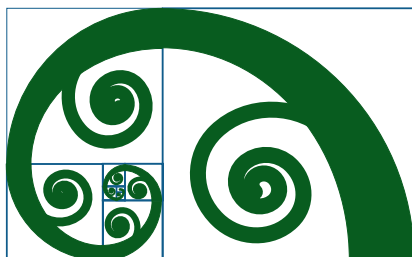


New Zealand Institute of Mathematics and its Applications (NZIMA)

Annual Report 2009



New Zealand Institute of
Mathematics & its Applications

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Approved by the Governing Board 23 March 2010

OVERVIEW FROM CHAIR OF THE NZIMA BOARD

Len Cook, Chair of the NZIMA's Governing Board, reports:

The focus of public policy initiatives in the last year has affirmed the importance of the Centres of Research Excellence. They have become key vehicles for pulling together the scientific capability of New Zealand in ways which can offset the institutional fragmentation that resulted from policy initiatives over the past two decades. This report highlights not only the breadth but also the scale of scientific work that can be achieved in a community of our size, when this occurs.



Len Cook

I am delighted to present the annual report of the New Zealand Institute of Mathematics and its Applications (the NZIMA), on behalf of its Governing Board. I can also report on the suitability and willingness of members joining the NZIMA's new governing board. They are well equipped to help enable such a vital part of our national scientific community engage positively in the government and wider policy environment where public-good science is valued, supported and funded.

While the long term future of this Institute is uncertain, we are now well placed to prepare to develop longer term responses to the loss of funding in the 2007 CoRE round,

building on the support we have both internationally and from university mathematics and statistics departments as well as professional societies in New Zealand. There are surely no other fields of endeavour in the sciences, humanities or commerce that have seen their capacity (to monitor, measure, compare and distill) increase so much that that very nature of what is studied, organized and exploited has altered irrevocably the shape of their discipline or business.

Again in 2009, the NZIMA has built on its already impressive international reputation in the mathematical sciences, while achieving beneficial outcomes for New Zealand and communicating what it does to the wider scientific and educational community. I hope that this year we can find ways of communicating well to political and government leaders how the NZIMA delivers value for money. While we can build on what has been achieved already here, the difficult financial position that New Zealand will face in the next decade means that we need to find better ways of enabling the

added value of the NZIMA to be compared with that coming from other proposals Ministers will have in front of them.

The nature of the ‘value added’ is partly reflected in the goals NZIMA set itself in 2002, of creating and sustaining a critical mass of researchers in concentrations of excellence in mathematics and statistics and their applications, and “lifting the game” for the mathematical sciences in this country, by using as models a number of other renowned mathematical sciences institutes overseas. This they have done in many, many ways.

For example, the list of honours and awards being won by the NZIMA’s researchers and students is impressive, and keeps growing. Publications in top international journals, special issues devoted to the NZIMA’s programmes, and large and increasing citation rates (far in excess of the worldwide average for the mathematical sciences) all attest to world class standing.

This excellence has not, however, been confined to particular areas of the discipline – strong outcomes are being seen in both fundamental and applied aspects of the mathematical sciences, very positive interactions with a wide range of other disciplines (including biology, computer science, ecology and medicine, as well as the more traditional engineering and physics), and concrete applications to business, industry and society in general.

What is clear is that the main players of the NZIMA have used their CoRE status and funding to support the development of the mathematical sciences in New Zealand far beyond the confines of their own research groups – foremost among these being the *NZ-IMAg*es bulletin and the *MathsReach* website for schools. This website, which has won acclaim from teachers around New Zealand, has been relaunched with even more videos and articles.

These things have come about because of the talents and leadership of the NZIMA’s principal investigators and management team, and because of their desire to achieve good things for science (in the broadest sense) and for New Zealand.

I applaud the NZIMA and all those involved in it, particularly the two Co-Directors, the Research Manager and the Executive Committee for their vision and efforts. There is no doubt in my mind that the NZIMA is pursuing the goals of the Centres of Research Excellence Fund in outstanding fashion. We must be better at finding ways of enabling those outside the mathematics statistical and other science communities that work with NZIMA to express this value, not only in terms of future benefits but also the potential for opportunities to be lost.

Len Cook

REPORT FROM DIRECTORS AND EXECUTIVE COMMITTEE

In introducing this report on another excellent year of NZIMA activities, we would like to mention a few particular highlights.

The year 2009 began for us with another highly successful summer meeting, this one at Napier on the theme of algorithmic information theory, computability and complexity. As is now customary at these meetings, a top-flight range of invited speakers presented material from the forefront of research, to a wide audience of students and mathematical scientists from across New Zealand. Although the outcomes of these meetings are difficult to quantify, it is clear that over the period they have taken place, the breadth, depth and quality of knowledge and research in the mathematical sciences in New Zealand has improved enormously.

Some recent statistics from the Web of Science show that since the 1990s, the numbers of publications in mathematical journals by New Zealand based authors has almost tripled, lifting the rank of mathematics among all disciplines in New Zealand from 22nd place in 1990–94 to 11th place in 2005–09. But this is not just about quantity. The quality of work being carried out has jumped as well, with our people now publishing in top-flight journals such as the *Annals of Mathematics*, *Journal of the European Mathematical Society*, *Transactions of the American Mathematical Society*, and *Journal für die Reine und Angewandte Mathematik*.

This quality is also being recognised by an increasing array of awards and honours, both nationally and internationally.

Professor Peter Hunter (a founding principal investigator in the NZIMA) won a “World Class New Zealand” Award from KEA early in the year, and also took up the chair of the Marsden Fund Council, and then later in the year won New Zealand’s top scientific honour, the Rutherford Medal. This latest award to Peter recognises his achievements in biomedical engineering and computational physiology, and in particular, the leading role he has played in the international Physiome Project, which is building sophisticated mathematically-based computer models of all the human body’s organs.

Professor Bill Barton, who is directing our Mathematics Education programme, has been elected President of the International Commission on Mathematical Instruction (ICMI), from January 2010. He is also chairing ICMI's "Klein project".

Two New Zealand-based mathematicians have been invited to give lectures at the next International Congress of Mathematicians, which will take place in India in 2010: Gaven Martin (Massey University), who is one of our PIs and co-director of two of our programmes with geometric themes, and Andre Nies (University of Auckland), who was a participant in one of our first programmes, on logic and computation. Only once before has a New Zealand-based mathematician been invited to speak at the ICM, and that was Rod Downey (another of our PIs), in 2006.

Such successes are not restricted to experienced researchers. Our students are also doing particularly well.

NZIMA scholar Vicky Wang (based at the Auckland Bioengineering Institute) won the best paper award at the Medical Image Computing and Computer Assisted Intervention (MICCAI) Society's Annual Conference, in 2009, for her work with fellow student Hoi Leng Lam on developing a computer model of the heart that could help clinicians diagnose and treat patients suffering from heart failure. Their paper was first out of 700 papers presented by entrants from 34 countries, and will appear in the highly-regarded journal "Medical Image Analysis".

Another of our students, Eyal Loz (who was engaged in the NZIMA's Combinatorics programme, with support from a Top Achiever Doctoral Scholarship) made some spectacular discoveries during his PhD at the University of Auckland on the "Degree-Diameter Problem" for combinatorial graphs (networks). This problem involves finding the largest possible connected network with specified maximum vertex degree d and diameter D ; such networks are optimal in terms of efficiency, with numerous practical advantages. Over a period of 50 years, computer scientists, engineers and mathematicians have striven to find the best possible networks for each degree-diameter pair (d, D) , and these are stored in a dynamic table that is used worldwide. In the course of his PhD, Eyal developed a novel application of 'voltage graphs' to construct several new networks that now hold degree-diameter records; in fact *over* half of the current best known networks were constructed by Eyal.

Also, towards the end of his PhD project, Eyal worked with Tanglin Consultancy in helping the NZ company Pacific Horizon with its manual scheduling system. The

combination of Eyal's combinatorial approach and Tanglin's IT expertise have enabled the company to increase revenues by over 8% pa, while reducing distribution and relocation costs. Collectively this will improve the company's profitability by 18% pa. These are phenomenal achievements for a PhD student, and highlight the enormous value of mathematics in solving practical problems.

Similar optimisation work for Norwegian paper company Norske Skog earned Andy Philpott (another of our principal investigators) and graduate Graeme Everett a place in the April finals of the 2009 Franz Edelman contest. Andy and Graeme used techniques from operations research and stochastic optimization to help members of the Norske Skog strategic management team in Oslo build a detailed model of its global operations (of 18 mills on 4 continents), and use this to identify opportunities for effective cost savings. Their approach proved to be far superior to a traditional financial analysis, and helped identify money-losing operations in areas that appeared to be well-run. Their analysis is estimated to be saving the company US\$100m per year. It was also the subject of a report in May in the US publication "Business Week".

During the year our two newest research programmes got well underway. Our programme on "Energy, Wind and Water" held a four-day workshop on mathematical methods that can be used in modeling New Zealand's energy economy and bio-energy, as well as tidal energy, oil and gas reservoirs, and wind energy. Our programme in Mathematics Education is investigating the mathematical conditions in the last years of schooling and first years of undergraduate education in New Zealand needed to ensure the provision of a sufficient flow of competent graduates to meet the needs of all sectors of society that require mathematical knowledge and abilities beyond Year 11. Aspects of this programme were discussed with secondary school teachers at the 2009 Conference of the NZ Association of Maths Teachers and at a workshop for university undergraduate course lecturers at the 2009 NZ Mathematics Colloquium. Further details of these and our other ongoing programmes can be found in this report.

Professor Eamonn O'Brien (University of Auckland) completed his 12-month Maclaurin Fellowship in 2009. A highlight of Eamonn's recent work has been his role in proving the Ore conjecture, which was a 50-year-old open question about commutators in finite simple groups.

Also during the year we transferred our *MathsReach* resource for schools and the wider community to a new host (though still at www.mathsreach.org), upgraded its

format, and added a lot more material. For her work on MathsReach, our Research Manager Margaret Woolgrove won a General Staff Excellence Award at the University of Auckland. In addition, our twice-yearly glossy bulletin NZ-IMAgEs is receiving wide acclaim among schools for the way in which it brings reality and a human face to much of the school mathematics curriculum, as well as showcasing mathematical activity in New Zealand. We very much appreciate the positive feedback we receive from teachers (and others) about these things.

