students at University of Waikato. It will be held in Taupo 17th-20th November.

There is to be another Mathematics in Industry Study Group (MINZ-MISG) here at Albany on 29th June-3rd July this year. As I said in my August column last year these events are enjoyable and instructive and I encourage all mathematicians to have a go and attend such an event. This particular event has the advantage of being in New Zealand, working with local industry, without the need to go offshore. Graeme Wake is directing the MISG.

You will find more details on these items elsewhere in the newsletter. Also included is my report on 2014. There are also calls for Fellowship, Award, and Student Travel funding applications and further information on the Kalman Prize established last year for the best paper in the New Zealand Journal of Mathematics.

Winston Sweatman

INVITED ARTICLES

Birthday problems and discrete logarithms

The birthday paradox

Most readers will know of the "birthday paradox", that in a room of 23 or more randomly chosen people it is more likely than not that two people share a birthday. This is not actually a paradox, but a mathematical theorem. It is called a "paradox" because most people think 23 people is much too few for the result to be true(it would be more natural to call it the "birthday surprise", but unfortunately that already means something else). From now on we call it the "birthday problem".

To see the truth of the statement, suppose we sample uniformly at random integers $x_1, x_2, \ldots, x_k$ such that $1 \leq x_i \leq 365$ for all i. What is the probability that the integers are all *distinct* (i.e., no shared birthday)? One easily sees that the probability is

$$p_k = 1\left(1-\tfrac{1}{365}\right)\left(1-\tfrac{2}{365}\right)\cdots\left(1-\tfrac{(k-1)}{365}\right).$$

The logic is that x_1 can cause no collision, x_2 can take any value except x_1, x_3 can take any value not in $\{x_1, x_2\}$ and so on. We have $p_{23} \approx 0.4927$ while $p_{22} \approx 0.5243$. Hence, the probability of a collision among 22 people is $1 - p_{22} \approx 0.4757$ whereas the probability of a collision among 23 people is $1 - p_{23} \approx 0.5073$.

Sometimes it is more useful to consider the *expected number* of trials k such that $|\{x_1, \ldots, x_k\}| = k-1$. For the birthday problem in a set of size N, the expected number of trials is $\sqrt{\pi N/2}$. This is a little trickier to prove, but not too hard. When $N = 365$ this is approximately 23.94. What this means is that if the experiment is repeated many times then the average of the values k will converge to 23.94.

One can consider a variant of the birthday problem where one has a room containing k boys and k girls, and one wants a boy and a girl to share the same birthday. What is the expected value of the total number of people $2k$ before this happens? The answer is $\sqrt{\pi N}$, where N is the number of possible birthdays [8, 11]. Intuitively this result is not surprising (as it is closely related to finding collisions in the set $\{1, \ldots, N\} \times \{\text{boy}, \text{girl}\}$ of size $2N$), but I do not know any way to derive this result immediately from the basic birthday result. When $N = 365$, the expected value of $2k$ is approximately 33.86.

I got interested in the birthday problem due to some algorithmic applications that I discuss in the next section. As part of this work it was necessary to develop a more general result, which I did with the help of Mark Holmes from the Statistics Department in Auckland [4]. During this work we developed the following "birthday paradox", which I leave as a teaser for you:

> In my hotel there is a meeting of the "boys born in January" club, and a meeting of the "random girls" club (whose birthdays are uniform throughout the year). I want to invite some boys and some girls into the lobby until I find a girl and a boy with the same birthday. But I also want to do this with the minimal total number of people in the lobby. According to what ratio should I invite boys and girls into the room? Should I invite 12 girls for every boy? Or $\sqrt{12}$ girls for every boy? Or is some other strategy best?

More precisely, let N be a multiple of 12 and let $Y \subset X = \{1, \ldots, N\}$ be such that $|Y| = N/12$. I wish to sample x_i uniformly from X and y_j uniformly from Y until $\{x_1, \ldots, x_k\} \cap \{y_1, \ldots, y_l\} \neq \emptyset$. I wish to know the *strategy* that minimises the expected value of $k+l$ for this to happen, as $N \to \infty$.

Discrete logarithms

The *discrete logarithm problem (DLP)* in a finite group G is: Given $g, h \in G$ to find an integer x, if it exists, such that $h = g^x$. This is a fundamental computational problem with applications to public key cryptography. It turns out that, without loss of generality, one may assume that g has prime order N.

There is a very simple algorithm (called the "baby-step-giant-step algorithm") that deterministically solves the DLP using $O(\sqrt{N})$ group operations and requires storing $O(\sqrt{N})$ group elements. This is exponential time and space, but it works in any group. It is known that that one cannot do better than $O(\sqrt{N})$ group operations when working with a "generic group"; in other words, to get a faster algorithm one needs to exploit some properties of the representation of the group.

In 1978 Pollard [9] invented a method based on the birthday problem that solves the DLP in an expected $O(\sqrt{N})$ group operations but only requires polynomially-bounded storage. The idea is to generate pseudorandom sequences of group elements of the form $g^a h^b$ where a and b are known to the algorithm. By the birthday problem one expects to find a collision after about $\sqrt{\pi N/2}$ group elements have been computed. Once one has a collision

$$g^{a_1} h^{b_1} = g^{a_2} h^{b_2}$$

then one can solve the discrete logarithm problem as $x \equiv (a_1 - a_2)(b_2 - b_1)^{-1} \pmod{N}$, as long as $b_1 \not\equiv b_2 \pmod{N}$. The challenge is to detect collisions without storing all the group elements. Pollard called his method the "rho method" as he uses a certain type of pseudorandom walk that has a "tail" and then falls into a "cycle", making a path like the symbol ρ. Van Oorschot and Wiener [12] showed how this method can be parallelised and achieved the "optimal" expected running time of $(\sqrt{\pi/2} + o(1))\sqrt{N}$ group operations. We are interested in the expected running time (rather than worst case) as it is the average running time if the algorithm is run repeatedly on many instances of the same size.

A related computational problem that arises in some cryptosystems is the *DLP in an interval*: Given a group G, elements $g, h \in G$, and an integer $M < |G|$, find x if it exists such that $h = g^x$ and $0 \leq x < M$. This problem is usually considered when M is significantly smaller than the order of the element g, and where it is known that a solution does exist.

The baby-step-giant-step algorithm can be used for this problem, requiring $O(\sqrt{M})$ group operations and storage of $O(\sqrt{M})$ group elements. Pollard [9] invented the "kangaroo algorithm" for this problem (in [10] he writes that he decided to use the name "kangaroo" after reading an article on kangaroos in the issue of Scientific American that contained Martin Gardner's description of the RSA cryptosystem). This algorithm also uses pseudorandom walks, but is based on a slightly different tool from probability theory than the birthday problem. The work of van Oorschot and Wiener [12] gives an algorithm with expected running time of $(2 + o(1))\sqrt{M}$ group operations.

Groups with efficient inversion

In the group $G = \mathbb{Z}_p^*$ it is actually much faster to compute a group operation (multiplication modulo p) than to compute an inversion (which involves running Euclid's algorithm). However, in some other groups (such as elliptic curves) it is much faster to compute the inverse of an element than to compute a group operation. We say that the latter groups have "efficient inversion". In this case, one can speed up the Pollard rho algorithm by essentially working in the set of equivalence classes of the group G under the relation $g \equiv g^{-1}$, see [6, 13]. One speeds up the algorithm by a constant factor $1/\sqrt{2}$. This isn't very much of a speed-up, but in this subject every little bit of improvement has some cryptographic significance.

However, it remained an open problem to exploit inversion in Pollard's kangaroo algorithm. With my student Raminder Ruprai, I started to investigate a different algorithm due to Gaudry and Schost [7]. This algorithm is based on the "boy-girl" version of the birthday paradox and is usually worse than the Pollard methods (it was invented for solving a "multi-dimensional" problem in a slightly different context). Our papers [2, 3] showed how the Gaudry-Schost algorithm can be improved by using non-uniform distributions (and this is what lead to my interest in generalisations of the birthday problem, as mentioned at the start of the article). The paper [3] solved the long-standing problem of getting a speedup to the interval DLP in groups with efficient inversion.

During this time I was also writing my book "Mathematics of public key cryptography" and I was in correspondence with John Pollard about his algorithms. One of the draft chapters I sent him contained an exercise to show that inversion cannot be incorporated into the kangaroo algorithm. On August 6, 2008 I received an email containing this text.

> Re: your exercise 16.53.
>
> Yes, I think there is a better way - but it does not gain much. But you will have to wait until September to get the details. If I do not survive until then, you will have to invent it for yourself. Which you will probably do - now that I have told you that there is something to find ...
>
> There is no obvious reason why I should not survive for longer, but you never know.

Luckily Pollard did survive and, once the new ideas had been fully analysed, we wrote a paper [5] that gives a general improvement to the kangaroo method in *any* group (we use some inversions, but do not require that inversions be faster than group operations). The basic idea is that "three kangaroos are better than two, and

four are even better", but I do not have space to go into the details. As Pollard predicted, the speedup is not as significant as one would hope: reducing the expecting running time from $(2+o(1))\sqrt{M}$ group operations to $(1.66+o(1))\sqrt{M}$ group operations. It is still an open problem to determine what is the optimal running time for the DLP in an interval, but it should be at least $(1.25+o(1))\sqrt{M} = (\sqrt{\pi/2}+o(1))\sqrt{M}$.

Along these lines, my recent BSc(Hons) student Alex Fowler investigated the question of whether five kangaroos are better than three. His surprising conclusion was that "five kangaroos are better than three, but seven kangaroos are worse than four". For details see [1].

Finally, the answer to the teaser is $k = l$, in other words, alternately choose a boy and a girl to enter the lobby. For proof see [4]. I hope you are surprised!

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Steven Galbraith

MATHEMATICAL MINIATURE

MM36: Judy Paterson, eigenvalues and diffusion

Mathematicians at Auckland University are mourning the death of Judy Paterson, a remarkable member of the Mathematics Department. Judy died in late February and left a legacy of kindness and generosity as well as a scholarship in the field of Mathematics Education. Judy's most recent research interest was chatting with mathematicians and finding out how they believe eigenvalues should best be introduced to students for the first time. Eigenvalues are ubiquitous and, not surprisingly, the preferred approach varies considerably depending on the mathematician doing the teaching and the students being taught. This miniature is dedicated to Judy's memory and contains some jottings about the role of eigenvalues in applied and computational mathematics. This is a story about difference equations, Fourier series and heat diffusion. In one space dimension, the version of the diffusion equation I will consider, is

$$\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}, \qquad x \in [0,1], \quad t \geq 0, \tag{1}$$

where $u(0,t) = u(1,t) = 0, u(x,0) = \varphi(x)$ are given as boundary and initial values.

