Volume 41 Number 5 2014

The Australian Mathematical Society

Gazette

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The *Gazette* publishes items of the following types:

- Reviews of books, particularly by Australian authors, or books of wide interest
- Classroom notes on presenting mathematics in an elegant way
- Items relevant to mathematics education
- Letters on relevant topical issues
- Information on conferences, particularly those held in Australasia and the region
- Information on recent major mathematical achievements
- Reports on the business and activities of the Society
- Staff changes and visitors in mathematics departments
- News of members of the Australian Mathematical Society

Local correspondents submit news items and act as local Society representatives. Material for publication and editorial correspondence should be submitted to the editors. Any communications with the editors that are not intended for publication must be clearly identified as such.

Notes for contributors

Please send contributions to gazette@austms.org.au. Submissions should be fairly short, easy to read and of interest to a wide range of readers.

Please typeset technical articles using LaTeX or variants. In exceptional cases other editable electronic formats such as plain text or Word may be accepted. Please do not use definitions in your TeX files, as they may conflict with our style files. If you find such definitions convenient, please use a text editor to reinstate the standard commands before sending your submission.

Please supply diagrams as vector images (not bitmaps) where possible, as postscript (.ps) or encapsulated (.eps) files. Please supply photos at high-resolution (i.e. at least 400 pixels per inch (16 pixels per mm) at the final size of reproduction. For example, if the image is to be printed at 90 mm wide, it must be at least 1400 pixels wide. If JPEG format is used, images must be created with a high quality factor, i.e. artefacts such as halos of dots or jagged edges should not be obtrusive at high magnification. For more information, see *An Introduction to Computer Images* at delta-intkey.com/www/images.htm.

More information can be obtained from the *Gazette* website.

Deadlines for submissions to 42(1), 42(2) and 42(3) of the *Gazette* are 1 February, 1 April and 1 June 2015.

Volume 41 Number 5 2014

Editorial

Sid and I welcome you to the last issue of the *Gazette* for 2014. Close to the end of another year of teaching, the *Gazette* will have its usual four-month gap between issues, with the next one due in March 2015. Interactions between mathematicians won't stop in the summer period, with a plethora of courses and conferences available, and listed in the news section.

In particular, the Annual Meeting in December will be a joint meeting with the New Zealand Mathematical Society, an event which happens every six years. This 8th Australia New Zealand Mathematics Convention will take place at the University of Melbourne. About 50 of our colleagues from across the Tasman are expected to participate. We welcome them and look forward to their contributions.

With this issue we see Peter Forrester step down as President of the Society. The next President's column will be from the incoming president Tim Marchant, who takes over the role at the annual meeting in December. We thank Peter for his contributions over the last two and a bit years.

Nalini Joshi reflects on the value of conferences large and small in her NCMS column. In particular, she reports on the possibility of Australia hosting the quadrennial International Conference on Mathematical Education in 2020.

Nalini has been contributing to the public profile of mathematics in other ways, with her appointment to the Commonwealth Science Coucil and her television appearance, on Q&A.

We report on several honours in this issue, most notably the award of the Royal Society's 2014 Royal Medal to Terry Tao. Calls for nominations for the Australian Mathematical Society's own medals are in the AustMS news column.

Geoff Prince reports on AMSI's continuing advocacy for mathematics in his column. Peter Johnston continues his service to the mathematical community with his annual collection of data about completions of Higher Degrees and Honours Degrees in Mathematics and Statistics from last year.

Gerry Joseph, John Giles and and Bob Anderssen have supplied a fitting tribute in their obituary of Reyn Keats, who passed away in April, after many years of contributions to mathematics in Australia.

Once again, we have our popular regular features, the Puzzle Corner and two book reviews.

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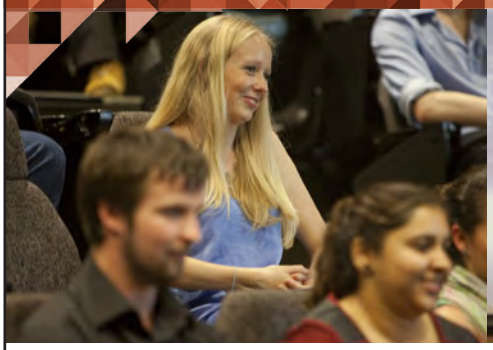
David Yost is a graduate of the University of Melbourne, the Australian National University and the University of Edinburgh. He has lived in eight countries and ten cities, returning to Australia in 2003, where he has recently completed eleven years at Federation University Australia and its predecessor institution, the University of Ballarat, including a three-year period as Deputy Head of School. While most of his research is in functional analysis, he has lately been interested in convex geometry.

Research
Australian Mathematical Sciences Institute

AMSI Sponsored Workshops

September 2014 – April 2015



Forthcoming events

EViMS: Workshop on the Effective Use of Visualization in the Mathematical Sciences
21–23 November 2014, Australian National University

New Directions in Fractal Geometry
23–28 November 2014, Australian National University, Coastal Campus

Sequences and Their Applications (SETA) 2014
24–28 November 2014, The University of Melbourne

BioInfoSummer 2014
1–5 December 2014, Monash University

Differential Geometry, Lie theory and Complex Analysis
5–7 December 2014, La Trobe University

Applied Statistics and Public Policy Analysis Conference
11–12 December 2014, Charles Sturt University

AMSI Summer School 2015
3–29 January 2015, University of Newcastle

Algebraic, Number Theoretic and Graph Theoretic Aspects of Dynamical Systems
2–6 February 2015, University of New South Wales

South Pacific Continuous Optimization Meeting
8–12 February 2015, University of South Australia

Symmetries and Spinors: Interactions Between Geometry and Physics
13–17 April 2015, The University of Adelaide

Workshop & travel funding available
Next round closes 28 November 2014

More info: www.amsi.org.au/events

President's Column

Peter Forrester*

With the annual conference this year not being until December, due to it being joint with the New Zealand Mathematical Society, my term as President extends a couple of months beyond the nominal two years. Still, the incoming President, Tim Marchant, will get to serve a full two-year term, as after the 2015 annual conference, which is to be held starting late September at Flinders University, the 2016 annual conference is scheduled to be held in early December. This new date was approved by Council at the annual general meeting this time last year in a bid to open up participation to members who have teaching commitments during the so-called common break week in 2nd semester. The location of the 2016 meeting is, at the time of writing, being negotiated between AustMS Vice President (Annual Conferences) Ole Warnaar and a University that indeed does not observe the common break week. Having more universities eligible to hold the annual meeting is also another important consideration in the change of date.

Remembering back to my first President's Column, I had occasion to make mention of the perennial issue of the importance of our communication skills, both with respect to the external representation of our discipline, and for the interests of our own research. Lately, the issue of communication for the purposes of representation of our discipline has again become prominent, with both some good and bad news. The good news is that AustMS member Terry Speed — the 2013 recipient of the prestigious Prime Minister's Prize for Science — has since August been lecturing around the country as the AMSI–SSAI lecture on topics relating to bioinformatics. This field is a prime example of modern inter-disciplinary research which is motivating new researchers — here geneticists and biologists — to take up studies in mathematics and statistics. The bad news is that in broader science forums — an example being the recent (15 September) Q&A on the ABC — mathematics and statistics is all too often mentioned only in passing. In particular the societal benefit of activities undertaken by applied mathematicians in the fields of mathematical modelling, optimisation and computer algorithms to name a few, or the underpinnings of developments in applied mathematics due to basic research in pure mathematics, aren't being given their due press. Geoff Prince at AMSI is very aware of this issue, and is making efforts wherever possible to coordinate the profiling of our discipline in the mass media.

There are happenings taking place in mathematics and statistics departments around the country at present which are unprecedented for the generational change they will set in place. Here I'm referring in particular to the 15 positions advertised all in one hit at Monash, and of the (staggered) recruitment of around 10 new staff members here at Melbourne. While indeed one hopes that new directions

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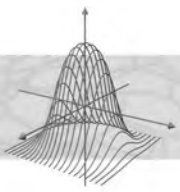
and future leaders will emerge out of this expansion phase, to sustain such growth even in the short term, new sources of funding, the retention or growth of service teaching, an increase in the quality and quantity of mathematics and statistics majors, and a larger intake of higher degree students from overseas will all be necessary. Certainly the passing of the budget proposal to increase the CPS funding for mathematics would get things off to a good start.

I have two concluding points to wrap up my series of President's Columns. The first is to echo the words of Thierry Coulhon, Director of the Mathematical Institute at the ANU, who, at a meeting relating to the formation of a national research centre, offered the opinion that an overarching goal should be to increase the visibility of the footprint left by Australian mathematics in the world arena. As a suggestion, one way AustMS could contribute to this goal is to commission some targeted research articles, reviews or even monographs for our publishing titles. Another idea is to consider sponsoring web-based lectures for a world-wide audience as pioneered so successfully by Chris Tisdell from UNSW. My second and final point is to pay tribute to the two pillars of AustMS's very existence, our honorary treasurer, Algy Howe, with over 20 years in the role, and our honorary secretary, Peter Stacey, who puts in a remarkable amount of work in both quantity and quality. That both Algy and Peter are continuing in their respective roles is certainly good news for Tim Marchant as he takes over as President this December.

Peter Forrester received his Doctorate from the Australian National University in 1985, and held a postdoctoral position at Stony Brook before joining La Trobe University as a lecturer in 1987. In 1994 he was awarded a senior research fellowship by the ARC, which he took up at The University of Melbourne. Peter's research interests are broadly in the area of mathematical physics, and more particularly in random matrix theory and related topics in statistical mechanics. This research and its applications motivated the writing of a large monograph 'log-gases and random matrices' (PUP, Princeton) which took place over a fifteen-year period. His research has been recognised by the award of the Medal of the Australian Mathematical Society in 1993, and election to the Australian Academy of Science in 2004, in addition to several ARC personal fellowships.



Puzzle Corner

Ivan Guo*

Welcome to the Australian Mathematical Society *Gazette*'s Puzzle Corner number 40. Each puzzle corner includes a handful of fun, yet intriguing, puzzles for adventurous readers to try. They cover a range of difficulties, come from a variety of topics, and require a minimum of mathematical prerequisites for their solution. Should you happen to be ingenious enough to solve one of them, then you should send your solution to us.