On a sadder note, we lost a member of our International Scientific Advisory Board when our colleague Keith Worsley died from pancreatic cancer in February 2009, aged only 57. During his career (which began as a student at Auckland) Keith made significant contributions both to statistical theory and its applications, most importantly in the field of human brain mapping, where his approach involved an innovative mix of probability theory, statistics and geometry.

Finally, as usual we would like to thank all those who have been involved positively in NZIMA's operations this year. We'd especially like to thank Len Cook (chair of our new Governing Board), directors of our current programmes and summer workshops, Margaret Woolgrove (Research Manager), Judy Paterson (who is helping with outreach to schools), Jenny Rankine for her assistance in producing *NZ-IMAgEs*, and Neil Morrison, Rob Carter and John Glass for their work with Margaret on our *MathsReach* resource. In addition, we'd like to thank heads of departments and leaders of professional societies in the mathematical sciences in New Zealand for their continued and valuable support of the NZIMA.

Marston Conder FNZMS FRSNZ FTICA

Vaughan Jones KNZM FRS FRSNZ

PROGRESS WITH RESPECT TO CoRE FUND OBJECTIVES

The Centres of Research Excellence (CoRE) Fund is intended to support research that:

- is of excellent (world-class) quality
- leads to knowledge transfer, and
- is focussed on New Zealand's future development.

Below are some of the highlights of the NZIMA's activities and achievements in 2009 that show we are meeting these objectives. Further details can be found elsewhere in this report.

Research Excellence

Our programmes are bringing together some of the world's best researchers in the relevant theme area, providing an excellent basis for stimulating top quality research and training students in New Zealand.

Significant advances in knowledge and applications are resulting from NZIMA activities - see the sections on Thematic Research Programmes, Maclaurin Fellowships and Postgraduate Research Projects.

Researchers involved with the NZIMA published a large number of articles in some of the world's top mathematics journals in 2009, including Annals of Mathematics, Journal für die Reine und Angewandte Mathematik, Journal of Algebra, Journal of Combinatorial Theory, Journal of Differential Equations, Journal of Fluid Mechanics, Proceedings of the London Mathematical Society and Proceedings of the American Mathematical Society.

NZIMA researchers have continued to win numerous honours and awards in 2009, including the following:

- Bill Barton (Director of our new programme in Mathematics Education) has been elected the next President of the International Commission on Mathematical Instruction (ICMI), from 2010 to 2012.

- Peter Hunter won 2009's "World Class New Zealand" Award, in the Research, Science, Technology & Academia category, presented by KEA New Zealand (Kiwi Expats Association) and New Zealand Trade and Enterprise to celebrate some of New Zealand's tallest poppies.
- Peter Hunter won the Rutherford Medal for 2010. This is New Zealand's top science honour, awarded for exceptional contributions to New Zealand science and technology.
- Vaughan Jones was knighted at a ceremony in Wellington in August 2009. Officially, Vaughan becomes a Knight Companion of the New Zealand Order of Merit (KNZM); this replaces his previous title of Distinguished Companion of the New Zealand Order of Merit (DCNZM), which he was awarded in 2002.
- David Vere-Jones (one of the NZIMA's founding Pls) has won the Campbell Award of the New Zealand Statistical Association. This award recognises David's exceptional contributions to the promotion and development of statistics in New Zealand (and beyond). In particular, it recognises his many contributions to statistics education at all levels, and his outstanding research and publication record.
- Matt Visser was elected a Fellow of the American Physical Society in November 2009.
- NZIMA scholar Vicky Wang (Auckland Bioengineering Institute) jointly won the best paper award at the Medical Image Computing and Computer Assisted Intervention (MICCAI) Society's Annual Conference in 2009.



Knowledge Transfer

- Each of the NZIMA's programmes have encouraged large numbers of students and professional mathematical scientists to take part in their conferences/workshops.
- Postgraduate students have been engaged in specific research projects by each of NZIMA's programmes, with a total of 68 students having been engaged both directly and on programme based research.
- The NZIMA organised or co-sponsored two other conferences and instructional workshops in 2009.
- In addition, many of the NZIMA's programmes have included a series of instructional lectures and/or seminars, for researchers from universities and CRIs, students, and interested parties from related disciplines, business/industry and relevant government departments.
- Our programme on Mathematics in the Nanosciences is highly multidisciplinary, involving interactions between researchers in mathematics, physics, chemistry and engineering.
- Our programme on Partial Differential Equations involves the application of mathematics to geothermal modelling, nanotechnology, sea-ice interaction, structural vibration and acoustics.
- Our programme on Modelling Invasive Species is stimulating interactions with the BioProtection CoRE, Landcare Research, AgResearch and the Canterbury Regional Council.
- Our programme on Algorithms involves intensive interaction between mathematics and computer science and applications in biology, ICT and social sciences.
- We have facilitated public lectures by high profile mathematicians such as Bernard Chazelle.



Bernard Chazelle

- Our twice-yearly newsletter, NZ-IMAgEs, produced two new issues, with the aim of showcasing a selection of mathematical activities across New Zealand, and making these accessible to a wider community.
- Our web-based resource, MathsReach (www.mathsreach.org), shows school students and teachers what lies beyond the school curriculum in mathematics and statistics, in terms of professional careers, research activity, hot topics, and interesting and important applications. Ten new videos and articles were prepared for the site during the year.
- The NZIMA website (www.nzima.org) is continually updated with programme information as well as other opportunities and linkages.
- Research findings are announced at national and international conferences, and published in national and international refereed journals.
- A quarterly electronic newsletter of NZIMA activities, appointments and occasional “profiles” of key people (e.g. Maclaurin Fellows, scholars, programme directors) is issued to a wide range of stakeholders.

Contribution to National Goals

- The NZIMA has “lifted the game” for the mathematical sciences in New Zealand, by focusing resources for greatest effect, helping our researchers work at the leading edge of their disciplines, creating new knowledge and also being able to assimilate new knowledge very rapidly, thus strengthening research-led teaching.
- We have developed an outreach programme to lift the profile of the mathematical sciences in the eyes of the public, schools, teachers and students, to increase awareness of possibilities and encourage greater enjoyment and participation in science and other subjects having a quantitative focus.
- Our MathsReach resource is putting across the idea that there is “maths behind every door”, highlighting the fact that mathematics underlies many recent advances in science, technology and everyday life and that mathematicians are involved in all of these areas.
- Our membership of the IMSI and PRIMA consortia are providing excellent opportunities for New Zealand students to participate in summer schools and other activities organised by our partner institutes overseas.

- We have encouraged the involvement of under-represented groups in research and postgraduate study in the mathematical sciences, and are celebrating their success.
- We are undertaking research that has potential and actual benefits for New Zealand's economy, society, and environment, such as the following:
 - Our programme on Modelling Invasive Species and Weed Impact is helping investigate the spread and subsequent impact of invading organisms in New Zealand ecosystems, in order to determine the optimal use of resources between the competing demands of controlling existing species and limiting new species, while maintaining biodiversity.
 - Our programme on Partial Differential Equations has been adapting methods developed in the cell-phone industry and in condensed matter physics to improve sound isolation in timber construction.
 - Research in our programme on Energy, Wind and Water is aimed at improving the approach to effective resource modelling and usage in New Zealand.
 - Our new programme in Mathematics Education will help to ensure the provision of a flow of competent graduates to help meet the needs of New Zealand's society and economy.
- With regard to national identity, the NZIMA's programmes and international linkages, and the high profile of our principals and their work, have fostered a growing international awareness of the quality and diversity of mathematical sciences research in New Zealand.



THEMATIC PROGRAMMES

The following nine programmes have now all been completed:

- Modelling cellular function
- Logic and Computation
- Numerical methods for evolutionary problems
- Phylogenetic genomics
- Combinatorics and its Applications
- Dynamical Systems and Numerical Analysis
- Geometry: Interactions with Algebra and Analysis
- Mathematical Models for Optimizing Transportation Services
- Hidden Markov Models

It is noteworthy that the directors of two of our early programmes, “Modelling cellular function” and “Phylogenetic genomics”, have since been invited to run programmes on similar topics at the Isaac Newton Institute for Mathematical Sciences in the UK. Professor Mike Steel was co-director of a Newton Institute programme on Phylogenetics from September to December 2007, and Dr Nic Smith will co-direct a Newton Institute programme on “The Cardiac Physiome Project: mathematical and computational foundations” from June to August in 2009.



Mike Steel

A summary of current programmes follows.

Geometric Methods in the Topology of 3-Dimensional Manifolds

This programme's theme is the study of 3-dimensional manifolds, and especially recent progress resulting from the use of geometry, with focus is on the techniques and consequences of recent work on Thurston's geometrisation conjecture.

Programme Director: Professor David Gauld (University of Auckland) et al

The programme commenced in January 2006, and is approaching completion.

Three postgraduate research students were involved in 2009:

- Stephen Budden completed his PhD thesis early in the year at the University of Auckland (under the supervision of David Gauld). He investigated the structure of “quandles”, especially their algebraic properties, and also their uses as knot invariants.
- Qing Zhang is writing up her PhD thesis at Massey University's Albany campus (under the supervision of Gaven Martin). Her research is looking at sharp bounds for commutator parameters of discrete groups with two generators and also involves gathering data on Dehn surgery on links up to 11 crossings.
- Sunanda Dikshit is working on a PhD project at the University of Auckland (under the supervision of David Gauld and Sina Greenwood), on differential structures on the square of the long line — and in particular, whether there are any structures that are not simply the product of two structures on the long line.

Partial Differential Equations: Applications, Analysis and Inverse Problems

This programme is devoted to the development of methods for solving partial differential equations (and related “inverse problems”), and the application of these to geothermal modelling, nanotechnology, sea-ice interaction, structural vibration and acoustics. Two of the three directors of this programme are working in non-mathematics departments (viz. Physics, and Engineering Science). Researchers in this programme routinely interact with non-mathematical disciplines. A major interaction has been with the statistical ‘complex models’ community with developments in treatments for modelling error, and model representation.

Programme Directors: Associate Professor Colin Fox (University of Otago), Professors Mike O’Sullivan and Boris Pavlov (University of Auckland) et al

The programme commenced in late 2006 and will close with a final workshop in January 2010.

One postdoctoral fellow is directly engaged in the programme: Dr Al Parker, who has been working on adapting numerical methods of linear algebra to sampling methods for probability densities, and Gaussian distributions in particular. His work in 2009 continued to focus on novel sampling methods. At the closing programme workshop in 2010 he will present his work on the equivalence between stationary linear solvers and Gibbs sampling algorithms. This breakthrough work, following on from earlier work in the programme by Al Parker and Colin Fox on non-stationary methods, has shown how to adapt the vast literature in computational methods for linear problems to give a many-orders-of-magnitude improvement in sampling algorithms as used in statistics.