In the "method of lines", the interval $[0,1]$ is divided into $N+1$ equal-width sub-intervals, and approximate values of u at the internal points are named $u_1(t), \ldots, u_N(t)$ as in the diagram.

The second partial derivatives can be approximated by

$$\left.\frac{\partial^2 u}{\partial x^2}\right|_{x=k/(N+1)} \approx (N+1)^2(u_{i-1} - 2u_i + u_{i+1}), \qquad i = 1,2,\ldots,N$$

and the discretised version of (1) becomes

$$\mathbf{u}' = A\mathbf{u}, \qquad A = (N+1)^2 M, \quad M = \begin{bmatrix} -2 & 1 & 0 & 0 & \cdots \\ 1 & -2 & 1 & 0 & \cdots \\ 0 & 1 & -2 & 1 & \cdots \\ \vdots & \vdots & \vdots & \vdots & \end{bmatrix}, \tag{2}$$

where $\mathbf{u}$ is the N dimensional vector with components u_i, $i = 1,2,\ldots,N$. I am curious about the eigenvalues of A but it is easy to find these as $\lambda = (N+1)^2\mu$ where μ is an eigenvalue of M. But first recall how the solution of a difference equation $av_{i+2} + bv_{i+1} + cv_i = 0$ is related to the quadratic equation $aX^2 + bX + c = 0$. If the quadratic has roots X_1 and X_2, assumed for the moment to be distinct, the solution to the difference equation is $v_i = C_1 X_1^i + C_2 X_2^i$, for C_1 and C_2 arbitrary constants. If $M\mathbf{v} = \mu\mathbf{v}$, then

$$v_{i+2} - (2+\mu)v_{i+1} + v_i = 0, \tag{3}$$

and hence $v_i = C_1 z^i + C_2 z^{-i}$ for some z, where we note that the product of the roots of the associated quadratic is 1. Because $v_0 = 0$, we have $C_2 = -C_1$ and because $v_{N+1} = 0$, it then follows that $z^{2N+2} = 1$. Hence, $z = \exp(\mathbf{i}k\pi/(N+1))$, with $k = 1,2,\ldots,N$ and $v_i = C\sin(ki\pi/(N+1))$. To find μ note that the sum of the roots in (3) is $2+\mu$ so that

$$\mu = \exp(\mathbf{i}k\pi/(N+1)) + \exp(-\mathbf{i}k\pi/(N+1)) - 2 = 2(\cos(k\pi/(N+1)) - 1) = -4\sin^2(k\pi/(2N+2)).$$

This gives the eigenvalues of A as

$$\lambda_k = -(2N+2)^2 \sin^2(k\pi/(2N+2)), \qquad k = 1,2,\ldots,N.$$

We had temporarily assumed that $X_1 \neq X_2$, which would have meant that $z \neq \pm 1$. The excluded special cases would have given a solution to the difference equation $v_i = z^i(C_1 + C_2 i)$, but no non-zero choices of C_1 and C_2 would fit the boundary values $v_0 = v_{N+1} = 0$. We can scale $\mathbf{v}_k$ by an arbitrary constant and we choose to write

$$\mathbf{v}_k^\top = \left[\sin\left(\tfrac{k\pi}{N+1}\right) \quad \sin\left(\tfrac{2k\pi}{N+1}\right) \quad \cdots \quad \sin\left(\tfrac{Nk\pi}{N+1}\right)\right].$$

Why should I have been so curious about the eigenvalues and eigenvector of A? I want to use this information to understand the solution of (2) and also numerical approximations to the solution. If $\mathbf{u}$ at time zero happens to be in the direction of an eigenvector it will stay in this directions and its magnitude will behave like $\exp(t\lambda)$. Similarly, numerical solutions will do the same except that $\exp(t\lambda)$ will be replaced by a rational approximation to this function. To cover more general initial values we need to use spectral decomposition

$$A = \sum_{k=1}^{N} \lambda_k \mathbf{v}_k (2/N) \mathbf{v}_k^{\mathsf{T}}.$$

The eigenvalues range from approximately $-k^2\pi^2$ for low values of k to approximately $-4(N+1)^2$ for k close to N. The eigenvalues close to zero represent the physically significant aspects of the method of lines approximation while the eigenvalues with large magnitude are the ones that cause trouble in carrying out numerical simulations.

We can return to the original problem (1) by taking the limit as $N \to \infty$. This converts eigenvalues to eigenfunctions which are nothing more than Fourier series terms $\sin(xk\pi)$. And multiplication by $(2/N)\mathbf{v}_k^{\mathsf{T}}$ becomes, in the limit, the calculation of Fourier coefficients.

In the if the $(1,1)$ and (N,N) elements of M are changed from -2 to -1 and the factor $(N+1)^2$ is changed to $(N-1)^2$ in (2), what do the eigenvalues of A become? And what does the modified problem correspond to physically?

In MM37 I would like to continue with this discussion. You might be able to stop me doing this by suggesting some other topic to me.

In MM35, with the help of my guest Nicolette, I tossed off a few problems which I am sure many readers solved for their own satisfaction. Of course I am disappointed they didn't share their answers with me because I am now compelled to give my own solutions. In this edition I will only give my answer to "There are a set of chameleons, 13 red, 15 blue and 17 green. When two chameleons of different colours meet, they both change to the third colour (when two chameleons of the same colour meet, nothing happens). The question is, can they ever all become the same colour?" No; because

$$K = 1 + (\text{the number of blue chameleons}) - (\text{the number of red chameleons})$$

starts at 3 and always changes by a multiple of 3. If the chameleons all became a single colour, then K would have value either 46, -44 or 1 and none of these is a multiple of 3.

I will postpone the weighing problem till next time but I will give my interpretation of:

$$\frac{(90-C_1)(90-C_2)\cdots(90-C_n)}{2u}$$

I think it means "Complements of the Cs on 2 u"

J. C. Butcher (butcher@math.auckland.ac.nz)

CYBERMATH

Mathematicians want to, and need to, publish their research. Alternatives to traditional journal publication have been gaining ground: arXiv.org, blogs, Twitter, etc. There now exist companies that aim to measure the online impact of scientific work (such as Altmetric and ImpactStory). The Journal of Brief Ideas aims to "provide a place for short ideas to be described – in 200 words or less — for these ideas to be archived, searchable and citable." Despite this growth in non-traditional methods for research communication and assessment, and the example of Grigorii Perelman, traditional journals are still the main venue for publication. Which criteria should we use to decide where to submit our work?

Cost to readers is important. Over the last year I have attempted to use the Official Information Act to force NZ universities to disclose how much they pay Elsevier, Springer and other commercial publishers for journal subscriptions. All have refused because of non-disclosure agreements (which clearly play into the publishers' hands), and the matter is now in the hands of the Ombudsman's office, who have agreed to investigate. This follows similar efforts by Tim Gowers and others in UK and by Ted Bergstrom and Preston McAfee in various American states. It is clear enough that NZ universities pay tens of millions of dollars annually to these publishers, who strongly resist the idea of transparency in pricing, while having no incentive to maintain high quality at all but a handful of outlets and restricting access to readers. What are the alternatives to subscription journals?

The idea that scholarly publications ought to be freely readable by anyone with an internet connection, rather than restricted to those with the means to pay subscriptions, is very attractive for both authors and readers. So-called "gold" open access journals (funded by author fees) are unpopular with mathematicians, but are gaining ground in other, better funded, fields. There are obvious concerns about how money may distort the peer review process, for example in recently-opened scam "journals" which exist only to pocket author fees by exploiting the pressure felt by researchers to publish. However, most of these predatory journals are clearly identifiable. The running costs of journals are wildly overstated by commercial publishers, many of whom have been acquiring or starting gold journals in the last few years. For example, Springer and Elsevier apparently feel that $500-$1000 is a lower bound on an acceptable author charge. However, the journal PeerJ, backed by O'Reilly Media, offers $99 lifetime membership, allowing several submissions per year free of charge in return for some refereeing work. It has recently started a Computer Science section — might we see a mathematics section soon?

There are several "diamond" open access journals, which charge no direct fees to authors or readers. This is achieved either by substantial subsidy or by dedicated volunteer work. During 2012-2015 I was a managing editor of a journal of the latter type. The New York Journal of Mathematics is apparently the oldest such general journal. Combinatorics, probability and theoretical computer science are well served, by the likes of Electronic Journal of Combinatorics and Theory of Computing. The New Zealand Journal of Mathematics is also a diamond journal. A comprehensive list of open access journals of all flavours can be found at DOAJ.

Cost is not the only issue. In addition to traditional "reputation" based on exclusivity, the following issues influence quality of the journal: whether the publication is easily machine-readable, how robust is the plagiarism-checking, whether the peer review is carried out in a timely manner and according to strict ethical standards, how referees receive credit for their work, whether original data and computer code is easily available to readers, and whether the journal offers an easy forum for corrections and post-publication reviews and comments. However, finding unbiased information on these criteria is not so easy.

In particular, traditional peer review is opaque, and open to abuse. In recent years we have seen some amazing phenomena occur in traditional journals controlled by large commercial publishers: authors refereeing their own papers, authors blatantly plagiarising, editors repeatedly accepting papers within hours, journals publishing joke/gibberish papers. My brief experience as an editor shows that mathematics journals are not immune to corruption of this sort. The possibility of malfeasance by editors is not something mathematicians think about much, unlike some more politically charged fields. However, it surely happens (see Igor Pak's anecdote about Duke Math J.). The peer review process in mathematics has been studied much less than the process for experimental sciences. I am not aware of a detailed study. However some possibly disturbing information on the reliability of the mathematics literature as a result of rather sloppy peer review practices has been compiled. This looks like a great PhD topic for someone working in philosophy of science.

Even if you are a very traditionally-minded researcher, it costs very little and is mostly perfectly legal, while being very helpful to readers, to (a) put the final accepted author-formatted versions of papers on arXiv.org and/or your institutional repository, (b) negotiate hard over copyright with journals, and (c) include a link to the version in (a) in the abstract of the final published version.