For each puzzle corner, the reader with the best submission will receive a book voucher to the value of $50, not to mention fame, glory and unlimited bragging rights! Entries are judged on the following criteria, in decreasing order of importance: accuracy, elegance, difficulty, and the number of correct solutions submitted. Please note that the judge's decision — that is, my decision — is absolutely final. Please email solutions to ivanguo1986@gmail.com or send paper entries to: Gazette of the Australian Mathematical Society, Faculty of Science and Technology, Federation University Australia, PO Box 663, Ballarat, Victoria 3353, Australia.

The deadline for submission of solutions for Puzzle Corner 40 is 15 January 2015. The solutions to Puzzle Corner 40 will appear in Puzzle Corner 42 in the May 2015 issue of the *Gazette*.

Notice: If you have heard of, read, or created any interesting mathematical puzzles that you feel are worthy of being included in the Puzzle Corner, I would love to hear from you! They don't have to be difficult or sophisticated. Your submissions may very well be featured in a future Puzzle Corner, testing the wits of other avid readers.

Rolling riddle

On average, how many times do you have to roll a die before all six numbers appear at least once?

Balanced views

Given a convex polygon $A_1A_2\cdots A_n$ in the plane, we say a point P (in the same plane) is *balanced* if

$$\angle A_1PA_2 = \angle A_2PA_3 = \cdots = \angle A_{n-1}PA_n = \angle A_nPA_1.$$

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(i) Prove that for any convex polygon with an odd number of sides, there is at most one balanced point in the plane.

(ii) Can there ever be more than one balanced point if the convex polygon has an even number of sides?

Spherical stroll

An ant is crawling on the surface of a sphere whose radius is one metre. After a while, the ant returns to its starting position. Prove that if the ant has crawled no more than 2π metres, then its path can be contained in some hemisphere of the sphere.

Digital division

Consider the set of all five-digit numbers whose decimal representation is a permutation of digits 1, 2, 3, 4 and 5. Is it possible to divide this set into two groups, so that the sum of the squares of the numbers in each group is the same?

Tricky triangulation

For $n \geq 3$, a convex n-gon can be divided into $n-2$ triangles by using $n-3$ of its diagonals. This is called a *triangulation*. For which values of n is it possible to triangulate a convex n-gon such that every vertex is adjacent to an odd number of the resulting triangles?

Solutions to Puzzle Corner 38

Many thanks to everyone who submitted. The $50 book voucher for the best submission to Puzzle Corner 38 is awarded to Jensen Lai. Congratulations!

Surface temperature

For the purpose of this puzzle, let us assume that the Earth is perfectly spherical, and the surface temperature is a continuous function of the Earth's surface.

(i) *Prove that there exist two antipodal points with the same surface temperature.*

(ii) *Fix a distance d less than the diameter of the Earth. Prove that there exist two points exactly d apart, that have the same surface temperature.*

Solution by Aaron Hassan: (i) For any point X on the Earth's surface, define a function $f(X)$ to be the difference in surface temperature between X and its antipodal point X', so $f(X) = T(X) - T(X')$ where T is the surface temperature. Since $f(X)$ is a continuous function of the Earth's surface, it suffices to find a point X such that $f(X) = 0$.

Take any point P on the equator and suppose that $f(P) \neq 0$. Without loss of generality, say $f(P) > 0$. If P' is the antipodal point of P, then

$$f(P') = T(P') - T(P) = -f(P) < 0.$$

Since $f(P)$ and $f(P')$ have opposite signs, by the intermediate value theorem, as we move from P to P' along the equator, there must be a point Q at which $f(Q) = 0$. Thus there must exist two antipodal points with the same surface temperature.

(ii) The argument is similar to part (i). Instead of the equator, let us concentrate on a circle Γ of diameter d on the Earth's surface (e.g. a set of points with the same latitude). This is possible since d is less than the diameter of the Earth. For any point X on Γ, define the function $f(X)$ to be the temperature difference between X and its opposite point on Γ. The argument from part (i) can now be applied to find two diametrically opposite points on Γ (so they have distance d) with the same surface temperature.

Triangle existence

(i) *For which integer values of x does there exist a non-degenerate triangle with side lengths of 5, 10 and x?*

(ii) *In a triangle, an altitude length refers to the perpendicular distance from a vertex to the opposite side. For which integer values of x does there exist a non-degenerate triangle with altitude lengths of 5, 10 and x?*

Solution by M.V. Channakeshava: (i) First recall the triangle inequality, which states that in any non-degenerate triangle, the sum of the two shorter sides is strictly greater than the longest side. Conversely, it is always possible to construct a triangle with given side lengths as long as they satisfy the triangle inequality.

In the present context, we have the inequalities

$$5 + 10 > x, \qquad 5 + x > 10, \qquad 10 + x > 5.$$

These are equivalent to $5 < x < 15$. Therefore the possible integer values for x are 6, 7, 8, 9, 10, 11, 12, 13 and 14.

(ii) If the area of the triangle is A, then the three sides of the triangle must be $\frac{2A}{5}$, $\frac{2A}{10}$ and $\frac{2A}{x}$. Again applying the triangle inequality, we have

$$\frac{2A}{5} + \frac{2A}{10} > \frac{2A}{x}, \qquad \frac{2A}{5} + \frac{2A}{x} > \frac{2A}{10}, \qquad \frac{2A}{10} + \frac{2A}{x} > \frac{2A}{5}.$$

These simplify to $\frac{10}{3} < x < 10$. So the possible integer values for x are 4, 5, 6, 7, 8 and 9.

Since we are working with the altitudes instead of the side lengths, the existence of such a triangle is less straightforward. To construct a triangle with altitudes 5, 10 and x where $\frac{10}{3} < x < 10$, start by constructing a triangle with side lengths $\frac{1}{5}$, $\frac{1}{10}$ and $\frac{1}{x}$. The altitudes of this triangle have the correct ratio of $5 : 10 : x$, so we can simply scale the triangle until they have the correct lengths.

Colourful lattice

In the coordinate plane, points with integer coordinates are called lattice points.

(i) *Suppose that each lattice point is coloured using one of n possible colours. Prove that there exist four lattice points with the same colour which are also the vertices of a rectangle.*

(ii) *Suppose that each lattice point is either coloured using one of n possible colours, or not coloured at all. Furthermore, suppose that it is not possible to find four lattice points with the same colour which are also the vertices of a rectangle. Prove that there exist arbitrarily large squares such that none of lattice points in their interior is coloured at all.*

Solution by Joe Kupka: (i) Consider the following horizontal row of $n+1$ lattice points

$$R_m = \big\{(1,m),\ (2,m),\ \ldots,\ (n+1,m)\big\}.$$

Since there are $n+1$ points but only n colours, two points in R_m must have the same colour.

Consider the rows $R_1, R_2, R_3, \ldots$ over all possible values of m. Since there are infinitely many such rows but only n^{n+1} possible colour combinations, there must be two rows, say R_i and R_j, with identical colourings. Recall that two points in R_i, say (p,i) and (q,i), have the same colour. It follows that the points (p,i), (q,i), (p,j) and (q,j) form a monochromatic rectangle.

(ii) Let N be an arbitrarily large positive integer. We can divide the lattice points into $N \times N$ blocks, each containing N^2 lattice points. Now treat each block as a single *hyper-lattice-point*, coloured by one of $(n+1)^{N^2}$ *hyper-colours* based on the colouring of the N^2 original points in the block.

We can apply part (i) to our hyper-lattice-points and hyper-colours. This produces four blocks with identical colourings in the position of a rectangle. If any of the original lattice points inside these blocks are coloured at all, then the four corresponding points from the four blocks immediately form a monochromatic rectangle, which is a contradiction. Thus none of these $N \times N$ blocks can be coloured at all. Since the choice of N was arbitrary, there must exist arbitrarily large squares with uncoloured interior lattice points, as required.

Drawing parallels

Two parallel lines are drawn on a sheet of paper. There is also a marked point which does not lie on either of these lines. Here is your challenge: using only an unmarked straight edge (and no compass), construct a new line through the marked point, that is also parallel to the two existing lines.

Bonus: *Can you find two different ways to achieve this?*

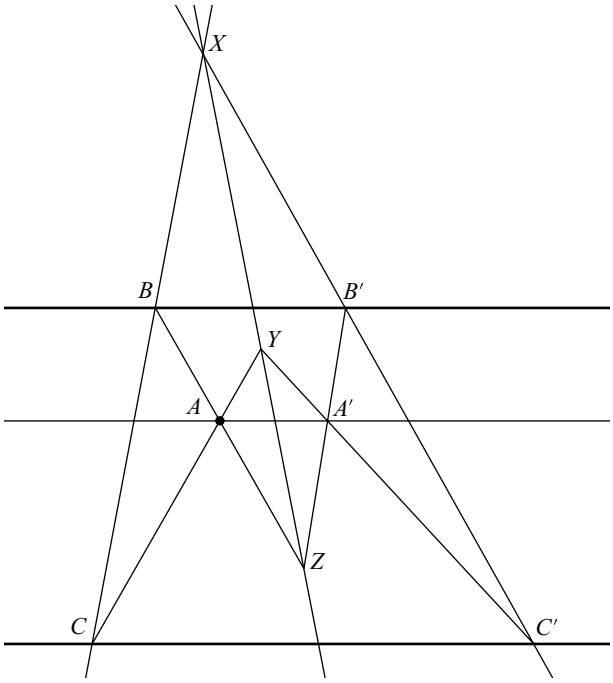
Solution by Jensen Lai: In this construction we shall utilise Desargues' theorem, which is as follows.

Let ABC and $A'B'C'$ be two triangles. Define the following points of intersection:

$$X := BC \cap B'C', \qquad Y := CA \cap C'A', \quad Z := AB \cap A'B'.$$

Then the points X, Y and Z are collinear if and only if the lines AA', BB' and CC' are either concurrent or parallel.

Refer to the diagram below. Suppose we would like to construct a line through A parallel to the two highlighted lines. Start by drawing three concurrent lines through an arbitrary point X and let two of them intersect the parallel lines at B, C and B', C' as shown. Now let BA and CA intersect the third line at the points Z and Y respectively. Finally let the intersection of YC' and ZB' be A'.