Two postgraduate research students were involved in 2009:

- Tiangang Cui is working towards a PhD on Bayesian methods for inverse problems applied to geothermal model calibration, at the University of Auckland. He continues to make progress at the leading edge of statistical methods for complex inverse problems. At the programme’s closing workshop he will present some dramatic algorithmic improvements that he has achieved in his PhD studies, interestingly combining recent ideas from the work of Prof Haario and Prof Kaipio, both of whom will also be participating in the workshop. The advance achieved by Cui means that, for the first time, automatic calibration of large numerical models of geothermal fields is computationally feasible. Tiangang Cui is calculating the first-ever inferential calibration for the Mokai geothermal field (in the Taupo region). This heralds a significant advance in modelling and computation for complex geophysical systems.
- Erfang Ma is working towards a PhD at the University of Otago. He has made steady progress on understanding the effect of discretization errors near electrodes in Electrical Impedance Imaging. It is expected that he will complete in 2010.

Modelling Invasive Species and Weed Impact

This programme's main aim has been the design of a mathematical and statistical framework for exploring the spread and subsequent impact of invading organisms in New Zealand ecosystems, in order to determine the optimal use of resources between the competing demands of controlling existing species and limiting new species, while maintaining biodiversity.

Programme Directors: Associate Professor Jennifer Brown, Dr Alex James and Professor David Wall (University of Canterbury) et al

The programme commenced in late 2006.

The programme is involving positive interactions with the BioProtection CoRE, Landcare Research, AgResearch, the Auckland Regional Council, the Canterbury Regional Council, and Environment Southland. Additional sponsorship has been obtained by the programme organisers from the University of Canterbury, AgResearch, Landcare, and the Miss E.L. Hellaby Indigenous Grassland Research Trust.



Tradescantia fluminensis
(Source: Kenpai, Commons Wikimedia)

The general spatial survey design developed in this programme (in conjunction with the US Environmental Protection Agency) is now in the 3rd year of use by the Southland Regional Council for weed surveillance. A similar design (together with a GIS tool and field-testing) has been proposed for a large-scale monitoring programme in the French Pyrenees for a rare river mole (Pyrenean Desman (*Galemys pyrenaicus*)). PhD student Meghan Williams spent three months in France on this project in 2009.

Three postdoctoral fellows were involved in 2009:

- Dr Britta Basse (funded by the University of Canterbury), modelling the spread of *Nasella tussock*
- Dr Richard Brown, working on spatial structure of long-range dispersal
- Dr Joe Stover (funded by the Department of Conservation), on modelling the disposal of garden waste.

Also three postgraduate research students were engaged in this programme in 2009:

- Dawn Lemke (PhD, University of Canterbury, in collaboration with the US Forest Service), on linking geographic information systems (GIS) with sampling strategies for weed monitoring
- Meghan Williams (PhD, University of Canterbury), on linking geographic information systems (GIS) with sampling strategies for weed monitoring, in collaboration with the BioProtection CoRE, Environment Southland and the University of Queensland
- Simon van Gennipp (PhD, University of York) spent four months at the University of Canterbury in 2009, working with Alex James on modelling *Tradescantia*.

Alex James was interviewed a second time for the NZIMA's MathsReach resource. Her interview, titled 'Return of the Bugs and Beech Trees ...' can be viewed at the website www.mathsreach.org/Videos.

Applications of Mathematics in the Nanosciences

This programme's main focus is on mathematical and computational methods for experimentation with (and model-based prediction of) nanoscale phenomena, and design and control of nanoscale systems. It is a highly multidisciplinary programme, involving interactions between researchers in mathematics, physics, chemistry and engineering.

Programme Director: Dr Shaun Hendy (Industrial Research Ltd, and the MacDiarmid Institute, Victoria University of Wellington) et al

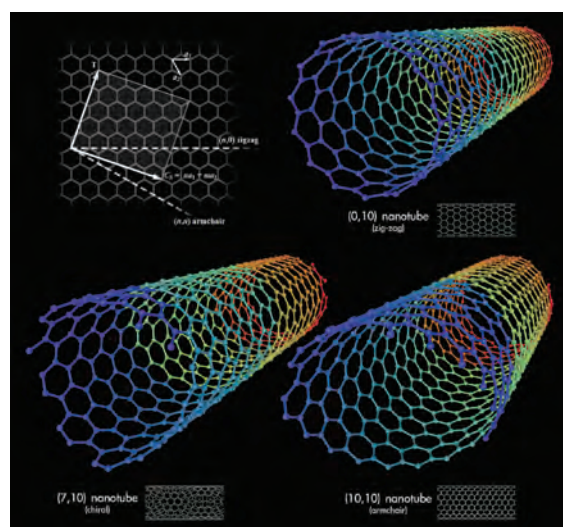
The programme commenced in 2007.

A one-day meeting on nano- and microfluidics was held in Wellington on 8 June 2009. Thirty people attended, including approximately 10 students. Particular highlights were invited talks by Dr Barry Cox (an Australian mathematician) about the flow of nanofluids and Dr Chiara Neto (an Australian chemist) about the properties of superhydrophobic surfaces. The programme also partially supported a visit of Professor Tim Schulze (University of Tennessee) in 2009, to work with Shaun Hendy and students Sione Paea and Dmitri Schebarchov on a multiscale model for crystal growth.

Postdoctoral fellow Dr Philip Zhang completed his project in late 2009, on phase-field models for melting, and a homogenization approach to solving effective slip problems in nanofluidics. Philip has taken up a full-time position in the Applied Maths team at Industrial Research Ltd.

Five PhD students at Victoria University of Wellington have been engaged in various ways in aspects of this programme, with support from the NZIMA, FRST, the Marsden Fund, and the MacDiarmid Institute for Advanced Materials and Nanotechnology, and all are close to completing:

- Srikanth Dhondi, on the flow of polymers in nano-channels
- Nat Lund, on effective slip flow problems
- Jade Mackay, on modelling of the growth of Zinc Oxide nano-rods [completed 2009]
- Sione Paea, on a multiscale model for the growth of crystals in supersaturated solutions



Carbon nanotubes
(Source: Mstroeck, Commons Wikimedia)

- Dmitri Schebarchov, on the modelling of carbon nanotube growth.

Dmitri Schebarchov was a finalist in the MacDiarmid Young Scientist of the year in 2009. Jade Mackay is now working with the MetService in Wellington.

Algorithms: New Directions and Applications

This programme centres on the design and analysis of algorithms, and their application to contemporary problems in such areas as discrete mathematics, computational biology, social sciences, and communication networks. Particular attention is being paid to randomized algorithms, approximation algorithms, probabilistic analysis, fixed-parameter tractability, and interaction between these topics.

Programme Directors: Professor Mike Atkinson (University of Otago), Associate Professor Charles Semple (University of Canterbury), Dr Mark Wilson (University of Auckland) et al

The programme commenced in 2008.

A highlight in 2009 was a series of public lectures by Professor Bernard Chazelle (Princeton University), titled 'What an iPod, a flock of birds, and DNA have in common', in Auckland, Wellington, Christchurch, and Dunedin. The lecture was well received in all centres and stimulated lots of interesting questions.

Mike Atkinson continued his work with Professor Steve Linton (University of St Andrews) on permutations and data structures, together with Michael Albert (Otago), Vincent Vatter (Dartmouth University) and Mireille Bousquet-Melou (Bordeaux).

Charles Semple worked with two visitors: Magnus Bordewich (Durham University) on algorithms in phylogenetics, and Simone Linz (UC Davis) on reticulation evolution.

Charles Semple and Mike Steel (University of Canterbury) organised the annual New Zealand Phylogenetics Conference at Kaikoura in February 2009, at which many of the participants' talks involved algorithmic aspects of phylogenetics.

This programme supported two postdoctoral fellows in 2009:

- Dr Alex Raichev (University of Auckland), who spent a year working on asymptotics of multivariate generating functions
- Dr Chris Dowden (University of Canterbury), who spent a year working on algorithmic problems in phylogenetics, and wrote three single-authored papers.

The programme has also engaged three postgraduate students:

- Reyhaneh Reyhani (University of Auckland), PhD on computational social choice
- Josh Collins (University of Canterbury), MSc on algorithmic aspects of reticulate evolution papers
- Beata Faller (University of Canterbury), PhD on algorithmic problems in conservation biology.

Beata Faller was a joint winner of the Combinatorial Mathematical Society of Australasia (CMSA)'s prize for the best student



Beata Faller

talk at the 33rd Australasian Conference on Combinatorial Mathematics and Combinatorial Computing, at Newcastle (Australia) in December 2009.

This programme has benefited through co-sponsorship from the Department of Computer Science at the University of Otago and the Marsden Fund. Hosting departments at Auckland, Wellington, Canterbury and Otago covered some of the costs of Bernard Chazelle's lecture series.

Magnus Bordewich (Durham University) and Bernard Chazelle (Princeton University) were both interviewed for the NZIMA's MathsReach resource. Their interviews, titled 'Random and algorithmic sampling', and 'iPods, a Flock of Birds and DNA' respectively, are both available at the website <http://www.mathsreach.org.nz/Videos>.

The NZIMA programme in Algorithmics sponsored a competition to produce a song on the topic of algorithms. The winner was Danver Braganza. The winning song lyrics and an article about the contest was published in NZ-IMAgEs in November 2009.

Conformal Geometry and its Applications

The themes of this programme are conformal and hyperbolic geometry, including symmetries and natural geometric equations, invariants and applications, and nonlinear elasticity and materials science.

Programme Directors: Professors Rod Gover (University of Auckland) and Gaven Martin (Massey University) et al

The programme began in 2008 and its main event was a meeting held at Nelson in January 2008, followed up by a workshop on parabolic geometry at Auckland during a focussed research period on parabolic geometry, PDE and prolonged systems (from July to September 2008).



Rod Gover

In 2009 the programme benefited from visits by Pierre Albin (Courant Institute, NY), Larry Peterson (North Dakota), Andrew Waldron (UC Davis) and Josef Silhan (MPI, Bonn) to the University of Auckland, supported by Rod Gover's Marsden Fund grant.

The programme is supporting one postdoctoral fellow: Dr Paul-Andi Nagy (University of Auckland), who is working on

special structures and natural differential operators, conformal techniques, Lie algebra prolongations, and applications.