Mark C. Wilson

PROFILE

Judy was born in 1948 on a farm in Zambia, going to boarding school and then moving with her family to South Africa. She completed her undergraduate degree and a Masters in Mathematics Education at Cape Town University, before taking a position at Leif College, a school for historically disadvantaged students in post–apartheid South Africa. She married Freddy Paterson and had three children, Katy, Marion and Jonny. Their lives were tragically disrupted when Freddy died in a cycling accident in 1993.

Encouraged by friends who had come to NZ, including Bill Williams (then the University of Auckland Director of Public Relations Office), Judy brought her children here to begin a new life in 1994. She quickly obtained a position at the new Senior College in downtown Auckland under Dawn Jones and John Graham. She and the children settled in Brown's Bay.

The Government demand for competition in teacher education led the Department of Mathematics to launch a pre–service secondary mathematics teacher programme. Judy was appointed to design and teach the programme in 1995. She subsequently ran an innovative programme, initiating a double-major mathematics/mathematics design (all other programmes required two separate major subjects). She made this so successful in turning out leading mathematics teachers that this design is now found nationwide.

Building on this success, Judy applied for funding for a development programme that took top secondary teachers in other subjects and, in a 1–year programme, transformed them into mathematics teachers. Such was the

success of this programme that all of the participants remain teaching, one decade later.

Judy enrolled for a PhD in mathematics education in 2004, exploring her hypothesis that teachers could be led to reconsider their pedagogy by inspiring them with new mathematics content learning. Not only did she prove the hypothesis, but she developed a theoretical model and provided evidence for the causal connections, using her data to identify necessary conditions for teachers to move from their own mathematical learning to thinking about their students as learners. Judy remains well–known by secondary mathematics teachers throughout the Auckland region, due to the programmes which she initiated to keep teachers in touch with the Department of Mathematics through public seminars and talks, workshops and research projects, and maintaining personal contacts. She will be remembered by them as the face of university mathematics for a long time to come.

From 2008 to 2010, Judy also worked under contract to the National Centre of Literacy and Numeracy for Adults (University of Waikato) on professional development for those in the foundation levels of the tertiary sector. Judy brought mathematical rigour, extensive experience with teaching and learning professional development, challenge, bluntness, fun, and her infectious laugh to this team and its work.

Judy's research career became focused on undergraduate mathematics education, an area in which she gained international recognition, particularly in the North American mathematics education community. She gained three major TLRI and Ako Aotearoa–funded research contracts: to explore ways to engage mathematicians in lecturing development; to adapt the model of Team–Based Learning to undergraduate mathematics; and to investigate the full spectrum of learning outcomes (not simply content and skills) that we expect of undergraduates in the mathematical sciences. These projects resulted in her significant publication record, and international invitations to speak and write.

The above factual account does not begin to describe Judy's personal qualities, nor explain the very special role that she played in the Mathematics Education Unit and the wider Department of Mathematics. Judy was a "people–connector" par excellence, being interested in what people were doing and listening to them deeply, particularly when they talked about teaching and learning experiences. Almost always the speaker would receive an e–mail shortly afterwards with her ideas, contacts they might like to use, or resources and references that related to the issue at hand. This knack of taking people seriously extended into personal relations, with the result that Judy was more than a colleague to all of us. She leaves a very large gap in our community, along with a reminder that the philosophical differences and varied approaches to the teaching of mathematics are a richness to be embraced, not a cause for division.

Judy Paterson died peacefully at home, surrounded by her children, on 24th February, 2015.

The Judy Paterson Scholarship was established in 2014 in recognition of the contribution made by Judy to Mathematics Education, and especially her work with secondary school mathematics teachers in the Auckland region. The main purpose of the Scholarship is to support graduate level professional development for a teacher from a decile 1 or 2 school in the wider Auckland region. It is funded by donations to the Mathematics Department General Fund.

The inaugural recipient is Siosiana Taukolo. Siosiana was born in Tonga and was educated at Queen Salote College. She came to NZ with her family in 2003 and continued her education at Birkenhead College. In 2005 Siosiana entered the University of Auckland Tertiary Foundation Certificate programme and subsequently enrolled in a BSc, majoring in mathematics and statistics, and graduated in 2009. A Teaching Diploma followed, after which she taught at Queen Salote College in Tonga, before returning to Auckland. She has been teaching at Otahuhu College since 2012.

Bill Barton

LOCAL NEWS

AUCKLAND UNIVERSITY OF TECHNOLOGY

SCHOOL OF COMPUTING AND MATHEMATICAL SCIENCES

On 27–28 November, the Mathematical Science Research Group (MSRG) successfully organised its inaugural symposium: The 2014 AUT Mathematical Sciences Symposium. This was jointly organised by Prof. Jiling Cao and Prof. Jeffrey Hunter, with the assistance of Dr Kate Lee, Dr Sarah Marshall and Dr Katharina Parry. The symposium attracted over 40 participants from New Zealand and overseas, with 32 talks including 8 invited plenary ones. Five "out of town" invited symposium speakers were funded from the MSRG Research Fund. 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 in these areas to collaborate with colleagues from other universities. It was an outstanding success with many favourable comments from the external participants. We are still exploring the possibility that the event can be continued on a regular basis.

Visitor

Dr Fucai Lin, from Minnan Normal University (China), started his visit at the School in March 2015. He has been awarded a scholarship by the Department of Education of Fujian Province. He will visit the School until September 2015 and work with Prof. Jiling Cao on a joint research project, "Mathematical methods for modern economic theory".

Graduation

Dr *Bing Huang* completed his PhD degree in Financial Mathematics in November 2014. Currently, he is working as a researcher at Parrot Analytics Ltd.

Travel and Conference Participation

Prof. *Jeffrey Hunter* presented a talk on "The accurate computation of key properties of Markov and semi-Markov Processes" in the invited special session on probability at the 8th Australia-New Zealand Mathematics Convention held at the University of Melbourne during 8–12 December 2014. He returned to Australia again in February where gave a talk on "A comparison of computational techniques of the key properties of Markov Chains" at the ANZIAM meeting held at the Outrigger Surfers Paradise over the period 1–5 February 2015. He is currently involved as the Chair of the International Organising Committee of the International Workshop on Matrices and Statistics to be held at Hainan Normal University, Haikou, Hainan, China over the period 25–28 May 2015.

Dr *Sarah Marshall* and Dr *Katharina Parry* attended the Joint Conference of the New Zealand Statistical Association and the Operations Research Society of New Zealand in Wellington from 23–26 November 2014. Both Sarah and Katharina presented talks at the conference.

Dr *Wenjun Zhang* was awarded an AUT contestable conference grant to present a research paper at the 8th International Conference on Applied Mathematics, Simulation, Modelling in Florence, Italy from 22–24 November 2014.

Wenjun Zhang

UNIVERSITY OF AUCKLAND

DEPARTMENT OF MATHEMATICS

Anna Barry, currently at the University of British Columbia, has accepted our offer of appointment to a lectureship in the Computational Mathematics Unit. She will take up her post in January 2016.

Marston Conder gave the opening lecture at a workshop on "Discrete Geometry and Symmetry" at the Banff International Research Station in February. In November 2014 the RSNZ awarded the Hector Medal "to Marston Conder for his outstanding contributions to mathematics both internationally and locally, particularly in the construction and analysis of discrete objects with maximum symmetry under given conditions".

Tanya Evans has been promoted to Professional Teaching Fellow, Level 4.

David Gauld's book on "Non-Metrisable Manifolds" was published in December 2014 by Springer. It is thought to be the first book published on that topic.

Vaughan Jones gave a series of 10 lectures on "An Introduction to von Neumann algebras", in February.

Dimitri Leemans received the 2014 NZMS Research Award "for his striking contributions to algebraic combinatorics that combine techniques from algebra, graph theory, combinatorics and number theory for the exploration and classification of highly symmetric geometric structures". It is the 4th successive award to members of our Department, and the 14th in total.

Wes Maciejewski has joined the Department as a lecturer attached to the Mathematics Education Unit during 2015. He obtained his PhD in 2012 from Queens

University, Ontario. He has published in both mathematics and education journals, and he has extensive lecturing experience.

Julia Novak has won a University Teaching Award (the first time for our Department), and she been promoted to Professional Teaching Fellow, Level 4.

Hinke Osinga has been selected as a Fellow of the Society for Industrial and Applied Mathematics, for her "contributions to theory and computational methods for dynamical systems". John Butcher is the only other New Zealand Fellow of that leading society.

Judy Paterson died on February 24 – an obituary article is published elsewhere in this *Newsletter*. Late in 2014 the Judy Paterson Scholarship was established in recognition of the contribution made by Judy to Mathematics Education, and especially her work with secondary school mathematics teachers in the Auckland region. The main purpose of the scholarship is to support graduate-level professional development for a teacher from a decile 1 or 2 school in the wider Auckland region. In January 2015 Judy began teaching a Summer School course, but after one week she became unwell and decided to retire. On January 29 she enjoyed greatly a celebration honouring her, which was attended by about 140 of her colleagues, friends and former students. Cheerful tributes to her were presented by James Sneyd, Brenda McNaughton, Sam McNaughton, Peter Radonich, Morgan Rangi, Jamie Sneddon, Vivien Kirk, Tanya Evans, Joel Laity, Arkadii Slinko and Bill Barton. Judy's happy thanks for that event was followed by the entire audience standing and applauding her. The first Judy Paterson Scholarship was awarded in March 2015, to Siosi'ana Taukolo.

Claire Postlethwaite has been promoted to Senior Lecturer, Level 6.

Tom ter Elst was an invited speaker at the International Workshop on Operator Theory and its Applications (IWOTA 2014) in Amsterdam, and an invited speaker at the AMSI/AustMS 2014 Workshop in Harmonic Analysis and its Applications at Maquarie University, both in July 2014. In January 2015 he was invited to the Oberwolfach workshop "Spectral Theory and Weyl Functions", and he was awarded a Simons Visiting Professorship.

Caroline Yoon has been appointed to fill the advertised position of Associate Professor of Mathematics Education. Congratulations to Caroline on this achievement, a reflection of her excellent international standing. The Science Faculty has now agreed to make two further appointments in Mathematics Education, one as Lecturer and one as Lecturer or Senior Lecturer – both positions have now been advertised.