Since X, Y and Z are constructed to be collinear, we may apply Desargues' theorem to triangles ABC and $A'B'C'$. In particular, AA' must be parallel to BB' and CC', as required.

Note: There is an alternative solution to the problem that uses Pascal's theorem. The theorem is as follows.

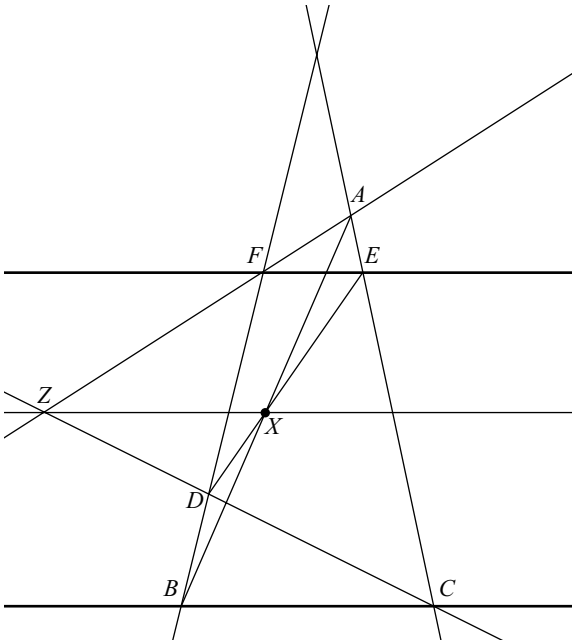
Let A, B, C, D, E and F be six points lying on the same conic. Define the following points of intersection:

$$X := AB \cap DE, \quad Y := BC \cap EF, \quad Z := CD \cap FA.$$

Then the points X, Y and Z are collinear.

Refer to the diagram below. We aim to construct a third parallel line through a point X this time. Begin by drawing two arbitrary lines and let them intersect the two parallel lines at F, B and E, C as shown. Now let D be the intersection of EX

and FB, and A be the intersection of BX and EC. Finally let the intersection of DC and AF be Z.

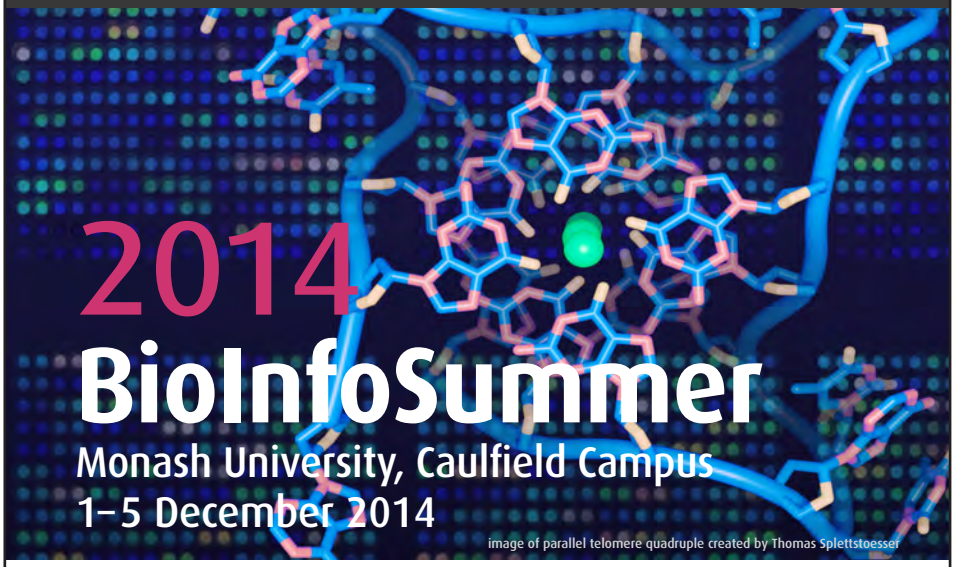


Since A, B, C, D, E and F lie on a pair of lines, which is a conic, we may apply Pascal's theorem. The three collinear points are X, Z and the intersection of BC and EF. But since BC and EF are parallel, we have to take the limiting case where their intersection Y is at infinity. The collinearity of X, Y and Z implies that XZ also passes through the same point at infinity. Therefore XZ is parallel to BC and EF, as required.

Ivan is a Postdoctoral Research Fellow in the School of Mathematics and Applied Statistics at The University of Wollongong. His current research involves financial modelling and stochastic games. Ivan spends much of his spare time pondering over puzzles of all flavours, as well as Olympiad Mathematics.

Research & Higher Education

Australian Mathematical Sciences Institute



2014 BioInfoSummer

Monash University, Caulfield Campus
1–5 December 2014

image of parallel telomere quadruple created by Thomas Splettstoesser

Bioinformatics is an exciting, fast-moving area analysing and simulating the structures and processes of biological systems. BioInfoSummer introduces students, researchers and others working in related areas to the discipline.

The program features:

- Introduction to molecular biosciences and bioinformatics
- Next-generation DNA sequencing and sequence evolution
- High-throughput technology and omics data analysis
- Methods in bioinformatics
- Systems biology

Speakers include:

Prof. Mark Ragan
Institute for Molecular Bioscience

Prof. Kate Smith-Miles
MAXIMA

Prof. Chris Overall
University of British Columbia

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Royal Medal for Terry Tao

Professor Terence Tao FRS has been awarded the Royal Society's 2014 Royal Medal for 'his many deep and varied contributions to mathematics, including harmonic analysis, prime number theory, partial differential equations, combinatorics, computer science, statistics, representation theory, and much more'.

The Royal Medals were founded by King George IV in 1825. Originally, two medals were awarded each year for the most important contributions in the physical, biological and applied sciences, by citizens or residents of Commonwealth countries and the Irish Republic. Since 1965, three medals have been awarded annually. Also known as the Queen's Medals, they are awarded by the Sovereign on the recommendation of the Council of the Royal Society. The three medals are of silver gilt and are accompanied by a gift of £5 000. The list of former recipients puts him good company. It includes: Andrew Wiles, Simon Donaldson, Roger Penrose, Michael Atiyah, J. F. C. Kingman, Subrahmanyan Chandrasekhar, Paul Dirac, Lord Rayleigh, James Joseph Sylvester, John Herschel, Arthur Cayley, Michael Faraday, George Boole, Fred Hoyle, Abdus Salam, Francis Crick and Charles Darwin.

Congratulations to Terry for yet another recognition of his outstanding achievements!

Higher Degrees and Honours Bachelor Degrees in Mathematics and Statistics Completed in Australia in 2013

Peter Johnston*

This report presents data relating to students who completed Honours or Higher Degrees in Mathematics during 2013. The data are part of an on-going project for the Australian Mathematical Society and should be read in conjunction with previous reports [1]–[14] covering the period 1993–2012.

This year represents the third occasion that data has been reported for two-year Coursework Masters degrees with classifications (similar to existing Honours degrees). The University of Melbourne is the only university to offer such degrees in place of the traditional Honours degree, although some other universities are expected to follow this model. In the discussions that follow, these data have been merged together and will be referred to simply as 'Honours', although the completions for the two degrees are presented in separate tables. As time goes on, and more universities offer Coursework Masters degrees of this type, the two data sets will be differentiated and displayed as separated entities (backdated to 2010).

Appendix 1 presents data for students completing Honours degrees in 2013, at all universities in Australia. Within each institution, the data are broken down into male and female students and into the three traditional areas of Mathematics: Pure; Applied and Statistics. There is also the general category 'Mathematics' for institutions that do not differentiate between the conventional areas. Finally, there is an 'Other' category for newer areas of mathematics such as Financial Mathematics. Each category is further broken down into grades of Honours awarded. Appendix 2 presents the Coursework Masters degrees awarded by the University of Melbourne in 2013. Appendices 1 and 2 combined show that in 2013 there were 173 Honours completions in Australia, with 119 (69%) receiving First Class Honours (compared with 113 out of 176 (64%) in 2012 and 116 out of 157 (74%) in 2011). Over recent years the average fraction of First Class degrees awarded has been about 70%.

Figure 1 presents the total number of students completing Honours degrees in Mathematics, including two-year Coursework Masters degrees (with classifications) over the period 1959–2013. It shows that in 2013 the number of Honours completions continues on about the same level as the previous year. The figure also shows the numbers of male and female students who completed Honours over the same time period. For last year, the number of male students has again increased over the previous years with 140 completions (130 in 2012 and 123 in 2011), while the

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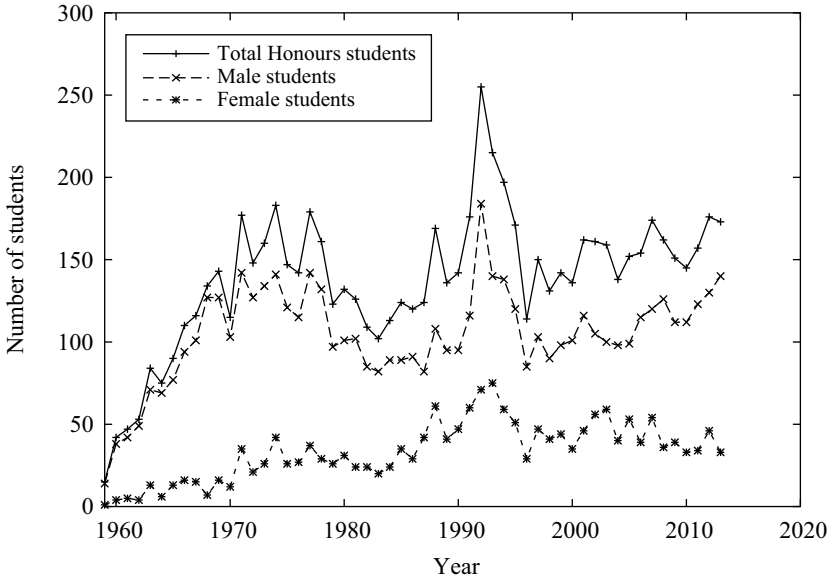

Figure 1: Number of Honours degrees, including two-year Coursework Masters degrees (with classifications), completed in Mathematics and Statistics, 1959–2013.