Several postgraduate research students have been engaged in various aspects of the programme, some supported by the Marsden Fund or the University of Auckland or Massey University:

- Niels Bernhardt (University of Auckland), PhD on the classification of holonomy groups of spinorial connections [completed 2009]
- Howard Cohl (University of Auckland), PhD on special functions and explicit constructions of fundamental solutions for geometric PDEs
- Haydn Cooper (Massey University), PhD on computation discrete hyperbolic geometry
- Samuel Dillon (Massey University), PhD on nonlinear and the Schoen Conjecture
- Maarten Jordens (Massey University), PhD on deformations of smallest weighted mean distortion algorithmic problems in conservation biology [completed 2009]
- Matthew Randall (University of Auckland), MSc on PDE in projective geometry
- Yuri Vyatkin (University of Auckland), PhD on submanifold structures in conformal geometry.

Energy Wind and Water

This programme's theme is the combined use of simulation, optimization and control algorithms to investigate and solve engineering problems involving energy, wind and water. Emphasis is placed on cross-disciplinary approaches in which simulation techniques, such as computational fluid dynamics, are combined with optimization algorithms to improve engineering designs, or with control algorithms to improve operations.

Programme Director: Professor Mike O'Sullivan (University of Auckland) et al

This programme's first main event was a four-day workshop on mathematical methods in research on Energy Wind and Water, at the University of Auckland, 9–12 February 2009. The workshop involved a mix of mathematical topics and general presentations, on tidal energy, oil and gas reservoirs, wind energy, modeling New Zealand's energy economy, and bio-energy. The main mathematical themes were model calibration

and model reduction with application to geothermal reservoirs, groundwater and aerodynamics. The workshop was attended by 33 full registrants, 13 students and



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an additional 10 people attending the presentations. The workshop has helped to initiate new international research collaborations.

Overseas invited experts who took part in this programme in 2009 (including some at the workshop) were Jim Beck (Caltech), Stefan Finsterle (Lawrence

Berkeley National Laboratory), Margot Gerritsen (Stanford), Omar Ghattas (University of Texas), Max Gunzburger (Florida State), Joaquim Martins (Toronto), Andrew Pollard (Queens University), Bart van Bloemen Waanders (Sandia National Laboratory), John Wilkins (Rutgers), Karen Willcox (MIT), Julie Young (Princeton), and George Zyvoloski (Los Alamos National Laboratory).

Two new ME students began work in 2009 on geothermal topics: Emily Clearwater and Laura Abrahams (University of Auckland).

Senior Secondary and Undergraduate Mathematical Science in New Zealand

This programme's overall aim is to investigate the mathematical conditions in the last years of schooling and first years of undergraduate education in New Zealand needed to ensure the provision of a sufficient flow of competent graduates to meet the needs of all sectors of society that require mathematical knowledge and abilities beyond Year 11.

Programme Director: Professor Bill Barton (University of Auckland) et al

Aspects of the programme were discussed with secondary school teachers at the 2009 Conference of the NZ Association of Maths Teachers (29 September to 2 October 2009) and a workshop was held for university undergraduate course lecturers at the 2009 NZ Mathematics Colloquium (8-11 December 2009).

The initial phase has concentrated on data collection and analysis, by a research fellow, Louise Sheryn. This included data concerning the New Zealand 'Pipeline'

— see below — followed by a nationwide survey of lecturers about the the expected mathematical understanding of students entering undergraduate degree programmes, and a nationwide survey of senior secondary teachers about the barriers to enrolment in advanced secondary and undergraduate mathematics courses.

The performance outcomes at first year university level of students continue to be studied by Alex James and colleagues at the University of Canterbury —their work indicates that the present system does, in fact, produce good numbers of students capable of good university grades in the mathematical sciences. Data from Auckland confirms these results.

A website has been developed. It holds information about the programme and provides a means for contributions by stakeholders in secondary and tertiary mathematics education. A stakeholder group is being formed.

The key period for this programme will be in 2010, beginning with a large international conference, followed by eight regional meetings which will help the development of a standards document and action plan.

Bill Barton (programme director) is also involved in two related projects being commissioned by the International Commission on Mathematical Instruction (ICMI), which is is an international non-governmental and non-profit-making scientific organisation established by the International Mathematical Union (IMU) to promote the development of mathematical education at all levels. Bill is President of ICMI.

- The ‘Pipeline’ project is investigating the supply and demand for mathematics students and personnel in educational institutions and the workplace, in a series of national case studies.
- The ‘Klein’ project, inspired by Felix Klein’s famous book *Elementary Mathematics from an Advanced Standpoint* (1908), aims to produce a book and website which will reflect contemporary trends in the mathematical sciences.



Felix Klein (Source: Wikipedia)

MACLAURIN FELLOWS

Full year Maclaurin Fellows

Professor Eamonn O'Brien (University of Auckland)

Eamonn O'Brien began his year as a full-time Maclaurin Fellow in July 2008, and completed it in 2009. His research involved joint projects with several people, including these:

- Dr Henrik Bäärnhielm (Braunschweig, and now a postdoctoral fellow at the University of Auckland), developing and implementing a version of CompositionTree : a framework that exploits the geometry of a linear group to construct its composition series.
- Professor Derek Holt (Warwick), utilising the Composition Tree work conducted with Henrik Baarnhielm, successfully incorporating it within the Trivial Fitting paradigm (a comprehensive algorithmic framework for linear groups) developed by Cannon and Holt, and developing various additional algorithms that use CompositionTree to provide the necessary computational infrastructure.
- Professor Wolfgang Willems (Magdeburg), investigating the long-standing question of existence of a binary self-dual doubly-even $[72,36,16]$ code, and obtaining restrictions on its automorphism group.
- Professor Bill Kantor (Oregon), constructing explicit short presentations for classical groups with significant progress having been made in constructing these.
- Dr Dane Flannery (Galway), developing an algorithm to decide finiteness of matrix groups defined over a field of positive characteristic, and thereby (together with previous work for groups in zero characteristic) providing the first complete solution of the finiteness problem for finitelygenerated matrix groups over a field.



Eamonn O'Brien

- Dr Max Neunhoffer (University of St Andrews) and Dr Felix Noeske (RWTH Aachen), on determining the exact base-size for permutation actions by the Baby Monster sporadic group on certain of its maximal subgroups, and on the selection of good bases for certain matrix group actions.

RESEARCH BY CO-DIRECTORS

Professor Marston Conder (who is supported also by the Marsden Fund) has been continuing his research, in combinatorial and computational group theory, with applications to the study of discrete objects with maximum symmetry. Particular highlights in 2009 were the construction of the first known chiral polytopes of rank greater than 5 (joint work with Alice Devillers (UWA)), a complete classification of regular Cayley maps for cyclic groups (joint work with Tom Tucker (New York)), and in a preliminary investigation of the symmetric genus spectrum of finite groups, discovery of new families of examples of group actions on Riemann surfaces with large order to genus ratio. In addition in 2009, he served as (the first) Vice-President International of the Academy of the Royal Society of New Zealand.

Professor Vaughan Jones has pursued an investigation of the relationship between large random matrices, planar algebras and subfactors, in joint work with Alice Guionnet and Dimitri Shlyakhtenko. A few new models have been constructed that can in principle be solved by the skein theoretic method. One of these models gives the same as that resulting from work of Tutte on counting configurations of curves on surfaces of genus zero. Others are entirely new. Unfortunately there is some difficulty in obtaining explicit solutions to the difference equations, even though they completely determine the solution (with simple boundary conditions). The planar algebra structure suggests other von Neumann algebras, including one that should be a model for Popa's universal enveloping algebra.

Vaughan Jones is also working with a group of postdoctoral researchers at Berkeley on subfactors of low index. Currently they are close to a classification of all finite depth subfactors of index less than five. One of the main techniques in this work is Jones's unpublished work on quadratic tangles. The hope is to go all the way up to index $3+\sqrt{5}$, where wild phenomena are expected to begin in the classification. This is consistent with calculations showing that index values are discrete, all the way up to index 9.

RESEARCH BY OTHER PRINCIPAL INVESTIGATORS

Professor James Sneyd (University of Auckland) works in mathematical biology, especially calcium modelling. He is working on a range of topics, with four postdoctoral fellows:

- Dr Kate Patterson, on the construction of a model of a saliva duct
- Dr Ivo Siekmann, on a stochastic model of an inositol trisphosphate receptor based on single-channel data — this will be the first model of its kind for a Type II receptor
- Dr Amanda Elvin, on a model of the mechanical properties of airway smooth muscle, incorporating both passive and active elements
- Dr Graham Donovan, on the lung project coordinated by Merryn Tawhai (Auckland Bioengineering Institute)

as well as four PhD and Masters students: Shawn Means (calcium microdomains), Wen Duan (GnRH neurons), Inga Wang (airway smooth muscle), Laurence Palk (parotid acinar cells) and Katie Sharp (calcium influx and oscillations).

Professor Matt Visser (Victoria University of Wellington) works in theoretical physics, especially quantum gravity and other topics such as general relativity. In research supported by the Marsden Fund and other sources, he worked with visitors Thomas Sotiriou (Cambridge), Silke Weinfrutner (UBC, Vancouver) and Elizabeth



Matt Visser

Winstanley (Sheffield), resulting in two immediate high-impact publications. He also published a book a book *The Kerr spacetime: Rotating black holes in general relativity* (written jointly with Susan Scott and David Wiltshire), and a popular article 'Black stars, not black holes' (written jointly with Stefano Liberati, Sebastiano Sonego and Carlos Barcelo) in the October 2009 issue of *Scientific American*, which has already been translated into Italian and Spanish.

RESEARCH BY POSTGRADUATE STUDENTS

Each of the NZIMA's thematic research programmes involves two or more postgraduate research students, with direct scholarship support from the NZIMA, and some aspects of their work were highlighted earlier in this report. In addition, the following postgraduate research student projects were supported by the NZIMA in 2009 (based on the merit of the student and the value of their project):

- Robin Averill (Victoria University of Wellington), PhD in mathematics education
- Haydn Cooper (Massey University) PhD on computational geometry and discrete groups
- Jonathan Crook (Victoria University of Wellington), PhD on modelling sea-ice
- Tiangang Cui (University of Auckland), PhD on geothermal model calibration
- Luke Fullard (Massey University), PhD on modelling hydrothermal eruptions: a numerical and experimental study
- Maarten Jordens (Massey University), PhD on distortion functionals and variations
- Javad Khazaei (University of Auckland), PhD on system integration of wind farms via stochastic optimisation
- Jing Liu (University of Auckland), PhD on New methods for estimating effective population size, N_e
- Dion O'Neale (Massey University), PhD in geometric numerical integration
- Rachael Tappenden (University of Canterbury), PhD on analysis, development and implementation of algorithms for fast image restoration
- Vicki Wang (University of Auckland), PhD on modelling of Left Ventricular Disease
- Lei Zhang (University of Auckland), PhD on optimisation of ambulance relocation and dispatch
- Yue Zhao (Massey University), Masters on transmission of a virus on a structured population
- Qizhi Zhou (University of Waikato), PhD in number theory
- Tong Zhu (University of Auckland), PhD on optimal control and phase transitions in stochastic networks.