Dr Endre Süli, Professor of Numerical Analysis at the Mathematical Institute of the University of Oxford, is the 2015 Forder Lecturer. He gave a seminar here on "Numerical approximation of non-divergence-form PDEs", and a Colloquium on "Finite-difference methods in the 21st century".

Tuan Chien passed his PhD oral examination for his thesis on "Equiangular lines, projective symmetries and nice error frames" (subject to minor corrections), and on the next day he started working as a mathematical consultant for a high-technology firm in Wellington. *Michael Lockyer* has passed his PhD oral examination (subject to minor corrections). *Jennifer Creaser* and *Andrew Keane* have each won a SIAM Student Travel Award to attend the SIAM Conference on Applications of Dynamical Systems (DS15), to be held on May 17–21, 2015, at the Snowbird Ski and Summer Resort in Snowbird, Utah, USA.

Visitors

Recent visitors include: Prof. Wolfgang Arendt (Universität Ulm), Dr Anna Barry (University of British Columbia), Dr Bindi Brook (University of Nottingham), Prof. Andreas Cap (Universität Wien), Prof. Alan Champneys (University of Bristol), Dr Heiko Dietrich (Monash University), Prof. Marcus du Sautoy (University of Oxford), Dr Ant Edwards (Swinburne University of Technology), Dr Piotr Faliszewski (AGH Institute of Technology, Krakow), Dr Joanna Fawcett (UWA), Prof. Gerhard Hiss (RWTH Aachen), Dr Matthew Jackson (Stanford University), Dr David Holgate (University of the Western Cape), Prof. Shih-Chang Huang (National Chang Kung University, Taiwan), Dr Marie Kray (Universität Basel), Dr Detlef Kuhl (Universität Kassel), Prof. Jaroslav Nešetřil (Charles University, Prague), Prof. Jean-Philippe Nicolas (University of Brest), Dr Eugenia O'Reilly Regueiro (UNAM, Mexico City), Dr Daniel Pellicer (UNAM, Mexico City), Dr Helmut Podhaisky (Martin Luther University of Halle-Wittenberg), Prof. Tim Rowland (University of East Anglia & University of Cambridge), Dr Manfred Sauter (Universität Ulm), Dr Jeroen Schillewaert (Imperial College), Prof. Martin Schneider (Institute of Algebra, Dresden), Dr Ivo Siekmann (University of Melbourne), Prof. Jozef Širáň (Open University & Slovak University of Technology, Bratislava), Dr Konstantin Sorokin (Higher School of Economics, Moscow), Dr Klara Stokes (University of Skövde, Sweden), Dr Nimrod Talmon (Technische Universität Berlin), Prof. Don Taylor (University of Sydney), Dr Katrin Tent (Universität Münster), Dr Christopher Voll (Universität Bielefeld), Dr Travis Willse (ANU), Dr Robert Wilson (Queen Mary University of London) and Dr Sara Zemljic (University of Iceland, Reykjavík).

Garry J. Tee

UNIVERSITY OF WAIKATO

DEPARTMENT OF MATHEMATICS

Reshma Ramadurai joined the department in January as a Research Fellow. Reshma completed her undergraduate degree in Computer Science and Engineering at the National Institute of Technology Calicut in India. This was followed by a MS in Mathematical Computer Science at the University of Illinois in Chicago. Her PhD studies in Algorithms, Combinatorics and Optimizations were carried out at Carnegie Mellon University in Pittsburgh.

Her main focus of research lies in Extremal Combinatorics, specifically in Ramsey-type and Turan-type problems arising in graphs and hypergraphs. Her expertise lies in using counting arguments and probabilistic tools to obtain results which yield improved bounds on parameters of interest, like Folkman numbers. In her previous postdoctoral position at the University of New South Wales in Sydney, she got interested in random graphs and proving contiguity results in the context of random regular hypergraphs. Her other passions include yoga, travel and meeting people, hiking, cooking, and reading. She did the Tongariro Alpine Crossing in early March and says she can't wait to go back there and do it all over again.

Our other Research Fellow *Frederic Effenberger* is leaving the department at the end of April to take up a research position at Stanford University. We wish him well in his new position.

The 2015 Forder Lecturer *Professor Endre Süli* has just completed his visit to the University of Waikato. He gave presentations titled "Finite difference methods in the 21st century" and "Discontinuous Galerkin finite element methods".

Stephen Joe

MASSEY UNIVERSITY

INSTITUTE FOR NATURAL AND MATHEMATICAL SCIENCES

Alexander (Sasha) Melnikov joins is joining the department as a new colleague. Alexander graduated from the Department of Mechanics and Mathematics, Novosibirsk State University, in 2006. In 2008 he completed an MSc in Mathematics and Theoretical Computer Science under the supervision of Sergey S. Goncharov, and in 2008, he moved to The University of Auckland to start a PhD program under the supervision of Bakhadyr Khoussainov and Andre Nies. He continued collaborating with Sergey S. Goncharov, a collaboration which resulted in several papers, and Sergey Savostjanovich suggested he write and submit a Candidate of Science dissertation based on these papers. As a consequence, he finished his PhD program with two dissertations, which intersect by one chapter only. Immediately after finishing his PhD program and before defending his PhD, he joined Guohua Wu and Keng Meng Ng at Nanyang Technological University as a postdoc. After one year in Singapore, he returned to New Zealand as a postdoc working with Rod Downey and Noam Greenberg at Victoria University of Wellington. This was followed by a postdoctoral fellowship at Berkeley.

Shaun Cooper

UNIVERSITY OF CANTERBURY

SCHOOL OF MATHEMATICS AND STATISTICS

Congratulations to *Chris Price* who has been promoted to Associate Professor and to *Mike Steel* on his promotion to Distinguished Professor. The status and title of Distinguished Professor is reserved for professors employed at the University of Canterbury who have clearly demonstrated world-class academic leadership and achievements of the highest international standing over a decade or more.

Mike is Director of the Biomathematics Research Centre and Deputy Director of the Allan Wilson Centre. His research involves the application of discrete mathematics and probability theory to contemporary problems in biology. He has carried out leading research in the area of phylogenetics, which is the science of reconstructing evolutionary trees and networks from genetic data. To underscore his standing Mike was awarded the Universitys Research Medal.

Congratulations to *Charles Semple* who has been awarded the College's Established Researcher Award and to *Maarten McKubre-Jordens* for his College of Engineering Early Career Teaching Award.

Congratulations to *Jennifer Brown* who was awarded life membership at the recent NZSA conference for her contributions to Statistics and to *Douglas Bridges* who was awarded the title of Emeritus Professor by the University Council in February.

At the end of the year we farewelled *Nuttanan (Nate) Wichitaksorn* who had been with us for two years as a statistics lecturer. Nate decided to return to Thailand because of family reasons. During his time in the School he collaborated on a variety of projects with colleagues within the School and other departments. Some of these collaborations will be ongoing while he is in Thailand and so a strong connection with UC will continue.

Best wishes to *Steve* and *Phillipa Gourdie* (formerly Williams) for a happy and fulfilled life together. Phillipa and Steve were married on 30 January – a celebration the happy couple generously shared with the School staff.

PhD students *Naeimeh Abi* (Statistics) and *Amir Malek* (Civil Engineering) planned to skype home their wedding for the benefit of their families in Iran. However, when the day arrived their internet connection failed, so they rushed into 'Abi's' office and married there – the Erskine Building's first wedding!

Fluids in New Zealand (FiNZ) 2015 was held in the School from 28–30 January. FiNZ was created in our School, and this third edition was organised by *Miguel Moyers Gonzalez* (Chair), Mathieu Sellier, Jim Denier, and *Phil Wilson*. Over 40 attendees from universities, crown research institutes, and industry enjoyed three plenary lectures and 27 contributed talks, which revealed the diversity and importance of research in fluid mechanics. A non-comprehensive list of talk topics is forensics, aquaculture, boat design, medical therapy, food processing, agriculture, ecology, coating, wind turbine design, neonatal intensive care, nanotechnology, lab-on-a-chip, computer chip cooling, semiconductor manufacture, and fundamental science. FiNZ aims to encourage discussion of work in progress, and the mentoring and training of young scientists. The lively discussions and roughly 2:1 ratio of students to established researchers at FiNZ 2015 fulfilled these aims. The organising committee gratefully acknowledges the support of the Australasian Fluid Mechanics Society, the UC School of Mathematics and Statistics, and UC Mechanical Engineering.

Douglas Bridges, who will be retiring in April, kept a busy schedule. He spent nearly 5 weeks in Stockholm in January–February, working with Erik Palmgren as part of the EU-NZ Marie Curie CORCON project. There he also continued with his monograph on Constructive Morse Set Theory. During the month of March he and *Maarten McKubre-Jordens* hosted Iosif Petrakis from the LMU Munich under the CORCON exchange initiative.

The Centre for Computable and Constructive Mathematics (CCCM) in the School of Mathematics and Statistics is part of a successful bid for a BIRS Programme Workshop in Oaxaca, Mexico. The conference on "Interval Analysis and Constructive Mathematics" will be held from 13–18 November 2016. The official organising committee comprises *Douglas Bridges*, Vladik Kreinovich (UT El Paso), Baker Kearfott (Louisiana), Patricia Melin (Tijuana), and Helmut Schwichtenberg (Munich). The main work on the proposal was done here by *Hannes Diener*, who did his usual fantastic job.

In early January the School welcomed Erskine Fellow Magnus Bordewich from the School of Engineering and Computing Sciences, Durham University, for a three-month stay in the School. His research interests are in discrete mathematics, theoretical computer science and applications in phylogenetics. Magnus was a Postdoctoral Fellow here in 2004 and returned for a three-month visit in 2009. He was teaching in MATH103 and working with Summer students on projects related to combinatorial and algorithmic phylogenetics. He was hosted by *Charles Semple*.

David Wall announced that he will be retiring in June, after 34 years at UC. David has been here longer than any of the current staff and has been instrumental in shaping the School, especially during his time as Head.

Remediation work in the Erskine building has finally come to a close just in time for the new teaching year. Surrounding fences and construction gear have been removed and we again have full access to all the rooms in the building. Construction and remediation work is still in full swing on campus and will be so for a few more years. As a consequence teaching spaces are in short supply, and classes are held all over Ilam campus or on Dovedale campus – a minor inconvenience compared to sharing our building with construction workers.