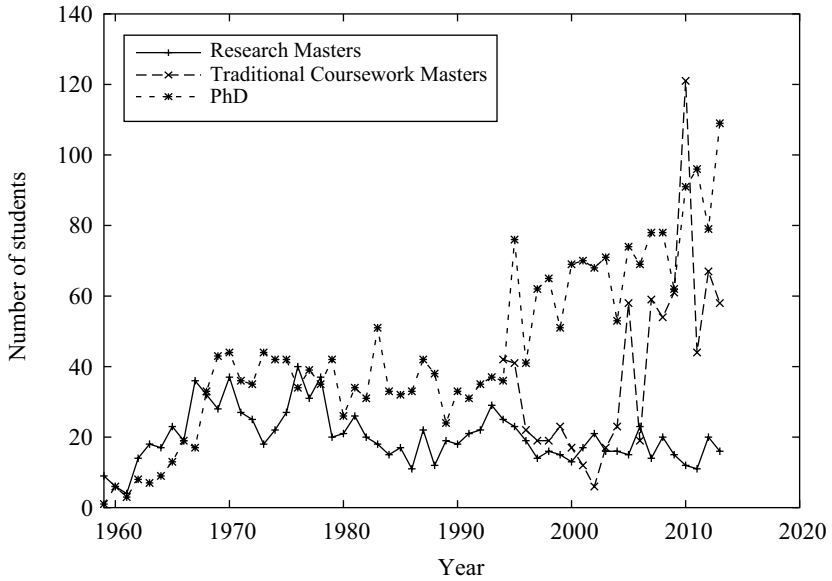

Figure 2: Number of research higher degrees completed in Mathematics and Statistics, 1959–2013.

number of female students decreased to 33 (compared to 46 in 2012) back to the level of 2011 (34).

Appendix 3 presents the data for Higher Degree completions in 2013. The data are broken down into traditional Coursework Masters, Research Masters and PhD degrees, with the latter two divided into the three typical areas of Mathematics. These data are also represented in Figure 2, as part of the overall Higher Degree data for the period 1959–2013. The figure shows that:

1. There was a considerable increase in the number of PhD completions compared with the previous two years. In 2013, there were 109 PhD completions (up from 79 in 2012 and 97 in 2011), of which 73 were by male students and 36 by female students. This represents a large increase in the number of male students (up from 48 in 2012) while the number of female students showed a slight increase (up from 31 in 2012).
2. The number of Research Masters completions (16) has decreased slightly, down from 20 in 2012.
3. There was a slight drop in Coursework Masters completions (58) in 2013, down from 67 in 2012, but more than in 2011 (44). However, these are considerably fewer than the 121 completions from 2010.

For those who are interested in the finer details, the raw data are available directly from me. Simply send me an e-mail. I have an Excel spreadsheet containing the complete data for 2013 as well as spreadsheets containing cumulative data from 1959 for Honours, Research Masters and PhD degrees.

I would like to thank the many people who took the time and effort to collect this data and forward it to me. This year I received 35 out of a possible 38 responses to requests for data, which is a very good response rate. Finally, if having read this report, you would like to contribute missing data for 2013, I would be happy to add it to the spreadsheet.

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Appendix 1. Number of Honours degrees completed in mathematics and statistics, 2013

Uni.	Sex	Maths			Pure			Applied			Statistics			Other			Honours
		I	IIA	IIB	III	I	IIA	IIB	III	I	IIA	IIB	III	I	IIA	IIB	III	Total
ACU	M																	0
	F																	0
ADF	M																	0
	F																	0
ANU	M	7		1														8
	F	2																2
BOU	M																	0
	F																	0
CDU	M																	0
	F																	0
CQU	M																	0
	F																	0
CSU	M	1																1
	F																	0
CUT	M																	0
	F																	0
DKU	M	1																1
	F																	0
ECU	M																	0
	F																	0
FDU	M									1								1
	F																	0
GFU	M																	0
	F																	0
JCU	M																	0
	F																	0
LTU	M					1				1				1				3
	F					1								1	1			3
MDU	M													1	1	1		3
	F																	0

Appendix 1. (continued)

Uni.	Sex	Maths				Pure				Applied				Statistics				Other				Honours
		I	IIA	IIB	III	I	IIA	IIB	III	I	IIA	IIB	III	I	IIA	IIB	III	I	IIA	IIB	III	Total
MNU	M					4				5	1	2			1							13
	F									2				1								3
MQU	M	1	1																			2
	F	1																				1
QUT	M									3	1											4
	F									1	1											2
RMT	M	3		2				1						2		1						9
	F		1	1										1								3
SCU	M																					0
	F																					0
SUT	M																					0
	F																					0
UAD	M	1	1															1	2			5
	F														1							1
UBR	M																					0
	F																					0
UCB	M																					0
	F																					0
UMB	M																					0
	F																					0
UNC	M	3	2																			5
	F																					0
UNE	M					1																1
	F																					0
UNS	M					4	1			2				3								10
	F					2	1															3
UQL	M					3				1	1			3				2				10
	F					2				1				1								4
USA	M																					0
	F													1								1
USN	M					5	1			5	1			4	1							17
	F										1			2	1							4
USQ	M										1											1
	F																					0
UTM	M					1				1												2
	F																					0
UTS	M										1	1		1								3
	F																					0
UWA	M					1				1	1			1								4
	F					1	1															2
UWG	M					3				3								3	1	1		11
	F																					0
UWS	M																					0
	F																					0
VUT	M																					0
	F																					0
Totals		20	6	3	0	29	4	1	0	25	10	3	1	23	6	2	0	6	3	1	0	143

Appendix 2. Number of two-year Coursework Masters degrees (with classifications) completed in mathematics and statistics, 2013

Uni.	Sex	Pure				Applied				Statistics				Other				Total
		I	IIA	IIB	III	I	IIA	IIB	III	I	IIA	IIB	III	I	IIA	IIB	III	
UMB	M	4			3	2				4	1	2	2	4	2	1	1	26
	F									1			2	1				4
Totals		4	0	0	3	3	0	0	0	5	1	2	4	5	2	1	1	30

Appendix 3. Number of research higher degrees completed in mathematics and statistics, 2013

Uni.	Sex	Coursework Masters	Research Masters			Research Masters Total	PhD				PhD Total
			Pure	Applied	Statistics		Pure	Applied	Statistics	Other	
ACU	M					0					0
	F					0					0
ADF	M			1		1					0
	F					0					0
ANU	M	2				0	4	2			6
	F	1		1		1		1			1
BOU	M					0					0
	F					0					0
CDU	M					0					0
	F					0					0
CQU	M					0					0
	F					0					0
CSU	M					0					0
	F					0					0
CUT	M					0					0
	F					0					0
DKU	M					0		1			1
	F					0					0
ECU	M					0					0
	F					0					0
FDU	M					0					0
	F					0					0
GFU	M					0					0
	F					0					0
JCU	M					0					0
	F					0					0
LTU	M	1			2	2					0
	F	2				0	2			2	4
MDU	M					0					0
	F					0				1	1
MNU	M					0	1	3	3		7
	F					0		4			4

Appendix 3. (continued)

Uni.	Sex	Coursework Masters	Research Masters Pure	Research Masters Applied	Research Masters Statistics	Research Masters Total	PhD Pure	PhD Applied	PhD Statistics	PhD Other	PhD Total
MQU	M					0	3				3
	F					0		3			3
QUT	M					0		6	1		7
	F					0		2	2		4
RMT	M	12			1	1				2	2
	F	13		1		1			1	2	3
SCU	M					0					0
	F					0					0
SUT	M					0		1			1
	F					0					0
UAD	M		1			1	1		1		2
	F			2	1	3					0
UBR	M					0					0
	F					0					0
UCB	M					0					0
	F					0					0
UMB	M		1	1		2	2	2			4
	F					0		1	1		2
UNC	M					0	1		1		2
	F					0					0
UNE	M					0					0
	F					0					0
UNS	M	2				0	6	2			8
	F	1	1			1		2			2
UQL	M	6				0	5	2	3		10
	F					0			1		1
USA	M					0		1	3	2	6
	F					0		1		2	3
USN	M		1	1		2	1	2	2		5
	F					0	1				1
USQ	M					0		1			1
	F					0					0
UTM	M					0					0
	F					0					0
UTS	M					0		1			1
	F					0		1			1
UWA	M					0	1	2			3
	F					0		1			1
UWG	M	14				0	1	3			4
	F	4		1		1		1	4		5
UWS	M					0					0
	F					0					0
VUT	M					0					0
	F					0					0
Totals		58	4	8	4	16	29	46	26	8	109

Reynold (Reyn) Gilbert Keats

15 February 1918 – 1 April 2014

Reyn Keats will be remembered as a champion for mathematics in establishing a clear presence for mathematics at the University of Newcastle and in contributing to the welfare of the Australian Mathematical Society. His early career and time at Defence laid the foundation for his understanding of the role and importance of mathematics from both theoretical and real-world perspectives. He saw the need to have a strong independent presence for mathematics at all levels of the education process as well as a strong mathematics profession interacting with the wider community.

The Early Years

Reyn was born in Port Pirie on 15 February 1918. He attended Port Pirie High School and was the dux of the school in 1933. But it was the time of the Great Depression and difficult for school leavers to gain employment. Reyn spent the first three months of 1934 at Adelaide High School with the hope of doing sufficiently well to be accepted as a student by the University of Adelaide. However, this plan ended when he was convinced by a fellow student to apply for employment as a bank clerk at the Savings Bank of South Australia. His application was successful and Reyn returned to Port Pirie as a junior clerk in that Bank. Reyn spent his limited free time at the Port Pirie Tennis Club. He improved his tennis and became Treasurer of the Club.

The War Years and Defence

Following the outbreak of World War II, Reyn joined the Army at the beginning of 1940, enlisting in the 2/48th Infantry Battalion as a private. In November 1940, he departed as a corporal with the Battalion being shipped to the Middle East. He served in the Siege of Tobruk (April – November 1941) and then moved with the Battalion to Syria. After 2–3 months there, the Battalion was assembled to move towards Egypt. The troops were confident that they were being returned

to Australia, now under threat from the Japanese, who had advanced into New Guinea. However, they were disappointed.