CONFERENCES, PUBLIC EVENTS AND OTHER ACTIVITIES

In addition to workshops and conferences that were held as part of its thematic programmes the NZIMA used its CoRE funding and status to lend support to the following events held in New Zealand in 2009:

- The annual NZIMA/NZMRI summer meeting took place at Napier, 4–9 January 2009, with the theme of algorithmic information theory, computability and complexity. The organisers were Rod Downey and Noam Greenberg (Victoria University of Wellington). Instructional lecture courses were given by Denis Hirschfeldt (Chicago) on algorithmic randomness, Ted Slaman (Berkeley) on never continuously random reals, Eric Allender (Rutgers) on derandomisation in complexity classes, Alexander Kechris (Caltech) on descriptive set theory, and Michael Yampolsky (Toronto) on computability of Julia sets. The lectures were entertaining and captivating, and presented material from the forefront of research not hitherto presented in New Zealand. About 50 participants, among them more than 20 students, also enjoyed a summery warm week in Hawke's bay, including a walk up to Sunrise Hut in the Ruahine range, guided by David Gauld.
- The third New Zealand Mathematics & Statistics Postgraduate Students (NZMASP) Conference was held at Foxton Beach, 23–26 November 2009. The meeting was organised by Atheer Matroud and Luke Fullard (from Massey University), with help from others around New Zealand, and sponsorship from the NZIMA. As in previous years, the conference was well attended (by 57

Participants at the NZMASP conference



students enrolled in honours, masters, and doctorate degrees at New Zealand universities). Student presentations were very enjoyable, and the attendees gained valuable experience and an opportunity to test out and refine

their talks ahead of bigger events such as the 2009 NZ Mathematics Colloquium. Of particular note were talks from Shannon Ezzat (University of Canterbury) who took out the prize for the best pure mathematics talk, Rachael Tappenden (University of Canterbury) who presented the best applied mathematics talk, Lyndon Walker (University of Auckland) who won the best statistics talk, and Yousaf Habib (University of Auckland) who was voted the “people’s choice” for 2009. Also, two members of the “Calcium Mafia” (from the University of Auckland), Emily Harvey and Katie Sharp, were highly commended.

- Several NZ-based mathematicians attended the first Pacific Rim Mathematical Association (PRIMA) Congress in July, at the University of New South Wales. The congress was a great success, and the next one is being planned for 2013, at a venue yet to be determined. Marston Conder represented the NZIMA at a meeting of PRIMA members (held during the Congress) at which future activities and directions for PRIMA were discussed. He has since been invited to join the PRIMA Steering Committee. For further information about PRIMA, see <http://www.primath.org>.

Public Events and Outreach

The NZIMA sponsored a series of public lectures (in Auckland, Christchurch, Dunedin and Wellington) in March 2009. The title of these lectures was “What an iPod, a Flock of Birds, and DNA have in common...”

In addition to his public lectures, Bernard Chazelle was interviewed for the *MathsReach* website, in an interview with the same title.

Ten interviews (including this one) were added to the *MathsReach* website (www.mathsreach.org) in 2009. These were:

- Andrew Balemi: Market Research Statistics
- Magnus Bordewich: Random and Algorithmic Sampling
- Bernard Chazelle: iPods, a Flock of Birds and DNA



Andrew Balemi

- Rachel Cunliffe: Census at School
- James Curran: Forensic Statistics
- Rachel Fewster: Rats! (and ecological statistics)
- Hugh Gribben: Origami
- Alex James: Return of the Bugs and Beech Trees...
- Clemency Montelle: Lost in Translation
- Raaz Sainudiin: Making Sense out of Chaos



Clemency Montelle

AWARDS AND HONOURS

The following is a selection of awards and honours won by NZIMA people in 2009:

- Bill Barton (Director of our new programme in Mathematics Education) has been elected the next President of the International Commission on Mathematical Instruction (ICMI), from 2010 to 2012.
- Rod Downey (who is one of our PIs and was our first Maclaurin Fellow), has been appointed to the Marsden Fund Council (and as convenor of its panel for Mathematical & Information Science (MIS)).
- Peter Hunter has been appointed by the Minister of Research, Science & Technology as the new chair of the Marsden Fund Council. Peter served as a member of this council and convenor of its Mathematical & Information Sciences Panel from 2005 to 2008.
- Peter Hunter won 2009's "World Class New Zealand" Award, in the Research, Science, Technology & Academia category, presented by KEA New Zealand (Kiwi Expats Association) and New Zealand Trade and Enterprise to celebrate some of New Zealand's tallest poppies.
- Peter Hunter won the Rutherford Medal for 2010. This is New Zealand's top science honour, awarded for exceptional contributions to New Zealand science and technology. In Peter's case, it recognises his distinguished achievements in

biomedical engineering and computational physiology, and in particular, the leading role he has played in the international Physiome Project, which is building sophisticated mathematically-based computer models of all the human body's organs.

- Vaughan Jones was knighted at a ceremony in Wellington in August 2009. Officially, Vaughan becomes a Knight Companion of the New Zealand Order of Merit (KNZM); this replaces his previous title of Distinguished Companion of the New Zealand Order of Merit (DCNZM), which he was awarded in 2002.
- Two NZ-based mathematicians have been invited to give lectures at the next International Congress of Mathematicians, which will take place in India in 2010: Gaven Martin (Massey University), who is one of our PIs and co-director of two of our programmes with geometric themes, and André Nies (University of Auckland), who was a participant in one of our first programmes, on logic and computation. Vaughan Jones gave an invited lecture at the 1986 ICM, and another at the following one (in 1990), when he won his Fields Medal, but the first NZ-based mathematician to be invited to speak at the ICM was Rod Downey, at the last ICM in 2006.
- Gaven Martin gave the Taft Memorial Lectures at the University of Cincinnati (Ohio) for 2009. He was also Van Vleck Distinguished visitor at Wesleyan University (Connecticut) in October 2009.
- Three people associated with NZIMA programmes were elected as Fellows of the Royal Society of New Zealand in 2009: Eamonn O'Brien (MacLaurin Fellow 2008/09 and co-director of our programme on Geometry: Interactions with Algebra and Analysis), Andrew Pullan (a key participant and co-organiser of our programme on Modelling Cellular Function), and Allen Rodrigo (participant in our programme on Phylogenetic Genomics).
- Andy Philpott (who was co-director of our programme on Mathematical Models for Optimizing Transportation Services), is a member of the 3-person Norske Skog team that was one of six finalists in the 2009 Franz Edelman contest. This team was nominated for the pivotal and highly effective role they have given Operations Research in achieving improved profitability.
- Nic Smith, director of one of our first programmes (Modelling cellular function, 2002–05), has been appointed Professor of Computational Physiology at the University of Oxford. Also Nic co-directed a programme on The Cardiac Physiome

Project: mathematical and computational foundations at the Isaac Newton Institute (Cambridge, UK) from June to August 2009.

- David Vere-Jones (one of the NZIMA's founding PIs) has won the Campbell Award of the New Zealand Statistical Association. This award recognises David's exceptional contributions to the promotion and development of statistics in New Zealand (and beyond). In particular, it recognises his many contributions to statistics education at all levels, and his outstanding research and publication record.
- Matt Visser was elected a Fellow of the American Physical Society in November 2009.
- NZIMA scholar Vicky Wang (Auckland Bioengineering Institute) jointly won the best paper award at the Medical Image Computing and Computer Assisted Intervention (MICCAI) Society's Annual Conference in 2009, for her work with fellow student Hoi Leng Lam on developing a computer model of the heart that could help clinicians diagnose and treat patients suffering from heart failure. Their paper was first out of 700 papers presented by entrants from 34 countries, and will appear in the highly-regarded journal Medical Image Analysis.
- Margaret Woolgrove (the NZIMA's Research Manager) won a General Staff Excellence Award at the University of Auckland, for her work on the NZIMA's *MathsReach* resource <http://www.mathsreach.org>. Margaret has managed the *MathsReach* project from the beginning, with assistance from her co-awardees Neil Morrison and Robert Carter (from the University of Auckland's Centre for Academic Development and Science IT group).

INTERNATIONAL LINKAGES

The NZIMA is a member of the International Mathematical Sciences Institutes (IMSI), an international consortium of research institutes in the mathematical sciences that run thematic programmes and have large visitor programmes, and is listed on the IMSI website:

www.fields.utoronto.ca/aboutus/IMSI.html

The NZIMA is a founding member of the new Pacific Rim Mathematical Association (otherwise known as 'PRIMA'), established at the end of 2005 with the aim of promoting and facilitating the development of the mathematical sciences throughout

the Pacific Rim region. This consortium of mathematical sciences institutes involves improved networking, coordination of activities, training (including summer schools), infrastructural assistance, sharing of expertise, and pooling of resources. More information about PRIMA and its intended activities can be now be found on its website <http://www.primath.org/>. A Pacific Rim Mathematical Congress was held in Sydney Australia in July 2009. Marston Conder has been invited to join the Steering Committee of PRIMA.



Communication linkages with institutes overseas have been set up through visits by one or both of the two Co-Directors (often while attending other conferences). These include the Fields Institute in Ontario, the Mathematical Sciences Research Institute (MSRI) in California, and the Pacific Institute of Mathematical Sciences (PIMS) in British Columbia.

Very strong international linkages have been developed by the NZMRI through its earlier programme of annual summer workshops, and these are being taken further by the involvement of invited overseas experts in NZIMA programmes and as visiting Maclaurin Fellows.

The NZIMA's website, the quarterly e-mail newsletter and our new NZ-IMAgEs bulletin (sent to a large number of people overseas) are proving useful devices for maintaining and enhancing international contacts.