Günter Steinke

UNIVERSITY OF OTAGO

DEPARTMENT OF MATHEMATICS AND STATISTICS

Congratulations to *Fabien Montiel* and his wife Yuri on the arrival of their little baby girl Charlotte on 11 December. Yuri and the baby are doing well. Best wishes to the proud parents.

We bid farewell to *Yuki Fujita*, our Assistant Statistical Consultant, who left us in December. Yuki is going back to Wellington. We wish her all the best for her future!

At the 8th Australia–New Zealand Mathematics Convention in Melbourne in December, *Astrid an Huef* was named a Fellow of the NZMS and *Florian Beyer* has been elected to the Council of the NZMS for three years. Moreover, our PhD student *Ilija Tolich* received an honourable mention in the Aitken Prize competition. Congratulations, Astrid, Florian and Ilija.

With certainty, *Misi Kovács* has been appointed to the editorial board of the "Journal of Uncertainty Quantification", a new journal jointly published by the Society for Industrial and Applied Mathematics (SIAM) and the American Statistical Association (ASA). The journal focuses on the characterisations of the uncertainties in complex modelling of processes, as well as sensitivity analysis, model validation, model calibration, data assimilation and code verification.

David Bryant is among the fifteen leading University of Otago academics who have been promoted to full professorships in February. Moreover, *John Harraway* has been promoted to Associate Professor. This

is certainly well-earned and reflects David's and John's qualities as excellent researchers and teachers. Congratulations, David and John!

Rebecca Green has started her position as a Fixed Term Lecturer for a year and *Romain Garby* his position as an Assistant Research Fellow. Welcome, Rebecca and Romain.

Visitors

John Rossi (Virginia Tech, USA) visited for three weeks in February, hosted by *Peter Fenton*. John and Peter are working on Wiman-Valiron theory for subharmonic functions.

Balázs Tóth (University of Miskolc, Hungary) came here for six weeks to work with *Misi Kovács* on finite elements for thin shells.

Dominic Martignetti (Plymouth University, England) visited the Department for three weeks. Together with *John Harraway* he is developing free apps for training in official statistics to be used in national statistics offices, especially in developing countries. The apps will cover price changes, population comparisons and data visualisation.

We also had short-term visits by Klaus Thomsen (Aarhus University, Denmark) and Timothy Williams (Nansen Environmental and Remote Sensing Centre, Norway). Klaus works with *Astrid an Huef* and *Iain Raeburn* on KMS states of C^*-algebras, and Timothy is studying wave interactions with sea-ice with *Fabien Montiel*.

Jörg Hennig

Colleagues mentioned in Local News reports (left to right, top to bottom): Erik Schlögl, Tava Olsen, Jiling Cao, Fucai Lin, Alexander Melnikov, Steve and Philippa Gourdie, Mike Steel being presented with the Canterbury Research Medal, Reshma Ramadurai, and Miguel Moyers Gonzalez.


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NERD

ABSTRACTS OF NZ PHD THESES

Mohammed Daher, Victoria University of Wellington

Supervisor: Peter Donelan

Date: 2013

Title: **Dual Numbers and Invariant Theory of the Euclidean Group with Applications to Robotics**

In this thesis we study the special Euclidean group SE(3) from two points of view, algebraic and geometric. From the algebraic point of view we introduce a dualisation procedure for $SO(3;\mathbb{R})$ invariants and obtain vector invariants of the adjoint action of $SE(3)$ acting on multiple screws. In the case of three screws there are 14 basic vector invariants related by two basic syzygies. Moreover, we prove that any invariant of the same group under the same action can be expressed as a rational function evaluated on those 14 vector invariants. From the geometric point of view, we study the Denavit-Hartenberg parameters used in robotics, and calculate formulae for link lengths and offsets in terms of vector invariants of the adjoint action of SE(3). Moreover, we obtain a geometrical duality between the offsets and the link lengths, where the geometrical dual of an offset is a link length and vice versa.

Michael Snook, Victoria University of Wellington

Supervisor: Dillon Mayhew

Date: 2013

Title: **Matroids, Complexity and Computation**

The node deletion problem on graphs is: given a graph and integer k, can we delete no more than k vertices to obtain a graph that satisfies some property π. Yannakakis showed that this problem is NP-complete for an infinite family of well-defined properties. The edge deletion problem and matroid deletion problem are similar problems where given a graph or matroid respectively, we are asked if we can delete no more than k edges/elements to obtain a graph/matroid that satisfies a property π. We show that these problems are NP-hard for similar well-defined infinite families of properties.

In 1991 Vertigan showed that it is #P-complete to count the number of bases of a representable matroid over any fixed field. However no publication has been produced. We consider this problem and show that it is #P-complete to count the number of bases of matroids representable over any infinite fixed field or finite fields of a fixed characteristic.

There are many different ways of describing a matroid. Not all of these are polynomially equivalent. That is, given one description of a matroid, we cannot create another description for the same matroid in time polynomial in the size of the first description. Due to this, the complexity of matroid problems can vary greatly depending on the method of description used. Given one description a problem might be in P while another description gives an NP-complete problem. Based on these interactions between descriptions, we create and study the hierarchy of all matroid descriptions and generalize this to all descriptions of countable objects.

Valentina Baccetti, Victoria University of Wellington

Supervisor: Matt Visser

Date: 2014

Title: **Phenomena at the border between quantum physics and general relativity**

In this thesis we shall present a collection of research results about phenomena that lie at the interface between quantum physics and general relativity. The motivation behind our research work is to find alternative ways to tackle the problem of a quantum theory of/for gravitation.

In the general introduction, we shall briefly recall some of the characteristics of the well-established approaches to this problem that have been developed since the beginning of the middle of the last century. Afterward we shall illustrate why one would like to engage in alternative paths to better understand the problem of a quantum theory of/for gravitation, and the extent to which they will be able to shed some light into this problem. In the first part of the thesis, we shall focus on formulating physics without Lorentz invariance. In the introduction to this part we shall describe the motivations that are behind such a possible choice, such as the possibility that the physics at energies near Planck regime may violate Lorentz symmetry. In the following part we shall first consider

a minimalist way of breaking Lorentz invariance by renouncing the relativity principle, that corresponds to the introduction of a preferred frame, the aether frame. In this case we shall look at the transformations between a generic inertial frame and the aether frame still requiring the transformations to be linear. The second step is to establish the transformations for the energy and momentum in order to define some dynamics and design possible experiments to test such assumptions. As an application we shall present two compelling models that minimally break Lorentz invariance, the first one only in the energy-momentum sector, the second one in the transformation between inertial frames. Following along the line of physics without Lorentz invariance, we shall next explore some threshold theorems in both scattering and decay processes by considering only the existence of some energy momentum relation $E(p)$, without making any further assumption. We shall see that quite a lot can be said and that 3-momenta can behave in a complicated and counter-intuitive manner.

In the second part of the thesis we shall address the thermodynamics of space-time and the important role played by entropy. In the introduction we shall outline the idea of induced gravity, which is the motivation behind this possible interpretation of general relativity as a mean field theory of some underlying microscopic degrees of freedom. In the next chapter we shall partially review Jacobson's thermodynamic derivation of the Einstein equations and generalise it to a generic bifurcate null surface. The interesting result we shall see is that, given the construction of the thermodynamic system via some virtual constantly accelerating observers, we can assign a "virtual" definition of Clausius entropy to essentially arbitrary causal horizons. To conclude this part we shall present some of the mathematical properties of entropy. In particular we shall focus on the simpler case of single-channel Shannon entropy and study under which conditions it is infinite, even though the probability distribution is normalisable. In the last part, we shall describe a proposal for a space-base experiment to test the effects of acceleration and gravity of quantum physics. In principle, the results of such an experiment could shed some light on fundamental questions about the overlap of quantum theory and general relativity; at the same time, they may enable experimentalists interested to implement quantum communication into space based technology, to correct adverse gravitational effects.

We conclude with a brief discussion of lessons learned from these different approaches.

Michael Welsh, Victoria University of Wellington

Supervisor: Dillon Mayhew

Date: 2014

Title: **On Maximum-Sized Golden-Mean Matroids**

A rank-r simple matroid is maximum-sized in a class if it has the largest number of elements out of all simple rank-r matroids in that class. Maximum-sized matroids have been classified for various classes of matroids: regular (Heller, 1957); dyadic (Kung and Oxley, 1988–90); k-regular (Semple, 1998); near-regular and sixth-root-of-unity (Oxley, Vertigan, and Whittle, 1998).

Golden-mean matroids are matroids that are representable over the golden-mean partial field. Equivalently, a golden-mean matroid is a matroid that is representable over GF(4) and GF(5). Archer conjectured that there are three families of maximum-sized golden-mean matroids. This means that a proof of Archers conjecture is likely to be significantly more complex than the proofs of existing maximum-sized characterisations, as they all have only one family.

In this thesis, we consider the four following subclasses of golden-mean matroids: those that are lifts of regular matroids, those that are lifts of nearregular matroids, those that are golden-mean-graphic, and those that have a spanning clique. We close each of these classes under minors, and prove that Archers conjecture holds in each of them. It is anticipated that the last of our theorems will lead to a proof of Archers conjecture for golden-mean matroids of sufficiently high rank.

Adam D Ward, Massey University, Albany

Supervisor: Gaven Martin

Date: September 2014

Title: **On Essential Self-adjointness, Confining Potentials & the L_p-Hardy Inequality**

Let Ω be a domain in $\mathbb{R}^m$ with non-empty boundary and let $H = -\Delta + V$ be a Schrödinger operator defined on $C_0^\infty(\Omega)$ where $V \in L^\infty_{loc}(\Omega)$. We seek minimal criteria on the potential V that ensures H is essentially self-adjoint, i.e. the closed operator $\bar{H}$ is self-adjoint. We overcome various technical problems to extend results of Nenciu &

Nenciu to more general domains, e.g. unbounded domains and domains with fractal boundary. A special case of our abstract condition shows that H is essentially self-adjoint provided that near the boundary

$$V(x) \geq \frac{1}{d(x)^2}\left[1 - \mu_2(\Omega) - \frac{1}{\ln(d(x)^{-1})} - \frac{1}{\ln(d(x)^{-1})\ln\ln(d(x)^{-1})} - \cdots\right],$$

where $d(x) = \mathrm{dist}(x, \partial\Omega)$ and the inequality contains a finite number of logarithmic terms. The constant $\mu_2(\Omega)$ is the variational constant associated with the L_2-Hardy inequality. Our results indicate that the existence of an L_2-Hardy inequality, and the specific value of $\mu_2(\Omega)$, depend intimately on the Hausdorff/Aikawa dimension of the boundary. In certain cases where Ω is geometrically simple, this constant, as well as the constant '1' appearing in front of each logarithmic term is shown to be optimal with regards to the essential self-adjointness of H.