Reyn, now a sergeant in the Signals Platoon, was informed by the senior officers that the Battalion would take part in the Battle of El Alamein. Reyn was sure that he would soon be involved in this battle against the Germans. However, that was not to be the case. About two weeks before the El Alamein battle commenced in July 1942, the commanding officer, Lt Col Windeyer, asked Reyn to accompany him into No-Mans-Land to assess the situation. Reyn did so and was relieved to find that the enemy was present but not vigilant. On the day following, Reyn was summoned to the Battalion's Headquarters where he was informed that he was being sent immediately to the Officers' School in Syria.

After completing Officers' School, Reyn was made Lieutenant and joined the Battalion again in Palestine in time to return with it by ship to Australia, reaching Melbourne at the end of February 1943. From there, he went to Maroochydore to teach 'Signals' for several months. In September, he was able to spend a short time in Adelaide before joining the Battalion again when it moved to New Guinea. They landed near Lae in October 1943 and forced a Japanese retreat. When the Battalion returned to Australia in February 1944, Reyn attended an extended training period in Ravenshoe on the Atherton Tablelands.

The Battalion went back to New Guinea in April 1945, but Reyn was not with them. On a morning in December 1944, he was halted by the Adjutant with the words: 'How would you like to be discharged?' to which Reyn responded 'Don't be tiresome, I'm busy.' However, he was to be discharged as a result of an application he had lodged several weeks earlier. He had found out that those who had been on active service for five years could apply to attend a university and the Federal Government would pay course fees and other expenses, plus three pounds five shillings per week. Reyn's application was successful and he attended his first lecture at the University of Adelaide in March 1945.

Reyn studied at Adelaide for three years and graduated with a B.Sc. in mathematics and physics in 1947. For graduate Reyn Keats, 1948 was an eventful year. He married Joy Brealey, a pre-school teacher. (They had met at a Red Cross dance at Glenelg Town Hall soon after Reyn joined the army in 1940 and had announced their engagement when Reyn returned to Australia in 1943.) After a brief honeymoon in Tasmania, Reyn and Joy travelled to England where Reyn worked as a research scientist at the Royal Aircraft Establishment at Farnborough till late 1950.

At a meeting of the Mathematical Association in Birmingham in April 1949, Reyn presented a paper with B.T. Gilroy, entitled 'Teaching of Mathematics in Australia', which was published in *The Mathematical Gazette* of October 1949. The authors noted, with some optimism, that:

> Some increase in [the number of students attempting an Honours Degree] has occurred in recent years, and with the present expansion of secondary industries and research facilities in all States, the opportunities for the mathematician should increase considerably.

Before he received his B.Sc. degree, the Australian Government Department of Defence had offered Reyn the opportunity to join the newly formed Long Range Weapons Establishment at Salisbury — renamed the Weapons Research Establishment (WRE) in 1955 — as a research scientist. A major purpose of this Establishment was to design and oversee the building of the guided missile range at Woomera. (Reyn had actually spent three weeks at Salisbury in 1948 before his transfer to England.)

Soon after his return to Australia in 1951, a first daughter Bronya was born and then a second daughter Kristin in 1953. Reyn spent two years at the Aeronautical Research Laboratory in Melbourne then returned to WRE at Salisbury, where he worked from 1953 to 1961, with occasional work-related visits to the UK. Reyn took part in both the preparation and launching of missiles at Woomera. One was an experimental test vehicle (ETV) for an anti-tank guided missile, which was first fired on 6 December 1954. The goal was to hit a five-metre-square target at a distance of about one kilometre. Reyn was the first to successfully hit the target. He was very impressed to find he had guided the missile into the target barely a metre from its very centre.

While at WRE in the 1950s, Reyn learnt to use an analogue computer, a huge device occupying most of the space in a large building. The experience that he gleaned was a key factor in ensuing years in the use of such computers for mathematical modelling of guided missiles that were being tested at the Woomera range. Then in 1960, when an IBM 7090 was purchased, Reyn, as a member of the Systems Assessment Division (SAD), successfully argued that all colleagues who could program in FORTRAN — not just those in the Mathematical Services Group — should be able to write their own code and have their computer programs run by the data-processing office staff.

A 1998 article on the history of SAD attests to Reyn's keen mathematical mind that was in evidence at WRE:

> Keats' background in mathematics and assessment was also important. He was, what one would call, a true mathematician, one of those people who are not really convinced of the truth of anything unless they can completely understand it in mathematical terms. [2, Part II]

Peter Morton's book *Fire across the Desert* [1] contains information on the entire program at Woomera and specific references to Reyn Keats and his work there.

Adelaide University and Ph.D.

Reyn had always wanted to be an academic, so he was thrilled when, in 1961, he was offered a job at the University of Adelaide as a senior lecturer in mathematics. As well as lecturing, he worked on his Ph.D. under Ren Potts and was awarded this degree in 1965 for his thesis entitled 'The application of correlation techniques to checking and adjusting mathematical models'. The acknowledgment included:

> The topic discussed in this thesis was conceived by the author as a desirable complement to the work, on the evaluation of guided weapons

> using mathematical models, in which he had been actively engaged at the Weapons Research Establishment, Salisbury, South Australia. The experimental work was carried out using computing equipment at W.R.E.

Reyn's brother John, who had moved to the University of Newcastle in 1965, informed Reyn in 1967 that a position for a mathematics professor was soon to be advertised. Reyn applied and unexpectedly was successful. He and Joy moved to Newcastle in January 1968, where they lived for the next 40 years.

Additional insight about Reyn can be obtained from Graeme Cohen's book *Counting Australia In* [3], in particular regarding Reyn's early research career and Ph.D. thesis (p. 134).

The University of Newcastle

Reyn took up his appointment in January 1968 as Professor of Mathematics and Head of the Department, which consisted of 10 teaching staff, 5 of whom had been appointed in the 1950s. The Mathematics Department had moved with the main departments of the University to the Shortland site in 1966 and has been offering its fourth-year honours course since then. The honours class of 1968, Reyn's first year at Newcastle, consisted of four students, Brailey Sims, Glenn Cocking, John Lloyd and Alan Fenwick, all of them going on to outstanding careers in mathematics, with Alan Fenwick completing a Ph.D. under Reyn's supervision.

Reyn's organisational astuteness and talent became immediately apparent. By 1969, he had reorganised the University's mathematics curriculum. Instead of teaching Pure Mathematics, Applied Mathematics and Statistics as separate subject units, Reyn introduced teaching by topics with a topic consisting of just over 20 hours of lectures, so that all students had the opportunity to see mathematics from a variety of perspectives. The Department had always had a major commitment to service teaching for engineers so specialised teaching could be accommodated within this more flexible topic structure. Students studying for honours took additional advanced topics. The topics curriculum continues to be the basis for the present day system.

Reyn's research interest was in the area of signal detection — in particular, the detection of underwater signals using arrays of hydrophones. He received regular annual grants from the Australian Department of Supply and its successors. Obviously, information about the research he had been engaged in for Defence is not publicly available. For example, the work done at Woomera on guided missiles was classified material. Nevertheless, from an examination of his published papers, it is clear that his enthusiasm for signal processing was passed on to his research students and collaborators.

His graduate students at Adelaide included Mee Chooi Cheng (Ph.D., 1968), Helen Hutchens (M.Sc., 1969), and several others jointly supervised with Ren Potts, while at Newcastle they included Barrie Stokes (M.Math., 1974), Alan Fenwick (Ph.D., 1975), Vincent Yu (M.Math., 1977), and Winifred Frost (M.Math., 1984).

Because of his earlier research work with industry, Reyn understood that students should know about the wide field of applied mathematics. Consequently, his early staff appointments to the Department included lecturers such as Rodney Vaughan, with research interests in Traffic Engineering, and Annette Dobson, with research interests in Medical Statistics. His objective was to ensure that the Department's doctoral students considered careers in industry to be as important as in academia. In 1971, Tony Guttmann was appointed. He comments that 'It was a wonderful time with typically three or four new appointments each year for a number of years. .... We were a young, active and enthusiastic group.'

Reyn saw the importance of contact with high schools, especially in attracting talented students from the Hunter Valley to study at the University of Newcastle. He organised staff to hold Summer Schools each January. These generally attracted over 100 senior students from the Hunter Valley, with many of them billeted in Newcastle. The first School was held in 1969, and Schools were held each year till 1987. The Department's Mathematics students were encouraged to be tutors in order to enhance their comradeship. Maurie Brearley, an Adelaide University colleague of Reyn, was an inspiring visiting lecturer at a Summer School later in the series. Working with the Newcastle Mathematics Association, Reyn organised the production of a high school mathematics journal, which ran to three issues a year. The first issue was in 1976 and the series continued till 1987.

Not surprisingly, Reyn was a skilful university politician. His outstanding achievement was to persuade the University Senate to create a Faculty of Mathematics in 1971. Graduates from the Faculty were awarded B.Math. (bachelors) and M.Math. (masters) degrees. Reyn became the foundation dean and held that role until 1976 and again from 1980 to 1982. There were 20 members of staff when the Faculty was formed. Faculty student numbers grew from 115 in 1971 to 280 in 1976. Reyn had been inspired by the outstanding example of the Faculty of Mathematics at the University of Waterloo in Canada. He organised a program of staff exchanges with Waterloo, which continued for some years. Reyn himself was an exchange professor in 1979 when he was awarded an honorary Doctor of Mathematics, D.Math., by the University of Waterloo. The concept of a faculty structure for mathematics was subsequently implemented at the Universities of Adelaide and Wollongong. Despite the break-up of the Faculty of Mathematics at Newcastle that has since occurred, the B.Math. degree continues to be offered.

One of the achievements that Reyn was particularly proud of was the number of outstanding women mathematics graduates from the Faculty of Mathematics, including Joan Cooper, who became Deputy Vice Chancellor at the University of NSW, Katherine Heinrich, who became President of the Canadian Mathematical Society, and Eileen Doyle, who became Chair of the Hunter Valley Research Foundation and a member of the CSIRO Board.

Reyn served as Deputy Chairman of University Senate 1977–1978 and participated in its various committees. He was for a time chairman of the Outside Studies Committee. He was Chairman of the Senate Committee investigating the feasibility of introducing year-round teaching incorporating cooperative programs such as the ones implemented at several North American universities. He was also active in

the University Staff Association and represented Newcastle at FAUSA federation meetings.