Strong and productive international linkages are also being maintained through the NZIMA's International Scientific Advisory Board, which includes a number of representatives from other members of the IMSI (such as the CMA, MSRI and PIMS), as well as prominent New Zealand-born mathematical scientists and others resident overseas.

GOVERNANCE AND MANAGEMENT

The NZIMA's previous Governing Board completed its term in 2008. A new board has been appointed and will meet for the first time in March 2010. Key ongoing challenges for this new board are to formulate strategies for the NZIMA to build its activities, funding, profile and outreach, with the additional challenge of dealing with the outcome of the 2006/07 CoRE selection round.

Our Advisory Board assists the NZIMA by providing advice when requested on the selection of thematic programmes and other important decisions.

Members of our Executive Committee (Rod Downey, David Ryan and Graham Weir) and other ad hoc committees assist the two Co-Directors in making decisions about activities for support using CoRE funds, including the selection of thematic programmes, Maclaurin Fellows, postgraduate scholars, and other activities for support.

The two Co-Directors are interacting with executives of other CoREs in New Zealand and in other mathematical sciences institutes overseas to help develop future strategies and explore opportunities for closer interaction. For example, the NZIMA is helping to promote and facilitate the development of the mathematical sciences throughout the Pacific Rim region through its membership of the Pacific Rim Mathematical Association (PRIMA).

Our Research Manager assists the two Co-Directors, Maclaurin Fellows and programme directors with administrative and financial matters, including annual reports, website development and organisation of conferences/travel, and produces a quarterly newsletter on the NZIMA's activities. She also project manages the production of our newsletter, *NZIMAg*es and items for our schools' website, *MathsReach*.

FINANCIAL STATEMENT

This report covers only the activities supported by the award to the NZIMA from the Centres of Research Excellence (CoRE) Fund.

Statement of Financial Performance for the 2009 year

Income	Actual	Budget	Variance
CoRE Funding	\$ 1,019,444	\$ 1,019,445	\$ (1)
Host/Partner Support	0	0	0
Total Income	\$ 1,019,444	\$ 1,019,445	\$ (1)
Expenditure			
Salaries			
Director & Principal Investigators	\$ 93,052	\$ 92,500	\$ (552)
Associate Investigators	48,544	110,000	61,456
Postdoctoral Fellows	236,793	137,500	(99,293)
Research/ Technical Assistants	0	0	0
Others	33,030	31,000	(2,030)
Total Salaries (a)	\$ 411,419	\$ 371,000	\$ (40,419)
Other Costs			
Project Costs	\$ 172,620	\$ 79,945	\$ (92,676)
Travel	82,065	42,500	(39,565)
Postgraduate Student Support	437,687	150,000	(287,687)
Project Overheads	153,742	185,500	31,758
Host Overheads*	147,378	185,500	38,122
Equipment depreciation	0	0	0
Rental - equipment	460	5000	4,540
Subcontractors	0	0	0
Extraordinary expenditure	0	0	0
Total Other Costs (b)	\$ 993,952	\$ 648,445	\$ (345,508)
Total Expenditure	\$ 1,405,371	\$ 1,019,445	\$ (385,927)
Surplus/Deficit	\$ (385,927)		

*Host overheads made up of

- Univ Auckland indirect costs	\$ 123,018
- NZIMA admin/office costs	24,360

RESEARCH PUBLICATIONS

The following is a selection of publications in 2009 by researchers supported by or involved with the NZIMA during recent times. Note that many of these will also appear in the lists of publications of other Departments or Centres/Institutes in the University of Auckland, or in those for some other New Zealand universities.

Articles in Refereed Journals and Refereed Conference Proceedings

Adamyany, V.; Pavlov, B.; Yafyasov, A.: Modified Krein formula and analytic perturbation procedure for scattering on arbitrary junction. Modern analysis and applications. The Mark Krein Centenary Conference. Vol. 1: Operator theory and related topics, 3–26, Oper. Theory Adv. Appl., 190, Birkhäuser Verlag, Basel, 2009.

Abreu, Gabriel; Visser, Matt: Quantum interest in $(3+1)$ -dimensional Minkowski space. Phys. Rev. D 79 (2009), no. 6, 065004, 9 pp.

Abreu, M.; Aldred, R.E.L.; Funk, M.; Jackson, Bill; Labbate, D.; Sheehan, J.: Corrigendum to: 'Graphs and digraphs with all 2-factors isomorphic'. J. Combin. Theory Ser. B 99 (2009), no. 1, 271–273.

Ahmed, S. Ejaz; Hunter, Jeffrey J.; Styan, George P.H.; Trenkler, Götz: Preface to the Proceedings of the 16th International Workshop on Matrices and Statistics, Windsor 2007. Held at the University of Windsor, Windsor, ON, June 1–3, 2007. Linear Algebra Appl. 430 (2009), no. 10, 2563–2565.

Albert, M.H., Atkinson, M.D., Aldred, R.E.L., Handley, C.C., Holton, D.A., McCaughan, D.J., Sagan, B.E.: Monotonic sequence games. Games of No Chance 3 (ed. M.H. Albert and R. Nowakowski), MSRI Publications 56 (2009), Cambridge University Press, pp. 309–327.

Albert, M.H., Atkinson, M.D., Vatter, V.: Counting 1324, 4231-avoiding permutations, Electronic J. Combinatorics 16 (2009), R136, 9 pages.

Albert, M.H.; Linton, S.A.: Growing at a perfect speed. Combin. Probab. Comput. 18 (2009), no. 3, 301–308.

Aldred, R.E.L.; Fujisawa, Jun; Saito, Akira: Two forbidden subgraphs and the existence of a 2-factor in graphs. Australas. J. Combin. 44 (2009), 235–246.

Aldred, Robert E.L.; Van Dyck, Dries; Brinkmann, Gunnar; Fack, Veerle; McKay, Brendan D.: Graph structural properties of non-Yutsis graphs allowing fast recognition. *Discrete Appl. Math.* 157 (2009), no. 2, 377–386.

Anderson, Glen D.; Sugawa, Toshiyuki; Vamanamurthy, Mavina K.; Vuorinen, Matti: Hypergeometric functions and hyperbolic metric. *Comput. Methods Funct. Theory* 9 (2009), no. 1, 269–284.

Armour, Aaron; Chen, Hui-Xiang; Zhang, Yinhuo: Classification of 4-dimensional graded algebras. *Comm. Algebra* 37 (2009), no. 10, 3697–3728.

Atkinson, M.D.; van Ditmarsch, H.P.; Roehling, S.: Avoiding bias in cards cryptography. *Australas. J. Combin.* 44 (2009), 3–17.

Balemi, Andrew; Lee, Alan: Comparison of GEE1 and GEE2 estimation applied to clustered logistic regression. *J. Stat. Comput. Simul.* 79 (2009), no. 3-4, 361–378.

Barcelo, C., Liberati, S., Sonogo, S., Visser, M.: Revisiting the semiclassical gravity scenario for gravitational collapse. *AIP Conference Proceedings* 1122 (2009), 99–106.

Barcelo, C., Liberati, S., Sonogo, S., Visser, M.: Small, dark, and heavy: But is it a black hole? *Proceedings of Science (BHs GR & Strings) 2009*, 010.

Barmpalias, George; Downey, Rod; Greenberg, Noam: K-trivial degrees and the jump-traceability hierarchy. *Proc. Amer. Math. Soc.* 137 (2009), no. 6, 2099–2109.

Bate, Michael; Martin, Benjamin; Röhrle, Gerhard: On Tits' centre conjecture for fixed point subcomplexes. *C. R. Math. Acad. Sci. Paris* 347 (2009), no. 7-8, 353–356.

Bates, J.H., Bullimore, S.R., Politi, A.Z., Sneyd, J., Anafi, R.C., Lauzon, A.M.: Transient oscillatory force-length behavior of activated airway smooth muscle. *Am. J. Physiol. Lung Cell. Mol. Physiol.* 297 (2009), L362–372.

Bodlaender, Hans L.; Downey, Rodney G.; Fellows, Michael R.; Hermelin, Danny: On problems without polynomial kernels. *J. Comput. System Sci.* 75 (2009), no. 8, 423–434.

Bonnefoy, Félicien; Meylan, Michael H.; Ferrant, Pierre: Nonlinear higher-order spectral solution for a two-dimensional moving load on ice. *J. Fluid Mech.* 621 (2009), 215–242.

Boonserm, Petarpa; Visser, Matt: Transmission probabilities and the Miller-Good transformation. *J. Phys. A* 42 (2009), no. 4, 045301, 10 pp.

- Bordewich, Magnus; Semple, Charles; Spillner, Andreas: Optimizing phylogenetic diversity across two trees. *Appl. Math. Lett.* 22 (2009), no. 5, 638–641.
- Bossert, Walter; Ryan, Matthew J.; Slinko, Arkadii: Orders on subsets rationalised by abstract convex geometries. *Order* 26 (2009), no. 3, 237–244.
- Brown, J.A., Mohammad Salehi M., Mohammad, M., Bell, G., Smith, D.R. An Adaptive Two-Stage Sequential Design for Sampling Rare and Clustered Populations. *Population Ecology* 50 (2008), 239–245.
- Brüning, J.; Martin, G.; Pavlov, B.: Calculation of the Kirchhoff coefficients for the Helmholtz resonator. *Russ. J. Math. Phys.* 16 (2009), no. 2, 188–207.
- Bryant, David: Hadamard phylogenetic methods and the n-taxon process. *Bull. Math. Biol.* 71 (2009), no. 2, 339–351.
- Butcher, J.C.: Order and stability of generalized Padé approximations. *Appl. Numer. Math.* 59 (2009), no. 3-4, 558–567.
- Butcher, J.C.: Practical Runge-Kutta methods for scientific computation. *ANZIAM J.* 50 (2009), no. 3, Special Issue, 333–342.
- Butcher, J.C.; Hewitt, L.L.: The existence of symplectic general linear methods. *Numer. Algorithms* 51 (2009), no. 1, 77–84.
- Butcher, John: General linear methods for ordinary differential equations. *Math. Comput. Simulation* 79 (2009), no. 6, 1834–1845.
- Calude, Cristian S.; Hay, Nicholas J.: Every computably enumerable random real is provably computably enumerable random. *Log. J. IGPL* 17 (2009), no. 4, 351–374.
- Calude, Cristian S.; Jürgensen, Helmut; Staiger, Ludwig: Topology on words. *Theoret. Comput. Sci.* 410 (2009), no. 24-25, 2323–2335.
- Calude, Cristian S.; Staiger, Ludwig: On universal computably enumerable prefix codes. *Math. Structures Comput. Sci.* 19 (2009), no. 1, 45–57.
- Celledoni, Elena; McLachlan, Robert I.; McLaren, David I.; Owren, Brynjulf; Quispel, G. Reinout W.; Wright, William M.: Energy-preserving Runge-Kutta methods. *M2AN Math. Model. Numer. Anal.* 43 (2009), no. 4, 645–649.
- Cenzer, Douglas; Csimá, Barbara F.; Khousainov, Bakhadyr: Linear orders with distinguished function symbol. *Arch. Math. Logic* 48 (2009), no. 1, 63–76.