REPORTS ON EVENTS

Grant recipient reports

At the end of January 2015 I attended the Mathematics in Industry Study Group hosted at the Queensland University of Technology, Brisbane. This is a five day workshop to solve problems put forward by industry partners in Australia and New Zealand. Industry presentations were on the first day, where each of the six problems was explained by company representatives. The mathematicians then broke into groups to discuss possible approaches. I joined the group working for SunWater, looking at what happens inside large water pipelines when a pump trips and causes a phenomenon known as water hammer. On the third day I switched groups and helped to tackle the problem of wind loading on a large mesh door for Centor. There were several sub-groups taking different approaches; I worked with Emma Greenbank (Victoria University) and Andrea Babylon (Massey University) to calculate the net pressure on the screen door with different wind configurations. This information was then fed into some of the computer simulations devised by others.

One thing which I enjoyed about the MISG was seeing how other people worked to tackle the problems. It gave me a good taste of collaborative research. Having only just completed my Honours I was the most junior attendee, but still found that I was able to contribute.

Following the MISG I also attended the ANZIAM conference held at Surfers Paradise. This was my first large conference and it was wonderful to be exposed to so many different ideas. I gave a presentation about my Honours project on temperature analysis of geothermal features in New Zealand's Taupo Volcanic Zone.

Thanks to the New Zealand Mathematical Society, the New Zealand branch of ANZIAM, and the CSIRO-ANZIAM student support scheme for financial assistance to attend the MISG and ANZIAM conference.

Heather Davidson

With the generous help of the New Zealand Mathematical Society travel grant, I was able to travel to Brisbane to attend the Mathematics in Industry Study Group in January this year. MISG was an excellent opportunity to work with experienced mathematicians to solve some real problems that are faced in industry. During the 5 days at the study group I worked on the Centor problem and as a result learned a lot about wind pressures on building structures. I believe the experience also give me an insight in the different ways to approach real industry problems that can help me in the future. I would once again like to thank NZMS for the opportunity to attend this workshop.

Emma Greenbank

Having never had attended an MISG before, I was quite nervous in the lead up to the workshop, however, I found it to be a very friendly environment.

The workshop had six different problems to choose from. Picking just one problem was quite difficult, but I ended up working on the Centor problem, as I felt it was the one I would be able to contribute the most to.

We had two very helpful and enthusiastic mediators, Dr Cameron Hall and Dr Mathew Mason, who divided us into groups, to work on different aspects of the problem. The team I worked with had the job of finding the net wind load on a screen door, taking into account different building orientations and wind conditions. Working in a team was a new experience for me, one which I thankfully found most enjoyable. I feel I learnt a lot about collaborating and team work, a skill which I am sure will prove to be helpful in the future!

MISG was an exciting and challenging new learning experience for me, one which I would highly recommend to anyone who has not attended before. I would love to attend MISG next year and am looking forward to our local New Zealand based one (MINZ) later this year.

Andrea Babylon

On December 8–12 2014 I attended the 8th ANZMC which was hosted by Melbourne University. I gave an oral presentation about some of the more recent results I have obtained during my PhD. The title of my presentation was "Analytical expressions for infection path probabilities of an SIR model on small networks". In this presentation I explained the various routes an infection can take when spreading through small networks which are representative of small communities or households. I also presented a poster which was based on some of the earlier work I did. The poster was titled "SIR Epidemics on Small Networks" and focused on finding the final size of an epidemic (the total number of individuals who were infected at some point during the epidemic) under different initial conditions.

One of the plenary presentations was titled "Burning Problems" by Professor John Hearne and involved solving optimisation problems for the best way to use emergency services in order to control bushfires efficiently and effectively. I spent most of my time in the mathematical biology stream which had a strong focus on infectious disease epidemiology. Some of the research questions being addressed in this area included how to incorporate differences in susceptibility and infectivity (i.e., are some individuals more or less susceptible or infectious than others) when modelling an epidemic. Finding the final epidemic size of an outbreak was a key focus point of multiple talks including my own; this was especially interesting for me to see how others are approaching the topic. Andrew Black focused on how to find the distribution for the final epidemic size from a stochastic model and presented a fast algorithm to do this which is much more efficient than previous algorithms.

I met and had a discussion with Professor Lewi Stone who is now based at RMIT University. Lewi has done some research on modelling the spread of infections on networks. I studied a couple of his papers earlier in my PhD so it was interesting being able to hear his point of view. Lewi is particularly interested in how clustering affects the spread of an infection through large networks. I also took this opportunity to catch up with colleagues who I had met prior to ANZMC8 including my old honours supervisor, Dr Stephen Davis, who is also in the infectious disease modelling and network analysis research fields, and Dr Roslyn Hickson who I have had a few discussions with over the past year about my research.

One professional highlight of the trip for me was being awarded an honorary mention for the Aitken Prize for the best presentation by a NZ student. Since beginning my PhD in 2012 my presentation skills have improved a great deal and getting an honorary mention was exciting for me. I always enjoy attending combined Australian and NZ conferences because it gives me the opportunity to see what other people in infectious disease modelling are working on and allows me to keep up connections with people who may be future collaborators.

I would like to sincerely thank the NZMS for their generous support which allowed me to attend the 8th ANZMC in December 2014.

Karen McCulloch

As I am sure many of the other students attending would agree, I found the early career workshop (ECW) incredibly beneficial. Part of the material covered the importance of outreach and being involved in your community. What I found most valuable were the talks about future employment opportunities and job seeking tactics. The career advice was helpful and I found that the workshop both encouraged and motivated me.

At the women in mathematics dinner, I had the pleasure of sitting next to Prof. John Hearne and discussing his research. He gave a most enjoyable plenary talk later in the week on bush fires. The questions and answers session after the dinner, particularly the question asked by Prof. Robert McKibbin about women in industry, was both interesting and insightful.

At ANZMC8, I presented both a talk and a poster. My talk was on modelling leptospirosis in wildlife and livestock and received a good amount of interest. During my talk, I compared leptospirosis between Australia and New Zealand, as well as comparing leptospirosis with Ebola, to make it relevant for the audience and current climate. I found the poster session particularly helpful. Being able to explain my work one-on-one, allowed the audience to ask more questions and make comments more freely. There was plenty of discussion on points that I had not thought about

For the most part, I attended the mathematical biology stream, which covered a broad range of topics, including some very interesting health problems. The mathematics of both cells and epidemics was a very popular topic. Prof. Kerry Landman gave a very engaging talk about modelling the movement of cells. She covered some of the problems arising in existing models and presented an alternative model which included a stochastic aspect, taking into account the more global nature of biological cell systems.

Thank you very much to NZMS for helping me get to both ECW and ANZMC8.

Andrea Babylon

NZMS NOTICES

40th Annual General Meeting of the NZMS

University of Melbourne, 9th December 2014.

Present: Astrid an Huef, Christopher Atkin, Andrea Babylon, Alona Ben-Tal, Florian Beyer, John Butcher, Brendan Creutz, Cain Edie-Michell, David Gauld, Jesse Goodman, Emily Harvey (minutes), Jörg Hennig, Stephen Joe, Vivien Kirk, Igor Klep, Karen McCulloch, Mark McGuinness, Robert McKibbin, Maarten McKubre-Jordens, Rua Murray, Hinke Osinga, Vladimir Pestov, Iain Raeburn, Mick Roberts, Harish Sankaranarayanan, Tim Stokes, Winston Sweatman (chair), Tom ter Elst, Ilija Tolich, Timm Treskatis, Chris Tuffley, Matt Wilkins.

Apologies: Boris Baeumer, Marston Conder, Shaun Cooper, Luke Fullard, Rod Gover, Carlo Laing, Dion O'Neale, Krishna Raghuwaiya, Bruce van Brunt, Graeme Wake.

Meeting opened 4:05pm.

1. Minutes of the 39th Annual General Meeting were accepted with spelling corrections (Winston Sweatman/Mark McGuinness, passed).

2. Matters Arising. None

3. President's report. Winston Sweatman read his report (as tabled). The President's report was accepted (Winston Sweatman/Astrid an Huef, passed).

4. Treasurer's report. Mark McGuinness spoke about his report (as tabled). The use of the phrase "qualified opinion" instead of the usual "unqualified opinion" in the auditor's report was noted. This was explained by the lack of sufficient evidence of the membership fees breakdown, due to the short time available. The importance of NZMS's charitable activity for the maintenance of charitable society status was discussed, including the math Olympiad and student grants. The Treasurer's report was accepted (Mark McGuinness/Maarten McKubre-Jordens, passed).

5. Appointment of auditors. The current auditor, Nirmala Nath from the School of Accountancy, Massey University, is to be re-appointed as Auditor. (Mark McGuinness/Winston Sweatman, passed).

6. Membership secretary's report. Was presented (as tabled) by Winston Sweatman. John Shanks will stay on as membership secretary. The meeting would like to thank John Shanks for his contribution and long service.

7. Election of councillors

   (a) Tom ter Elst and Graham Weir are departing from the council; the Society thanks them for their service.

   (b) Astrid an Huef was nominated as incoming vice-president (Robert McLachlan/Bruce van Brunt) and was elected.

   (c) There were five nominations for Council: Florian Beyer (Astrid an Huef/Boris Baeumer), Noam Greenberg (Mark McGuinness/ Rod Downey), Igor Klep (Tom ter Elst/Marston Conder), Rua Murray (Charles Semple/Stephen Joe), Bruce van Brunt (Mark McGuinness/Robert McKibbin). McKubre-Jordens and David Gauld acted as returning officers. Florian Beyer, Rua Murray, and Bruce van Brunt were elected.

8. Report of 2013 Colloquium was presented (as tabled). Tim Stokes reported that the 2013 Colloquium was a success and that the small surplus has been returned to the Society. Rua Murray requested a breakdown of Trinity Wharf costs.