Retirement and Contributions to the Australian Mathematical Society

Reyn retired in July 1983. He then channelled some of his activity in support of the work of the Australian Mathematical Society. Newcastle University had hosted the Annual General Meeting of the Society in 1974 and 1982. In 1985, Reyn was appointed Advisor on Public Relations, a position to which he was reappointed in 1986 and 1988. He travelled through North America and Britain visiting overseas mathematical organisations. His report urged the formation of an Australian Mathematical Society Council, which was formed in 1989. He also called for a mathematics presence in the Australian Science and Technology Centre.

Reyn was a strong supporter of professional accreditation 'as a means of establishing the Society as a professional organisation recognised as such by business, industry and academe'. Accreditation was finally set up in 1994, with Fellows (FAustMS), Accredited Members (MAustMS), and Graduate Members (GAustMS).

Following retirement, Reyn and Joy continued to live in Newcastle for another 24 years, travelling often to visit their children and grandchildren in New Orleans and Canberra. In November 2007, they moved to Canberra to be nearer their daughters and their families, both of whom were now living there.

Reyn Keats died in Canberra on 1 April 2014. He is survived by his wife Joy, his two daughters Bronya and Kristin, four grandchildren Timothy, Patrick, Rebecca and Katrina, and one great-grandson Eli.

From bank clerk to 'Rat of Tobruk' to weapons research scientist to Professor of Mathematics, Reyn Keats had a remarkable life. As a 'founding father' of mathematics at the University of Newcastle, he has had a long and lasting influence on the Australian mathematical community.

Acknowledgement

The authors gratefully acknowledge the assistance of Bronya Keats in compiling this obituary of her father.

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Book Reviews

Lectures on Real Analysis

Finnur Lárusson
Australian Mathematical Society Lecture Series, No. 21,
Cambridge University Press, 2012, ISBN 978-1107608528

This slim volume is a real gem (pun intended). Starting from an axiomatic treatment of the real numbers — on which more later — it builds up a rigorous first treatment of real analysis. It works up to the point of being able to define and show the properties of exp, log, sin and cos, and proves, with the aid of a little metric space theory, Picard's theorem. This gives the unique existence of continuously differentiable solutions to certain first-order, single variable differential equations. The exposition is aided by many examples and exercises, which move between very concrete problems and calculations, and abstractly useful abstract lemmas. This book is currently the textbook for the second-year real analysis course at the University of Adelaide (alas that I did not get to enjoy this book as a student!).

Lárusson states the two goals of the book as: to treat calculus carefully from first principles and to practice the reading and writing of proofs. The exercises that deal with proofs start out from the level of proving standard properties of rational numbers from ordered field axioms, and basic naïve set theory. They progress with the material in sophistication up to, for instance, one direction of the Heine–Borel theorem, or the equivalence of the topological and metric definitions of continuity for maps between metric spaces. As a basis for a lecture course, the existence of so many exercises through the text will be welcomed by lecturers, especially as they are well integrated into the progression of each chapter.

The axiomatic base that the book starts from is that of a complete ordered field. Or rather, the Peano axioms for the natural numbers are implicitly assumed (in the guise of the induction axiom and the 'standard structure' of the naturals), as well as the existence of integers and rationals, and then the book introduces the axioms for a field and ordered field. Some basic set theoretic notions and terminology is also introduced, such as functions and boolean operations on sets. Two proofs are given for the non-existence of a rational square root of two, the first of which does not rely on the notion of divisibility and common factors, as should be the case in a ground-up treatment with no number-theoretic background.

Completeness, as an axiom, is introduced in Chapter 2, using the least upper bound property, and the real numbers are defined as 'the' complete ordered field. A real number is defined as 'an element of a complete ordered field'. Since any such field is unique up to an isomorphism of complete ordered fields, it does not matter which model one uses, or if one works *synthetically*: from the axioms with no reference to models. The existence of constructions (Cauchy sequences and Dedekind cuts) of the reals from the rationals are mentioned, but not treated. In the reviewer's opinion, this is not a drawback in a first course on analysis, since the details of these constructions are not actually used in anything that follows. The

Archimedean property and other standard properties, including uncountability, are shown to follow from completeness. The book uses Cantor's original proof, using nested intervals, rather than any explicitly diagonal argument. Using decimal expansions is a model-dependent approach and not without irrelevant subtleties!

The third chapter introduces sequences and series, and culminates in showing the equivalence of five characterisations of the field of real numbers: completeness, nested interval property plus the Archimedean property, the monotone convergence theorem, the Bolzano–Weiertrass theorem, and the Cauchy criterion plus the Archimedean property. This is a taste of the area called Reverse Mathematics: showing exactly which axioms are necessary, and usually equivalent to, a given theorem. Such a result is useful for emphasising just why the axioms we use are chosen.

Chapters 4 and 5 treat the basic topological notions of open, closed and compact sets, and continuity. The approach to continuity and compactness is via sequences, so one could argue that the book uses sequential contintinuity and sequential compactness throughout. For metric spaces, such as the reals or certain function spaces as used in the book later, sequential definitions are equivalent to the usual notions. We also meet, at this point, uniform continuity and the intermediate value theorem. One of the exercises in this chapter is to prove the existence of nth roots in the reals, fulfilling a promise made in Chapter 2. In fact, this is a pleasant feature of the book: sometimes concepts that are 'known' (existence and basic properties of the function sin, for instance) are used, but always with a forward pointer to where they will be proved in a later chapter.

Chapters 6 and 7 treat differentiation and (Riemann) integration respectively, covering the standard theorems (Rolle's theorem, mean value theorem, l'Hôpital's rule, fundamental theorem of calculus). Importantly, continuous functions on intervals are proved Riemann integrable, though it is pointed out that discontinuous functions may or may not be so (the last exercise gets the student to show that a certain function with uncountably many discontinuities is Riemann integrable). Chapter 7 ends with defining the logarithm and exponential functions.

Chapter 8 is in a sense the end of the 'core' part of the book, treating sequences and series of functions, power series, Taylor series and the like. The spaces of continuous and integrable functions are proved to be complete for the sup norm, though in more elementary terms. This is used in the later chapters dealing with function spaces as metric spaces. The trigonometric functions are approached as follows. Suppose we are given bounded smooth functions s and c such that $s' = c$, $c' = -s$, $s(0) = 0$ and $c(0) = 1$. Then from a corollary to Lagrange's remainder theorem (both given in the text), one can write down the Maclaurin series for both s and c, and show that they are uniquely determined by these properties. Clearly s and c will turn out to be sin and cos respectively, and some of their standard properties are derived. The existence of the number π is defined as the unique smallest period of sin (equivalently one could say the smallest positive zero of sin).

The last two chapters are a relaxed introduction to metric spaces and continuous maps, enough to treat the metric spaces $\mathcal{C}[a, b]$ with the sup metric. Plenty of

other important examples are given to show the ubiquity of the notion of metric (sequence spaces, ultrametric spaces, Euclidean spaces with various standard metrics). The key result of the last chapter, leading up to Picard's theorem, is the Banach fixed-point theorem, stating that to every continuous contraction of a non-empty complete metric space, there is a unique point fixed by that contraction.

The book is described in the back-matter as being appropriate for a second-year undergraduate, or a more advanced student needing a foundation in real analysis. This should not be its only audience; anyone writing a textbook should have a copy as an example in how to do the job well. The scope of the book is ideal, and it is a pity that there are not more undergraduate texts of this size and quality.

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Lectures on $N_X(p)$

Jean-Pierre Serre
CRC Press, 2012, ISBN 978-1-4665-0192-8

Jean-Pierre Serre requires little introduction. His mathematical contributions were recognised in 1954 by a Fields Medal and in 2003 by the inaugural Abel Prize (and by many other awards in-between), while his exceptional writing skills were rewarded in 1995 by a Steele Prize for mathematical exposition. The book under review, based on lectures delivered in 2009 and 2011 in Taiwan and thoroughly revised for publication, lives up to the high expectations created by the juxtaposition of technical prowess and presentation genius that characterises Serre's work.

What's $N_X(p)$?

The book answers this question in its first four lines. Paraphrasing slightly: Let X denote a set of multivariate polynomial equations with integer coefficients. Given a prime number p, we reduce all the polynomials modulo p and we count the number $N_X(p)$ of common solutions to the resulting congruences.

A simple case

Consider the equation

$$x + y = 0. \tag{1}$$

Picking the prime $p = 5$ gives rise to the congruence

$$x + y \equiv 0 \pmod 5,$$

which has the disappointingly easy solution $y \equiv -x \pmod 5$, leading us to the list

$$\{(0,0),(1,4),(2,3),(3,2),(4,1)\}.$$

Therefore $N_X(5) = 5$. More generally $N_X(p) = p$. Even more generally, replacing the field $\mathbb{F}_p$ with the field $\mathbb{F}_{p^n}$ for some $n \in \mathbb{Z}_{\geq 1}$, we get $N_X(p^n) = p^n$.

Not very interesting, you say?

Let's package the numbers $\{N_X(p^n) \mid n \in \mathbb{Z}_{\geq 1}\}$ into a function

$$\zeta_{X,p}(s) = \exp\left(\sum_{n=1}^{\infty} \frac{N_X(p^n)}{n} \frac{1}{p^{ns}}\right) = \frac{1}{1-p^{s-1}}$$

and then throw all the prime numbers together[1]

$$\zeta_X(s) = \prod_{p \text{ prime}} \zeta_{X,p}(s) = \prod_{p \text{ prime}} \frac{1}{1-p^{s-1}}.$$

Then $\zeta_X(s) = \zeta(s-1)$, where ζ is the Riemann zeta function. And suddenly, one of the simplest examples reveals some unexpected depth, and a relation with the most famous currently open problem in mathematics.

Another million-dollar problem

Of course, Serre is interested in equations more general than (1). The number $N_X(p)$ can be defined when X is the solution set of any system of integer polynomials. This is the bread and butter of (arithmetic) algebraic geometry, where such X is treated as a geometric object called a scheme over $\mathbb{Z}$. The example in (1) is a line, but more interesting geometry is just around the corner.