Cenzer, Douglas; Downey, Rodney G.; Remmel, Jeffrey B.; Uddin, Zia: Space complexity of abelian groups. *Arch. Math. Logic* 48 (2009), no. 1, 115–140.

Champneys, Alan R.; Kirk, Vivien; Knobloch, Edgar; Oldeman, Bart E.; Rademacher, J.D.M.: Unfolding a tangent equilibrium-to-periodic heteroclinic cycle. *SIAM J. Appl. Dyn. Syst.* 8 (2009), no. 3, 1261–1304.

Conder, Marston D.E.: Regular maps and hypermaps of Euler characteristic -1 to -200 . *J. Combin. Theory Ser. B* 99 (2009), no. 2, 455–459.

Conder, Marston D.E.; Kwon, Young Soo; Siran, Jozef: Reflexibility of regular Cayley maps for abelian groups. *J. Combin. Theory Ser. B* 99 (2009), no. 1, 254–260.

Conder, Marston: On symmetries of Cayley graphs and the graphs underlying regular maps. *J. Algebra* 321 (2009), no. 11, 3112–3127.

Conder, Marston; Nedela, Roman: A refined classification of symmetric cubic graphs. *J. Algebra* 322 (2009), no. 3, 722–740.

David, T.; Alzaidi, S.; Farr, H.: Coupled autoregulation models in the cerebro-vasculature. *J. Engrg. Math.* 64 (2009), no. 4, 403–415.

Day, Adam R.: On the computational power of random strings. *Ann. Pure Appl. Logic* 160 (2009), no. 2, 214–228.

de Carvalho, Marcelo H.; Little, C.H.C.: Circuit decompositions of join-covered graphs. *J. Graph Theory* 62 (2009), no. 3, 220–233.

Detinko, A.S.; Flannery, D.L.; O'Brien, E.A.: Deciding finiteness of matrix groups in positive characteristic. *J. Algebra* 322 (2009), no. 11, 4151–4160.

Dhondi, S., Pereira, G., Hendy, S.C.: Molecular dynamics simulations of polymeric fluids in narrow channels: Methods to enhance mixing, *Phys. Rev. E* 80 (2009), 036309.

Edgar, K., Hendy, S.C., Spencer, J.L., Tilley, R.D.: The Synthesis of Carbon Nanotubes from Metal Nanoparticles”, *AIP Conference Proceedings* 1151 (2009), 145.

Elvin, A.J.; Laing, C.R.; Roberts, M.G.: Transient Turing patterns in a neural field model. *Phys. Rev. E* (3) 79 (2009), no. 1, 011911, 6 pp.

Eusébio, Augusto; Figueira, José Rui; Ehr Gott, Matthias: A primal-dual simplex algorithm for bi-objective network flow problems. *4OR* 7 (2009), no. 3, 255–273.

- Figueira, Santiago; Miller, Joseph S.; Nies, André: Indifferent sets. *J. Logic Comput.* 19 (2009), no. 2, 425–443.
- Geelen, Jim; Gerards, Bert; Whittle, Geoff: Tangles, tree-decompositions and grids in matroids. *J. Combin. Theory Ser. B* 99 (2009), no. 4, 657–667.
- Geelen, Jim; Kung, Joseph P.S.; Whittle, Geoff: Growth rates of minor-closed classes of matroids. *J. Combin. Theory Ser. B* 99 (2009), no. 2, 420–427.
- Gehring, Frederick W.; Martin, Gaven J.: Minimal co-volume hyperbolic lattices. I. The spherical points of a Kleinian group. *Ann. of Math. (2)* 170 (2009), no. 1, 123–161.
- Gibbons, P.B.; Mathon, R.: Enumeration of generalized Hadamard matrices of order 16 and related designs. *J. Combin. Des.* 17 (2009), no. 2, 119–135.
- Gin, E., Falcke, M., Wagner, L.E., Yule, D.I., Sneyd, J.: Markov chain Monte Carlo fitting of single-channel data from inositol trisphosphate receptors. *J. Theoretical Biology* 257 (2009), 460–474.
- Gin, E., Falcke, M., Wagner, L.E., Yule, D.I., Sneyd, J.: A kinetic model of the inositol trisphosphate receptor based on single-channel data. *Biophysical J.* 96 (2009), 4053–4062.
- Goldblatt, Robert: Conservativity of Heyting implication over relevant quantification. *Rev. Symb. Log.* 2 (2009), no. 2, 310–341.
- Goldblatt, Robert; Hodkinson, Ian: Commutativity of quantifiers in varying-domain Kripke models. *Towards mathematical philosophy*, 9–30, *Trends Log. Stud. Log. Libr.*, 28, Springer, Dordrecht, 2009.
- Gover, A.R.; Shaukat, A.; Waldron, A.: Tractors, mass, and Weyl invariance. *Nuclear Phys. B* 812 (2009), no. 3, 424–455.
- Gover, A.R.; Shaukat, A.; Waldron, A.: Weyl Invariance and the Origins of Mass, *Phys. Letters B* 675 (2009), 93–97.
- Grünwald, Stefan; Huber, Katharina T.; Moulton, Vincent; Semple, Charles; Spillner, Andreas: Characterizing weak compatibility in terms of weighted quartets. *Adv. in Appl. Math.* 42 (2009), no. 3, 329–341.
- Greenberg, Noam; Miller, Joseph S.: Lowness for Kurtz randomness. *J. Symbolic Logic* 74 (2009), no. 2, 665–678.

Grosjean, J.-F.; Nagy, P.-A.: On the cohomology algebra of some classes of geometrically formal manifolds. *Proc. Lond. Math. Soc.* (3) 98 (2009), no. 3, 607–630.

Hairer, Ernst; McLachlan, Robert I.; Skeel, Robert D.: On energy conservation of the simplified Takahashi-Imada method. *M2AN Math. Model. Numer. Anal.* 43 (2009), no. 4, 631–644.

Heikkala, Ville; Vamanamurthy, Mavina K.; Vuorinen, Matti: Generalized elliptic integrals. *Comput. Methods Funct. Theory* 9 (2009), no. 1, 75–109.

Hendy, S.C., Awasthi, A., Schebarchov, D.: Molecular dynamics simulations of nanoparticles, *Int. J. Nanotechnology* 6 (2009), 274–287.

Hendy, S.C., Lund, N.J.: Effective slip lengths for flows over surfaces with nanobubbles: the effects of finite slip”, *Journal of Physics: Condensed Matter* 21 (2009), 144202.

Hendy, S.C., Schebarchov, D.: Superheating in metal nanoparticles with non-melting surfaces, *European Physical J. D* 53 (2009), 63–68.

Himstedt, Frank; Huang, Shih-chang: Character table of a Borel subgroup of the Ree groups $2F_4(q^2)$. *LMS J. Comput. Math.* 12 (2009), 1–53.

Hlineny, Petr; Whittle, Geoff: Addendum to matroid tree-width. *European J. Combin.* 30 (2009), no. 4, 1036–1044.

Holmes, Mark: The scaling limit of senile reinforced random walk. *Electron. Commun. Probab.* 14 (2009), 104–115.

Humphries, Peter J.; Semple, Charles: Note on the hybridization number and subtree distance in phylogenetics. *Appl. Math. Lett.* 22 (2009), no. 4, 611–615.

Hunter, Jeffrey J.: Coupling and mixing times in a Markov chain. *Linear Algebra Appl.* 430 (2009), no. 10, 2607–2621.

Iwaniec, Tadeusz; Martin, Gaven; Sbordone, Carlo: L_p -integrability & weak type L_2 -estimates for the gradient of harmonic mappings of D . *Discrete Contin. Dyn. Syst. Ser. B* 11 (2009), no. 1, 145–152.

Jackiewicz, Z.; Zubik-Kowal, B.; Basse, B.: Finite-difference and pseudo-spectral methods for the numerical simulations of in vitro human tumor cell population kinetics. *Math. Biosci. Eng.* 6 (2009), no. 3, 561–572.

- Jaikin-Zapirain, A.; Newman, M.F.; O'Brien, E.A.: On p -groups having the minimal number of conjugacy classes of maximal size. *Israel J. Math.* 172 (2009), 119–123.
- James, Alex; Green, Simon; Plank, Mike: Modelling the dynamic response of oxygen uptake to exercise. *Discrete Contin. Dyn. Syst. Ser. B* 12 (2009), no. 2, 361–370.
- Kalnins, Ernest G.; Kress, Jonathan M.; Miller, Willard, Jr.; Post, Sarah: Structure theory for second order 2D superintegrable systems with 1-parameter potentials. *SIGMA Symmetry Integrability Geom. Methods Appl.* 5 (2009), Paper 008, 24 pp.
- Kanibir, A.; Reilly, I.L.: Generalized continuity for multifunctions. *Acta Math. Hungar.* 122 (2009), no. 3, 283–292.
- Khoussainov, Bakhadyr; Liu, Jiamou: On complexity of Ehrenfeucht-Fraïssé games. *Ann. Pure Appl. Logic* 161 (2009), no. 3, 404–415.
- Khoussainov, Bakhadyr; Liu, Jiamou; Minnes, Mia: Unary automatic graphs: an algorithmic perspective. *Math. Structures Comput. Sci.* 19 (2009), no. 1, 133–152.
- Khoussainov, Bakhadyr; Minnes, Mia: Model-theoretic complexity of automatic structures. *Ann. Pure Appl. Logic* 161 (2009), no. 3, 416–426.
- Kojadinovic, Ivan; Holmes, Mark: Tests of independence among continuous random vectors based on Cramér-von Mises functionals of the empirical copula process. *J. Multivariate Anal.* 100 (2009), no. 6, 1137–1154.
- Korobeinikov, Andrei; Norbury, John; Wake, Graeme C.: Long-term coexistence for a competitive system of spatially varying gradient reaction-diffusion equations. *Nonlinear Anal. Real World Appl.* 10 (2009), no. 1, 93–103.
- Lee, Jack; Niederer, Steven; Nordsletten, David; Le Grice, Ian; Smail, Bruce; Kay, David; Smith, Nicolas: Coupling contraction, excitation, ventricular and coronary blood flow across scale and physics in the heart. *Philos. Trans. R. Soc. Lond. Ser. A Math. Phys. Eng. Sci.* 367 (2009), no. 1896, 2311–2331.
- Leedham-Green, C.R.; O'Brien, E.A.: Constructive recognition of classical groups in odd characteristic. *J. Algebra* 322 (2009), no. 3, 833–881.
- Lim, T.H., McCarthy, D., Hendy, S.C., Brown, S.A., Tilley, R.D.: Real-Time TEM and Kinetic Monte Carlo Studies of the Coalescence of Decahedral Gold Nanoparticles, *ACS Nano* 3 (2009), 3809–3913.