9. Report of 2014 Colloquium. Astrid an Huef thanked Paul Norbury for his work organising the conference, with over 500 attendees. Suggestions for future colloquia organisation: publish the closing time on the final day as early as possible for people booking flights. Poster session: there are guidelines to help in the organisation of these.

10. Forthcoming colloquia. The 2015 Colloquium will be held in Christchurch by the University of Canterbury on the UC campus. Preliminary dates: December 1–3, with opening events on the afternoon/evening of the 30 November. Aim to have speakers decided by a joint speakers committee between UC and NZMS council, by April 2015. Possible venues for 2016 and 2017 meetings are Victoria and Auckland.

11. Report on NZ Journal of Mathematics. David Gauld reported that the back issues are all online and open access, but are only hosted on the University of Auckland intranet. Progress is being made towards hosting them on the Society's website as well. A vote of thanks to David Gauld for his work on the Journal was passed (Winston Sweatman/Mark McGuinness, passed).

12. Update on Forder, Aitken, and Maclaurin lecturers. As in President's report.

13. General business. Hinke Osinga noted that she had really enjoyed the interesting research talks from prize-winners at the opening of the ANZMC8. There was discussion around potential options for opening events, and the organisers will think about ways to make the opening of the NZMS colloquia more stimulating in future meetings.

Meeting closed 5:02pm.

President's report 2014

This year we celebrate forty years of the New Zealand Mathematical Society, which was established in 1974. I have the good fortune to be the twenty-fourth person to be President of the New Zealand Mathematical Society. We owe a debt of gratitude to the people from those earlier days, who founded our society. The NZMS has contributed much to the mathematical life of New Zealand over the years.

Membership

We welcome new members. The current total membership is 245. A decrease from last year's value is largely due to changes in the numbers of student memberships and is discussed in the Membership Secretary's report. Supervisors are urged to explain the benefits of NZMS membership to their students and to encourage them to join and remain members. Can all members, student or non-student, please tell new recruits to their departments about the NZMS.

I would like to record my gratitude to John Shanks. He continues in his long and distinguished service as our Membership Secretary.

Activities

We have awarded travel grants to Rosalie Hoskings, Peter Langfield, Jennifer Creaser, Andrea Babylon, Aidin Jalilzadeh, Karen McCulloch, Matt Wilkins, Emma Greenbank, Shishay Gebregiyorgis, Ali Zaidi, Harish Sankaranarayanan, Heather Davidson, Andrew Keane. An important event during the year is the New Zealand Mathematics Convention (ANZMC 2014). The Gloria Olive Travel Award and Fellows Fund (proceeds from Fellowships applications) were put towards supporting students to participate in this conference presenting their work in posters and talks.

We provided grants in support of the ANZIAM 2014 conference in Rotorua, the New Zealand Mathematics and Statistics Postgraduate Conference, the 38th Australasian Conference on Combinatorial Mathematics and Combinatorial Computing and the Melbourne Early Career Workshop attached to ANZMC 2014.

The 2014 Forder Lecturer will be Endre Süli of the University of Oxford. His tour will take place over March and April 2015. The reciprocal Aitken Lecturer will be Steven Galbraith of the University of Auckland who will be going the UK in their (northern) Autumn 2015. James Sneyd, of the University of Auckland, is the Maclaurin Lecturer and toured the US in October and November 2014. In the reciprocal direction, Ingrid Daubechies of Duke University has accepted the 2015 Maclaurin Lectureship to tour New Zealand.

I am very grateful to Tom ter Elst who volunteered to be coordinator of the 2015 Lecture Tours of New Zealand.

The NZMS now has a Women in Mathematics page on its internet site. I am grateful for Emily Harvey for assembling this page. Efforts are being made both in New Zealand and internationally to increase awareness of and to address the issues, and the NZMS must continue contributing.

The NZMS newsletter continues to flourish in its electronic form. I am grateful to Mark Wilson who as editor continues to seek improvements as well as running the newsletter.

I am grateful to David Gauld and the NZJM Committee. The New Zealand Journal of Mathematics continues publication online and the process is underway to make back issues available. In his report, David describes the exciting establishment of the Kalman prize. NZMS members are encouraged to support the journal.

NZMS Awards

The NZMS Research Award winner for 2014 is Dimitri Leemans of the University of Auckland "for his striking contributions to algebraic combinatorics that combine techniques from algebra, graph theory, combinatorics and number theory for the exploration and classification of highly symmetric geometric structures".

The NZMS Early Career Award winner for 2014 is David Simpson of Massey University (Palmerston North) "for his contributions to the analysis of the effects of randomness and uncertainties in nonsmooth dynamical systems".

The 2014 Aitken Prize for the best spoken presentation by a student at the NZMS Colloquium goes to Timm Treskatis of the University of Canterbury for his talk "Accelerated gradient vs. primal-dual methods in nonsmooth optimisation".

The 2014 ANZIAM poster prize for the best poster by an early career researcher at the NZMS Colloquium goes to Andrea Babylon of Massey University (Albany) for her poster "Modelling Leptospirosis in Livestock".

The following new Fellows of the New Zealand Mathematical Society were announced at the 2014 NZMS Colloquium Dinner: Astrid an Huef, Gaven Martin, Graham Weir and Sir Vaughan Jones.

Other Awards and Honours

In May, Gaven Martin was elected Vice President of the Royal Society of New Zealand.

In Korea in August, Sir Vaughan Jones was elected Vice-President of the International Mathematical Union. Hinke Osinga was an Invited Speaker at the International Congress of Mathematicians.

In October, Iain Raeburn of University of Otago was elected a Fellow of the Royal Society of New Zealand.

In November, Geoff Whittle was awarded a James Cook Fellowship for his research project "Rota's Conjecture".

At the RSNZ Research Honours Dinner, two former presidents of the NZMS received medals. Both them have made huge contributions to the NZMS and New Zealand Mathematical Sciences Community.

Our founding president David Vere-Jones of Victoria University of Wellington was awarded the Jones medal "to recognise his lifetime achievement in statistics, both for his revolutionary research on modelling earthquakes and his teaching of statistics and mathematics in New Zealand". The medal selection panel said: "During his long and distinguished career, he has made outstanding and fundamental research contributions in probability, statistics and the mathematical sciences in general."

Marston Conder of the University of Auckland has been awarded the Hector medal "for his outstanding contributions to mathematics both internationally and locally, particularly in the construction and analysis of discrete objects with maximum symmetry under given conditions." The medal panel noted that "over the last 30 years, Professor Conder's leadership and service in the New Zealand mathematical sciences community have been exemplary."

The Butcher-Kalman Invited Speaker

The NZMS gratefully received donations from the Margaret and John Kalman Charitable Trust and from the Mathematical Chronicle Funds. The money is to encourage younger members of the New Zealand mathematical community and will be used to fund a speaker at the NZMS Colloquium. The speaker will be named the Butcher-Kalman Invited Speaker and will be a New Zealand resident mathematician who is within ten years of completion of her/his doctoral degree. The first Butcher-Kalman speaker will be at the 2015 NZMS Colloquium.

Acknowledgements

I am grateful to the organisers of this year's Australia New Zealand Mathematics Convention (ANZMC 2014) and Astrid an Huef for being the NZMS Council representative in the organisation.

There are many people who contribute to the running and life of the NZMS. I am grateful to them all. I thank Council for their efforts. In particular, I thank Emily Harvey who took over as Secretary this year, Mark McGuinness who is stepping down having been Treasurer for two years, Tom ter Elst who steps down after six years on Council, and Graham Weir who leaves after seven years on Council including his presidency and has given me much valuable advice in my first year as NZMS President.

Winston Sweatman

Call for nominations for the 2015 NZMS Research Award

The annual NZMS Research Award was instituted in 1990 to foster mathematical research in New Zealand and to recognise excellence in research carried out by New Zealand mathematicians. This award is based on mathematical research published in books or recognised journals in the last five calendar years: 20092013. Candidates must have been residents of New Zealand for the last three years.

Nominations and applications should include the following:

- Name and affiliation of candidate.
- Statement of general area of research.
- A list of books and/or research articles published within the last five calendar years: 20102014.
- An electronic copy (pdf) of the each of the five most significant publications selected from the list above.
- A clear statement of how much of any joint work is due to the candidate.
- A Citation, of at most 40 words, summarising the mathematical research underlying the application.
- Names of two persons willing to act as referees.

A judging panel shall be appointed by the NZMS Council. No person shall receive the award more than once. The award consists of a certificate including an appropriate citation of the awardee's work, and will be announced and presented (if at all possible) at the New Zealand Mathematics Colloquium Dinner in 2015 which this year will be at the University of Canterbury in December.

All nominations and applications should be sent by 31 July 2015 to the NZMS President Winston Sweatman. Submissions should be made by email to w.sweatman@massey.ac.nz, stating clearly that they are for the NZMS Research Award.

Call for nominations for the 2014 NZMS Early Career Award

This award was instituted in 2006 for early career New Zealand mathematicians. Criteria for eligibility are the same as for the Marsden fast start grants. Essentially, this means that applicants must be within seven years of confirmation of PhD with an allowance made for extenuating circumstances. The candidate will be judged on their three best papers and a two-page CV. The papers should be published or in press. In cases of joint authorship, a clear statement of the mathematical contribution of the candidate should be made. The candidate will have completed a significant part of their research within NZ. They would also normally be expected to be a member of the NZMS. Candidates will also provide a Citation, of at most 40 words, summarising the mathematical research underlying the application. It is recommended that self-applicants approach a colleague to write this Citation.

A judging panel shall be appointed by the NZMS Council. No person shall receive the award more than once. The award consists of a certificate including an appropriate citation of the awardees work, and will be announced and presented (if at all possible) at the New Zealand Mathematics Colloquium Dinner in 2015 which this year will be at the University of Canterbury in December.

All nominations and applications should be sent by 31 July 2015 to the NZMS President Winston Sweatman. Submissions should be made by email to w.sweatman@massey.ac.nz, stating clearly that they are for the NZMS Early Career Award.