Let X be the set of solutions of the equation

$$y^2 - y = x^3 - x^2. \tag{2}$$

The numbers $N_X(p)$ turn out to be given by the formula[2]

$$N_X(p) = p + 1 - a_p,$$

where the integers a_n are the coefficients of the power series

$$F(q) = q \prod_{n=1}^{\infty} (1-q^n)^2(1-q^{11n})^2 = \sum_{n=1}^{\infty} a_n q^n.$$

This is in itself something magical: it says that the geometric object X (an elliptic curve) is related to the analytic object F (a modular form) in a way that illustrates

[1] Here s is a complex variable and the expressions may make sense only after restricting s to an appropriate half-plane, namely $\mathrm{Re}(s) > \dim(X)$.

[2] Well, almost. The formula holds if we view X as a curve in the projective plane $\mathbb{P}^2$ (rather than the affine plane). This amounts to turning (2) into its homogeneous version $y^2z - yz^2 = x^3 - x^2z$, discarding the solution $(0,0,0)$, and identifying solutions of the form (x,y,z) and $(\lambda x, \lambda y, \lambda z)$ for $\lambda \neq 0$.

a special case of the modularity conjecture of Shimura–Taniyama–Weil (the most famous consequence of which is Fermat's Last Theorem).

The zeta function of X, defined as before, turns out to be

$$\zeta_X(s) = \frac{\zeta(s)\zeta(s-1)}{L(s)},$$

where

$$L(s) = \sum_{n=1}^{\infty} \frac{a_n}{n^s}.$$

And the complex function $L(s)$ has analytic continuation to all $s \in \mathbb{C}$, as predicted by the Birch and Swinnerton-Dyer conjecture. So we are only on page 11 of Serre's book and have already encountered two million-dollar problems and some of the most exciting concepts of the last half-century of number theory. As hard as it may be to believe, the remaining 150 pages live up to this promising start, with the Sato-Tate conjecture and the higher-dimensional prime number theorem making extended appearances.

The master plan I

The first aim of the book is to explore a central question about the numbers $N_X(p)$:

Fixing X, how does $N_X(p)$ vary with p?

Here is one of the answers given by Serre: Let $X(\mathbb{C})$ denote the complex variety defined by the equations of X. Then the dimension of $X(\mathbb{C})$ is less than d if and only if $N_X(p) = O(p^d)$ as the prime p gets large.

It is striking to notice the magical and easily stated way in which the topology of the complex variety $X(\mathbb{C})$ knows about the number of modulo p solutions of the original equations (and vice-versa). This is a leitmotif going back at least as far as the 1940s with André Weil's formulation of his famous conjectures, followed by the creation of several types of cohomology theories of arithmetic interest (and Deligne's proof of the Weil conjectures in the 1970s), and leading to the building of the still-largely-conjectural edifice of motives.

In addition to the issue of the variation of $N_X(p)$, the book touches upon several related questions. Efficient ways of computing the number of solutions are mentioned for several special types of X. Congruence properties modulo primes $\ell \neq p$ are used to show that if $N_X(p) = N_Y(p)$ for almost all primes p, then $N_X(p^n) = N_Y(p^n)$ for almost all primes p and all exponents n. Equidistribution results related to the numbers of solutions are proved to follow from a very general form of the Sato–Tate conjecture (special cases of which have recently been settled).

The master plan II

Serre declares upfront his second objective for the book: to review and bring together ideas from algebraic geometry, representations of profinite groups, several flavours of cohomology, algebraic and analytic number theory, and modular forms.

These topics have gone through significant developments over the last half-century, with Serre himself playing an important role in them.

The pedagogical aim of the text is supported by many beautiful examples, abundant and precise bibliographical notes, and by about 60 exercises (nontrivial, but with hints). Proofs start appearing after the four background chapters, and give just the right amount of detail to illuminate the argument without drowning it in technicalities.

Summary

The study of the number of solutions to equations is a particularly well suited pretext for this succinct, elegant, and readable introduction to modern mathematics. The book will be useful to advanced students and researchers who will benefit from a well organised exposition of the main issues surrounding the numbers $N_X(p)$ and related topics.

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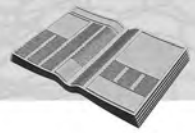

NCMS News

Nalini Joshi*

Big International Meetings in the Mathematical Sciences

I attended my first International Congress of Mathematicians (ICM) in 2010 as President of the Australian Mathematical Society. I just came back from my second one held 13–21 August 2014 in Seoul, Korea. In recent years I have also attended the International Congress of Industrial and Applied Mathematics (ICIAM) in 2011 and the Joint Math Meeting in the USA, twice. The Joint Math Meeting easily trumps the others in numbers, with over 7000 participants! I write this column to let you know about another big meeting, which I hope will be held in Australia, and to encourage your involvement. By the time you read this, we will have submitted a bid to hold the International Congress of Mathematical Education (ICME-14) in 2020.

It was the 2010 ICM that changed my approach to big mathematical meetings. What I never expected at that first ICM, and what led me to attend the second one, is the surprisingly deep, inspirational mathematical conversations I had with mathematicians whom I had never met before. These, along with sudden realisations of mathematical ideas from talks in fields vastly different to my own, changed my previous preference for small specialised meetings. The second ICM also had a uniquely unexpected beginning: the exhilaration of celebrating the first Fields medal awarded to a female mathematician, Maryam Mirzakhani, which still reverberates with a quiet delight in my soul.

Immediately prior to the ICM, I attended the General Assembly of the International Mathematical Union. The over-full slate of items for consideration at the GA was accompanied by what was at times intense, emotional debate. The debate and the long days had the curious benefit of creating a camaraderie that lasted well through the ICM. I came to see the combined events: the GA, the International Congress of Women Mathematicians (held in interspersing days) and the ICM as a continuous expression of the spirit and creativity of mathematics around the world.

At the 17th General Assembly in Gyeongju, Korea, Australia had a group of four delegates for the first time, corresponding to our newly elevated status as Group IV member of the IMU. My fellow delegates were Julie Clutterbuck (Monash), Michael Coons (Newcastle) and Brendan McKay (ANU). Julie and Michael were selected by AMSI and AustMS as early- to mid-career mathematicians whose travel was supported to encourage them to consider organising a future ICM in Australia.

Delegates and representatives of National Committees are often the ones invited to official receptions during the ICM. Collectively, we attended receptions held

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by Brazil, Canada, France, Japan, Norway, UK, and USA. At one of these, I was asked why Australia didn't have a reception. It seemed mean-spirited to respond with the truth: that we do not have any funds to pay for receptions. But I realised that this was also a matter of choice. A reception would be like holding a dinner and inviting friends to our home: it is a generous way to celebrate being part of the global mathematics enterprise and a way to make Australia's contributions more visible.

Holding a big meeting in Australia is another way of making a generous, visible contribution to the world stage. To my knowledge, we have had three big mathematical meetings in Australia: ICME-5 held 1984 in Adelaide, ICMP 1997 in Brisbane and ICIAM 2003 in Sydney. I am told that ICME-5 generated a tremendous boost to mathematics education in Australia. Since then, Australia has been in the top three or four countries in the world in terms of the number of ICME delegates. Many Australians have held leadership positions in international mathematics education organisations. Currently, Cheryl Praeger is a Vice-President of the International Congress of Mathematical Instruction (ICMI). Holding ICME-14 in Australia would also be an advantage for mathematical educators in the Asia Pacific region.

The Australian Academy of Science is the adhering body for ICMI and so the National Committee for Mathematical Sciences is acting as the point of contact for the bid for ICME-14. The expression of interest was prepared by AAMT (Australian Association of Mathematics Teachers) and MERGA (Mathematics Education Research Group of Australasia) and submitted late in 2013. It was a hurried time, late in the year and the information about the bid being submitted may have slipped people's minds. The bid is now being prepared with the help of Business Events NSW, which is a not-for-profit venture between the NSW Government, Destination New South Wales and other organisations. The full bid documents are due on 1 November 2014.

The next step in the deliberations will occur with a site visit, when three ICMI representatives will visit the proposed site (President, a Vice-President and the Secretary General) along with the Director of the ICMI office at the IMU headquarters in Berlin. The site visit is likely to occur in the first quarter of 2015.

Would you like to be involved? Please drop me a line.

Nalini Joshi is an ARC Georgina Sweet Laureate Fellow and the Chair of Applied Mathematics at The University of Sydney. She was the President of the Australian Mathematical Society during 2008–2010, elected a Fellow of the Australian Academy of Science in 2008, became the Chair of the National Committee of Mathematical Sciences in 2011, and was elected to the Council of the Australian Academy of Science in 2012.

AMSI News

Geoff Prince*

Five years at AMSI and 36 (on and off) at La Trobe

On 9 September I racked up five years as director of AMSI. For those of you who don't know, I have now formally resigned from La Trobe and my contract at AMSI has been renewed till July 2018 (my use-by date). I will continue at La Trobe in an adjunct position. I was very sorry to leave La Trobe, where I started as a PhD student in 1978. On this occasion I will be inappropriately partisan and say that the La Trobe department of mathematics and statistics has a wonderful record of academic achievement. It has weathered far too many externally imposed structural changes along with one of the worst down-sizings in the country during the 1990s. And yet the collegiality and integrity of the department's teaching and academic processes has seen it survive. It was a tough decision to leave and I wish all my close friends and colleagues the very best for the future. I hope that their membership of AMSI will help them stay strong.

AMSI intern expansion in 2015

AMSI is pleased to announce that it has brokered a co-investment with universities in Sydney and Melbourne that will see a four-fold increase in our business development capacity in those cities. This will mean more internships for our PhD students and a faster rate of growth in the program. I want to acknowledge the enormous help that we have had from Canada's Mitacs www.mitacs.ca and from their former CEO Arvind Gupta, now President of the University of British Columbia.

Recognition for PhD supervision: call for assistance

AMSI is currently building a case to have the Commonwealth funding weighting of PhD enrolments in the mathematical sciences raised to the same level as that in the laboratory sciences. Our case will be based on the intense technicality of the PhD theses in our discipline. Brian Davey, Gary Glonek and I are building the argument and we would be very pleased to hear from any *Gazette* readers who have experience around this issue. Please contact me on director@amsi.org.au.