Linz, S., Semple, C: Hybridization in non-binary trees. *IEEE/ACM Trans. Comp. Biology and Bioinformatics* 6 (2009), 30–45.

Loz, Eyal: Graphs of given degree and diameter obtained as abelian lifts of dipoles. *Discrete Math.* 309 (2009), no. 10, 3125–3130.

Lund, N.J.; Hendy, S.C.: Effective slip length of nanoscale mixed-slip surfaces. *ANZIAM J.* 50 (2009), no. 3, Special Issue, 381–394.

Luo, W.; Wake, G.C.; Hawk, C.W.: Numerical determination of critical conditions for thermal ignition. *ANZIAM J.* 50 (2009), no. 3, Special Issue, 283–305.

Mackay, Jade R.; White, Stephen P.; Hendy, Shaun C.: Modelling the growth of zinc oxide nanostructures. *ANZIAM J.* 50 (2009), no. 3, Special Issue, 395–406.

Mahmood-Ul-Hassan; Meylan, Michael H.; Peter, Malte A.: Water-wave scattering by submerged elastic plates. *Quart. J. Mech. Appl. Math.* 62 (2009), no. 3, 321–344.

Martin, Gaven J.: The Teichmüller problem for mean distortion. *Ann. Acad. Sci. Fenn. Math.* 34 (2009), no. 1, 233–247.

Mayhew, Dillon; Newman, Mike; Whittle, Geoff: On excluded minors for real-representability. *J. Combin. Theory Ser. B* 99 (2009), no. 4, 685–689.

McLachlan, R.I.; Quispel, G.R.W.; Tse, P.S.P.: Linearization-preserving self-adjoint and symplectic integrators. *BIT* 49 (2009), no. 1, 177–197.

McLachlan, Robert I.: The structure of a set of vector fields on Poisson manifolds. *J. Phys. A* 42 (2009), no. 14, 142001, 3 pp.

McLachlan, Robert; Zhang, Xingyou: Well-posedness of modified Camassa-Holm equations. *J. Differential Equations* 246 (2009), no. 8, 3241–3259.

Meylan, Michael H.: Time-dependent linear water-wave scattering in two dimensions by a generalized eigenfunction expansion. *J. Fluid Mech.* 632 (2009), 447–455.

Meylan, Michael H.; Eatock Taylor, Rodney: Time-dependent water-wave scattering by arrays of cylinders and the approximation of near trapping. *J. Fluid Mech.* 631 (2009), 103–125.

Moors, Warren B.; Spurny, Jiri: On the topology of pointwise convergence on the boundaries of L_1 -preduals. *Proc. Amer. Math. Soc.* 137 (2009), no. 4, 1421–1429.

- Nies, André; Semukhin, Pavel: Finite automata presentable abelian groups. *Ann. Pure Appl. Logic* 161 (2009), no. 3, 458–467.
- O’Neale, Dion R.J.; McLachlan, Robert I.: Reconsidering trigonometric integrators. *ANZIAM J.* 50 (2009), no. 3, Special Issue, 320–332.
- O’Sullivan, Michael J.; Saunders, Michael A.: Stabilizing policy improvement for large-scale infinite-horizon dynamic programming. *SIAM J. Matrix Anal. Appl.* 31 (2009), no. 2, 434–459.
- Postlethwaite, Claire M.: Stabilization of long-period periodic orbits using time-delayed feedback control. *SIAM J. Appl. Dyn. Syst.* 8 (2009), no. 1, 21–39.
- Pretolani, Daniele; Nielsen, Lars Relund; Andersen, Kim Allan; Ehrgott, Matthias : Time-adaptive and history-adaptive multicriterion routing in stochastic, time-dependent networks. *Oper. Res. Lett.* 37 (2009), no. 3, 201–205.
- Pritchard, Geoffrey; Wilson, Mark C.: Asymptotics of the minimum manipulating coalition size for positional voting rules under impartial culture behaviour. *Math. Social Sci.* 58 (2009), no. 1, 35–57.
- Schebarchov, D., Hendy, S.C.: Capillary absorption of metal nanodroplets by single-wall carbon nanotubes, *Nano Letters* 9 (2009), 3668.
- Shebarchov, D., Hendy, S.C., Polak, W.: Molecular dynamics study of the melting of a supported 887-atom Pd decahedron, *Journal of Physics: Condensed Matter* 21 (2009), 144204.
- Shorten, P.R., Sneyd, J.: A mathematical analysis of obstructed diffusion within skeletal muscle. *Biophysical J.* 96 (2009), 4764–4778.
- Skakala, J., Visser, M.: Birefringence in pseudo-Finsler spacetimes. *J. Physics: Conference series* 189 (2009), 012037.
- Sotiriou, Thomas P.; Visser, Matt; Weinfurtner, Silke: Phenomenologically viable Lorentz-violating quantum gravity. *Phys. Rev. Lett.* 102 (2009), no. 25, 251601, 4 pp.
- Sotiriou, Thomas P.; Visser, Matt; Weinfurtner, Silke: Quantum gravity without Lorentz invariance. *J. High Energy Physics* 10 (2009), 33.
- Steel, Mike; Faller, Beáta: Markovian log-supermodularity, and its applications in phylogenetics. *Appl. Math. Lett.* 22 (2009), no. 7, 1141–1144.

- Suebcharoen, T.; Satiracoo, P.; Wake, Graeme C.: Distributed delay logistic equations with harvesting. *Differential Integral Equations* 22 (2009), no. 3-4, 321–337.
- Tuffley, Christopher: Generalized knot groups distinguish the square and granny knots. With an appendix by David Savitt. *J. Knot Theory Ramifications* 18 (2009), no. 8, 1129–1157.
- Vandal, Alain C.; Conder, Marston D.E.; Gentleman, Robert: Minimal covers of maximal cliques for interval graphs. *Ars Combin.* 92 (2009), 97–129.
- Visser, M.: Black holes in general relativity. *Proceedings of Science (BHs GR & Strings)* 2009, 001.
- Visser, Matt: Explicit form of the Mann-Marolf surface term in (3+1) dimensions. *Phys. Rev. D* 79 (2009), no. 2, 024023, 5 pp.
- Visser, Matt: Lorentz symmetry breaking as a quantum field theory regulator. *Phys. Rev. D* 80 (2009), no. 2, 025011, 15 pp.
- Visser, M.: Quantum gravity: Progress at a price. *Nature Phys.* 5 (2009), 385–386.
- Visser, M., Weinfurtner, S., White, W.: Signature-change events in emergent spacetimes with anisotropic scaling. *J. Physics: Conference series* 189 (2009), 012046.
- Walker, B., Hendy, S.C., Tilley, R.D.: Density functional studies of surface functionalization in semiconductor quantum dots, *AIP Conference Proceedings* 1151 (2009), 98.
- Walker, B.G., Hendy, S.C., Tilley, R.D.: Mixed Si-Ge nanoparticle quantum dots: a time-dependent density functional theory study, *European Physical J. B* 72 (2009), 193–201.
- Wang, Jianfeng; Teo, K.L.; Huang, Qiongxiang; Ye, Chengfu; Liu, Ruying: A new expression for the adjoint polynomial of a path. *Australas. J. Combin.* 43 (2009), 103–113.
- Wang, S.H.; Van Daele, A.; Zhang, Y.H.: Constructing quasitriangular multiplier Hopf algebras by twisted tensor coproducts. *Comm. Algebra* 37 (2009), no. 9, 3171–3199.
- Weinfurtner, Silke; Jain, Piyush; Visser, Matt; Gardiner, C.W.: Cosmological particle production in emergent rainbow spacetimes. *Classical Quantum Gravity* 26 (2009), no. 6, 065012, 49 pp.

Wilson, Mark C.: *Random and exhaustive generation of permutations and cycles*. Ann. Comb. 12 (2009), no. 4, 509–520.

Zeller, S., Rudiger, S., Engel, H., Sneyd, J., Warnecke, G., Parker, I., Falcke, M.: *Modeling of the modulation by buffers of Ca^{2+} release through clusters of IP3 receptors*, Biophysical J. 97 (2009), 992–1002.

Books

Astala, Kari; Iwaniec, Tadeusz; Martin, Gaven: *Elliptic partial differential equations and quasiconformal mappings in the plane*. Princeton Mathematical Series, 48. Princeton University Press, Princeton, NJ, 2009. xviii+677 pp. ISBN: 978-0-691-13777-3

Keener, James; Sneyd, James: *Mathematical physiology. Vol. I: Cellular physiology*. Second edition. Interdisciplinary Applied Mathematics, 8/I. Springer, New York, 2009. xxvi+470+A2+R45+I29 pp. ISBN: 978-0-387-75846-6

Keener, James; Sneyd, James: *Mathematical physiology. Vol. II: Systems physiology*. Second edition. Interdisciplinary Applied Mathematics, 8/II. Springer, New York, 2009. pp. i–xxvi, 471–974, A1–A2, R1–R45 and I1–I29. ISBN: 978-0-387-79387-0

Nies, André: *Computability and randomness*. Oxford Logic Guides, 51. Oxford University Press, Oxford, 2009. xvi+433 pp. ISBN: 978-0-19-923076-1

Wiltshire, D.L., Visser, M., Scott, S.M. (eds): *The Kerr spacetime: Rotating black holes in general relativity*. Cambridge University Press, 2009, 362 pages.

Research report

Basse, B., Bourdôt, G., Brown, J.A., Lamoureaux, S.: *New Zealand National Weeds Distribution Database: a feasibility study*. Report for Environment Southland, Envirolink medium advice 499-ESRC212, University of Canterbury Research Report UCDMS2008/8, 17 pages.