Reminder about financial assistance

The NZMS invites applications for Student Travel Grants from students to support them presenting their research at conferences, attending workshops, and developing new collaborations.

http://nzmathsoc.org.nz/downloads/applications/NZMS_StudentTravelGrantApplication_2015.pdf

Applications from students who require financial assistance in order to attend the New Zealand Mathematics and Statistics Postgraduate (NZMASP15) conference, Taupo 17–20 November 2015, or the New Zealand Mathematical Society Colloquium (NZMC15), Christchurch 1–3 December 2015, must be received before the deadline of Tuesday, 2 June 2015.

Members of the NZMS may apply for financial assistance with the costs of hosting mathematical visitors, organising conferences or workshops, attending conferences, and any other mathematical research-related activity.

http://nzmathsoc.org.nz/downloads/applications/NZMS_FundingApplication_2015.pdf

Notice for the New Zealand Mathematics and Statistics Postgraduate Conference 2015 (NZMASP15)

NZMASP is a conference for Honours, Masters, and PhD students studying mathematics and statistics in New Zealand, and provides a good environment for students to exchange ideas, to network, and also an opportunity to practice presenting their research. We encourage postgraduate students across New Zealand to attend and present a short talk.

NZMASP15 is hosted by the University of Waikato and will be held at the Suncourt Hotel and Conference Centre in Lake Taupo from the 17th to the 20th November. Accommodation and lunches are provided for, as well as a conference dinner.

The Facebook group "NZMASP15" is online now. The official website will be up and running soon and registrations will be opened in July. For more details, please contact the organisers at nzmasp15@waikato.ac.nz.

Fellowships

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. I would encourage members to consider applying and to encourage and nominate their colleagues who meet the criteria. Some people are unsure what is involved. There is even an anecdote of a member wondering whether they had sufficient credentials when they had won the NZMS Research Award, been a former NZMS President and been elected FRSNZ. Any one of these would have been sufficient to meet the third criterion below.

Here are the complete criteria, all three 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, and 3.3 or 3.4 or 3.5:
   - 3.1. Have demonstrated a high level of attainment in mathematics;
   - 3.2. Have demonstrated a high level of responsibility in mathematics;
   - 3.3. Have made a substantial contribution to mathematics;
   - 3.4. Have made a substantial contribution to the profession of mathematician;
   - 3.5. Have made a substantial contribution to the teaching or application of mathematics.

Honorary Members have the right to become a Fellow immediately upon application to the Council and without payment of a fee.

At present, members' applications are encouraged before 1 June 2015. Full details and the application form are on the NZMS internet site http://nzmathsoc.org.nz/?accreditation.

Proceeds from fellowship applications will be put into a Fellows Fund.

GENERAL NOTICES

Maths-for-Industry NZ event

Are you interested in solving thought-provoking and industry relevant challenges through mathematics? We are looking for more mathematicians, academics and students keen to meet today's business challenges head-on.

Join an assembly of New Zealand's and Australia's brightest maths minds on 29th June–3rd July, Massey University Auckland to work on solving complex questions. Attendance is free for participating mathematicians, together with all other mathematical scientists, and subsidies are expected for postgraduate students to attend. Teachers of mathematics are welcome as well.

A number of NZ businesses, including Compac Sorting, will be involved and are now identifying the challenges they need solved. Up to six core business problems will be presented to participating mathematicians by businesses.

In these workshops, Industrial organisations present problems from their own context, and then subgroups are formed to develop solutions during the week, culminating in a review session on the final day. A plenary address will be given by a leading international industrial mathematical scientist. Publication of reports is encouraged for the ANZIAM Journal of Applied Mathematics (Series E).

The newly formed Mathematics-in-Industry New Zealand (MINZ) is running the event, led by Australian and New Zealand Industrial and Applied Mathematics Group (ANZIAM) and Kiwi Innovation Network (KiwiNet), and is supported by Centre for Mathematics-in-Industry Massey University, AUT Mathematical Sciences Group, Te Pūnaha Matatini (the Complex Systems Centre) and Callaghan Innovation.

In recent years staff, students and industry representatives from New Zealand have participated in the ANZIAM-led Mathematics in Industry Study Groups largely held in Australia. It has been 9 years since an event like this has been held in New Zealand, so we welcome its return to our shores.

These events are often the launch pad for long term partnerships between mathematicians and businesses, powering up innovation within industry. Opportunities for future ongoing collaborations exist and some internships for postgraduates are likely to be available. The MINZ event includes a social dinner – an ideal opportunity for you to network with industry representatives and colleagues.

See the website http://www.minz.org.nz for more details, and register your involvement by 1st June.

When:	29th June to 3rd July, 2015
Where:	Massey University Auckland
Cost:	Free to mathematicians and PhD students (including morning and afternoon teas, lunches and a workshop dinner).
Register:	By Monday 1st June, 2015 at http://www.minz.org.nz.

For more information contact us:

Professor Emeritus Graeme Wake
Massey University
Phone +64 (0) 9 414 0800 ext 43602
Email: G.C.Wake@massey.ac.nz

Seumas McCroskery at KiwiNet
Mob: +64 21 617 752
Email: seumas@kiwinet.org.nz

Kalman Prize

The editors and committee of the New Zealand Journal of Mathematics are pleased to announce that Dr Cédric Bonnafé and his paper "*Semicontinuity properties of Kazhdan-Lusztig cells*. New Zealand J. Math. 39 (2009), 171–192" received the inaugural Kalman Prize for the best paper published in the past 5 years in the New Zealand Journal of Mathematics.

This is a prize of $NZ5,000 and is named after John Kalman who was a professor of mathematics at the University of Auckland from 1964–1993, and was a leading promoter of mathematics in New Zealand. The prize is generously supported by a grant from the Margaret and John Kalman Charitable Trust.

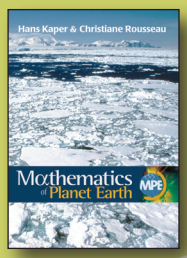
Dr Bonnafé is currently Directeur de Recherche at CNRS based within the Institut de Mathématiques et de Modélisation de Montpellier, France. More details about the recipient can be found at http://www.math.univ-montp2.fr/~bonnafe/.

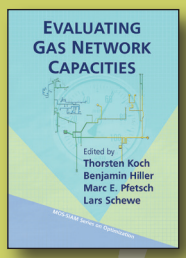
Dr Bonnafé's primary research interests are in Deligne-Lusztig theory, and Mackey formulas; in particular he studies the geometry of the groups $\mathrm{SL}(n,q)$ and $\mathrm{SU}(n,q)$ and the geometry of the Deligne-Lusztig varieties and associated conjectures. He is the author of the well received book "Representations of $\mathrm{SL}(2,q)$" published by Springer-Verlag, London in 2011.

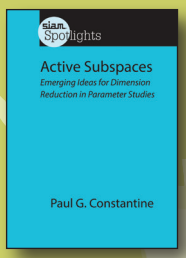
The next award will be made in October 2015 and all papers published since 2010 are eligible for this award.

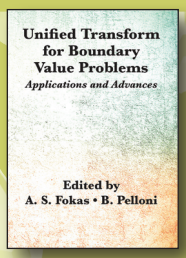
The New Zealand Journal of Mathematics welcomes high quality papers across the spectrum of mathematics. The journal is published by a joint committee of the New Zealand Mathematical Society and the Mathematics Department of the University of Auckland. The journal does not have page charges and published papers are freely available online (http://nzjm.math.auckland.ac.nz/index.php/New_Zealand_Journal_of_Mathematics).

New & Notable Titles from SIAM









Mathematics of Planet Earth: *Mathematicians Reflect on How to Discover, Organize, and Protect Our Planet*

Hans Kaper and Christiane Rousseau

Our planet faces many challenges. In 2013, an international partnership of more than 140 scientific societies, research institutes, and organizations focused its attention on these challenges. This project was called Mathematics of Planet Earth and featured English- and French-language blogs, accessible to nonmathematicians, as part of its outreach activities. This book is based on more than 100 of the 270 English-language blog posts and focuses on four major themes: A Planet to Discover; A Planet Supporting Life; A Planet Organized by Humans; and A Planet at Risk.

2015 • Approx. xii + 202 pages • Softcover
978-1-611973-70-9 • List $39.00
SIAM Member $27.30 • OT140

Evaluating Gas Network Capacities

Thorsten Koch, Benjamin Hiller, Marc E. Pfetsch, and Lars Schewe, Editors

MOS-SIAM Series on Optimization 21

This book provides an introduction to the field of gas transportation planning and discusses in detail the advantages and disadvantages of several mathematical models that address gas transport within the context of the technical and regulatory framework. It shows how to solve the models using sophisticated mathematical optimization algorithms and includes examples of large-scale applications of mathematical optimization to this real-world industrial problem.

2015 • xvi + 376 pages • Softcover
978-1-611973-68-6 • List $99.00
MOS/SIAM Member $69.30 • MO21

Active Subspaces: *Emerging Ideas for Dimension Reduction in Parameter Studies*

Paul G. Constantine

SIAM Spotlights 2

Active subspaces are an emerging set of dimension reduction tools that identify important directions in the parameter space. This book describes techniques for discovering a model's active subspace and proposes methods for exploiting the reduced dimension to enable otherwise infeasible parameter studies. Readers will find new ideas for dimension reduction, easy-to-implement algorithms, and several examples of active subspaces in action.

2015 • x + 100 pages • Softcover
978-1-611973-85-3 • List $39.00
SIAM Member $27.30 • SL02

Unified Transform for Boundary Value Problems: *Applications and Advances*

Athanasios S. Fokas and Beatrice Pelloni

This book describes state-of-the-art advances and applications of the unified transform and its relation to the boundary element method. The authors present the solution of boundary value problems from several different perspectives, in particular the type of problems modeled by partial differential equations (PDEs). They discuss recent applications of the unified transform to the analysis and numerical modeling of boundary value problems for linear and integrable nonlinear PDEs and the closely related boundary element method.

2015 • xii + 293 pages • Softcover
978-1-611973-81-5 • List $94.00
SIAM Member $65.80 • OT141

Finite Dimensional Linear Systems

Roger W. Brockett

Classics in Applied Mathematics 74

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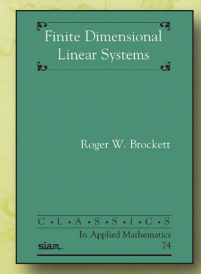

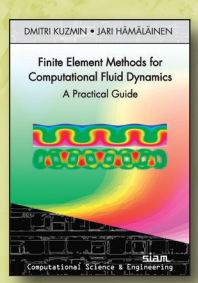

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