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A farce of tragic proportions

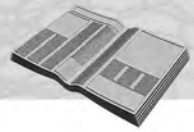
You may or may not have heard me rant about the fact that neither the state nor federal governments know how many (really how few) secondary maths teachers are graduated each year. This is mainly because the pedagogy subjects taken in pre-placement training courses are not differentiated by discipline in the reporting to the Commonwealth. Last month I heard about a situation which adds an element of farce to this already laughable situation. At one university the enrolments in some of the pedagogy subjects, including maths, are small enough that they will attract fines from a grossly over-zealous university administration. To protect the subjects, the education faculty is camouflaging them by amalgamation but maintaining the internal discipline structure. Of course this will also make them forever invisible for the purposes of counting maths teacher graduations!

ATTENTION: Changes to workshop applications

There have been changes to the rules and rounds for applications to AMSI, AustMS and ANZIAM for workshop funding — don't be caught out — go to the new Research pages at www.research.amsi.org.au In particular, we are now insisting on greater national attendance coverage and details of measures to be taken to improve female participation.

The next round closes on 28 November 2014 — rounds are now twice–yearly!

I was a Monash undergraduate and took out a La Trobe PhD in 1981 in geometric mechanics and Lie groups. This was followed by a postdoc at the Institute for Advanced Study in Dublin. I've enjoyed teaching at RMIT, UNE and La Trobe. My research interests lie mainly in differential equations, differential geometry and the calculus of variations. I'm a proud Fellow of the Society, currently a Council and Steering Committee Member. I became AMSI director in September 2009.



News

General News

Commonwealth Science Council

The Federal Government has announced the formation of the Commonwealth Science Council as a replacement for the Prime Minister's Science Engineering and Innovation Council, which last met in June 2013 (http://www.pm.gov.au/media/2014-10-14/lifting-australias-competitiveness-through-science-0).

Chaired by the Prime Minister, the Science Council will now be the pre-eminent body for advice on science and technology, advising the Government on areas of national strength, current and future capability and on ways to improve connections between Government, research organisations, universities and business.

Professor Nalini Joshi is one of five eminent scientists and five business leaders appointed to the Science Council.

Our congratulations to Nalini on her appointment!

Mathematicians in the Media

Nalini Joshi appeared on the ABC program Q&A on 20 October. The program can be viewed or downloaded at http://www.abc.net.au/tv/qanda/txt/s4088125.htm.

Prehistory of the Solar System

A team led by Dr Maria Lugaro and Professor Alexander Heger of the Monash Centre for Astrophysics have published an article on the prehistory of the Solar System in the journal *Science*, Vol. 345, no. 6197, pp. 650–653. Read the Monash news article at http://monash.edu/news/show/step-closer-to-birth-of-the-sun or download the paper from http://arxiv.org/pdf/1408.2050v1.pdf.

Journal of the Australian Mathematical Society

The *Journal of the Australian Mathematical Society* has moved to a new tracking system for submissions and peer review, Scholar One. Papers are now only accepted from the Scholar One site: http://mc.manuscriptcentral.com/jaz.

Completed PhDs

Monash University

- Dr Yanfei Kang, *Detection, classification and analysis of events in turbulence time series*, supervisors: Kate Smith-Miles and Danijel Belusic.

- Dr Stephen McCormick, *The phase space for the Einstein–Yang–Mills equations, black hole mechanics, and a condition for stationarity*, supervisors: Todd Oliynyk and Robert Bartnik.
- Dr Carolyn Doherty, *Evolution, nucleosynthesis and final fates of super and massive asymptotic giant branch stars*, supervisor: John Lattanzio.
- Dr George Angelou, *On the role of doubly-diffusive mixing in low-mass red giant branch stars*, supervisor: John Lattanzio.
- Dr Eriny Azmy, *Exact solution of inverse kinematic problem of 6R serial manipulators using Clifford algebra: applications of Clifford algebra in robotics*, supervisor: Alan Pryde.

Queensland University of Technology

- Dr Su Yun Kang, *Bayesian models for spatio-temporal assessment of disease*, supervisor: Kerrie Mengersen.
- Dr Zaiton Mat Isa, *Mathematical modelling of fumigant transport in stored grain*, supervisor: Troy Farrell.

University of Melbourne

- Dr Drew Heard, *Morava modules and the K(n)-local Picard group*, supervisors: Craig Westerland and Nora Ganter.
- Dr Yi Huang, *Moduli spaces of surfaces*, supervisor: Paul Norbury.
- Dr David Lazaridis, *Mixed-effects models with penalized fixed effects*, supervisor: Andrew Robinson.

University of New South Wales

- Dr Julie Wood, *The circulation on the continental shelf of south-eastern Australia from 2009 to 2013*, primary supervisor: Moninya Roughan.

University of Sydney

- Dr Inga Samonenko, *Nonparametric permutation test statistics and their saddlepoint approximations*, supervisor: John Robinson.
- Dr Duncan Sutherland, *Numerical study of vortex generation in bounded flows with no-slip and partial slip boundary conditions*, supervisor: Charlie Macaskill.

Awards and other achievements

Australian National University

- Emeritus Professor Richard Brent FAA has been awarded the 2014 Moyal Medal. The Moyal Medal is awarded annually by Macquarie University for research contributions to mathematics, physics or statistics, the areas of research of the late Professor José Enrique Moyal who was Professor of Mathematics at Macquarie University from 1973 to 1977. See

https://maths.mq.edu.au/medal/medallists.html for a list of previous winners and https://maths.mq.edu.au/medal/lecture2014.html for details of this year's Moyal Lecture, which has just taken place.

Monash University

- As reported briefly in the last issue, Professor Kate Smith-Miles was awarded one of the ARC's prestigious 2014 Australian Laureate Fellowships. Prof Smith-Miles received $2.83 million for her research project entitled 'Stress-testing algorithms: generating new test instances to elicit insights'. The project aims to develop a new paradigm in algorithm testing, creating novel test instances and tools to elicit insights into algorithm strengths and weaknesses. Professor Smith-Miles is also one of the two female researchers to receive a Georgina Sweet Australian Laureate Fellowship, which will see her take an ambassadorial role to promote women in research in addition to her research project.

University of Sydney

- The London Mathematical Society has announced that Professor Nalini Joshi is the Special LMS Hardy Fellow for 2015. She will undertake a lecture tour of the UK in the (English) summer which will end with the Hardy Lecture at the Society Meeting on Friday 3 July in London.

  Visit http://www.lms.ac.uk/events/lectures/hardy-lectureship for further details.
- The first Mrs Elva Rae Talented Mathematics Student Award has been awarded to Karen Leung for her project 'Impulsive control of the twisting somersault', to be undertaken under the supervision of Holger Dullin.

Appointments, departures and promotions

Griffith University

- Dr Hoda Rahmati, from Iran, has been awarded a Keizo/Obuchi Postdoctoral Research Fellowship by the United Nations, and is now working with Dr Anand Tularam on Modelling the level of water security in Asia and its long term implications for Australia.

Monash University

- Dr Padraig O'Cathain has commenced as Research Fellow. Padraig's research interests are in algebraic design theory, compressed sensing and computational algebra.

University of Melbourne

Appointments

- Dr Michael Wheeler

Departures

- Dr Guangjun Xu

University of New South Wales

These staff members have been promoted to Associate Professor at UNSW (effective 1 January 2015).

- Dr Daniel Chan
- Dr Francis Kuo
- Dr Bill McLean
- Dr Moninya Roughan
- Dr Chris Tisdell

University of Newcastle

- Dr Ohad Giladi has been appointed as Research Associate working with Laureate Professor Jon Borwein and CARMA.

University of Sydney

- Oded Yacobi was appointed as Lecturer in the School of Mathematics and Statistics.

New Books

Federation University

Bagirov, A., Karmitsa, N. and Mäkelä, M. M. (2014). *Introduction to Nonsmooth Optimization: Theory, Practice and Software*. Springer International, Switzerland. http://www.springer.com/business+%26+management/operations+research/book/978-3-319-08113-7

University of New South Wales

Donovan, P. and Mack, J. (2014). *Code Breaking in the Pacific*. Springer International, Switzerland. https://www.maths.unsw.edu.au/news/2014-09/code-breaking-pacific-peter-donovan-john-mack

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Conferences and Courses

Conferences and courses are listed in order of the first day.

EViMS 2: Effective use of Visualisation in the Mathematical Sciences workshop

Date: 21–23 November 2014
Venue: Australian National University
Web: http://maths.anu.edu.au/events/effective-use-visualisation-mathematical-sciences-evims-2

For more information, please see the website, or *Gazette* 41(4), p. 263.

New Directions in Fractal Geometry workshop

Date: 24–28 November 2014
Venue: Australian National University, Kioloa Coastal Campus
Web: http://maths.anu.edu.au/events/new-directions-fractal-geometry

For more information, please see the website, or *Gazette* 41(4), pp. 263–264.

Sequences and Their Applications (SETA) 2014

Date: 24–28 November 2014
Venue: University of Melbourne
Web: people.eng.unimelb.edu.au/udaya/seta14/

For more information, please see the website, or *Gazette* 41(4), p. 264.

The Biarri Applied Mathematics Conference

Date: 25–26 November 2014
Venue: RMIT, Melbourne
Web: http://bamconf.com/

BAMCONF 2014, MATHS EVERYWHERE. Now more than ever maths is pervading every nook and cranny of science, industry commerce and government. The BAM Conference this year will highlight the breadth of places where the mathematical sciences are making a difference, perhaps even where you might least expect: from the burgeoning analytics sphere to bioinformatics, telecommunication network design, disaster modelling, climate science, sport and finance. Over two days BAMConf will showcase mathematical tools and techniques used to solve problems in the real world, through case studies and in-depth talks. From this you will also get a glimpse of the many and diverse career paths that mathematics offers.

CTAC 2014

Date: 1–3 December 2014
Venue: Australian National University
Web: http://maths.anu.edu.au/events/ctac-2014

For more information, please see the website, or *Gazette* 41(3), p. 200.

BioInfoSummer 2014

Date: 1–5 December 2014
Venue: Monash University (Caulfield Campus), Melbourne
Web: http://www.amsi.org.au/index.php/higher-education/bioinfosummer

For more information, please see the website, or *Gazette* 41(3), pp. 200–201.

Australasian Applied Statistics Conference

Date: 1–5 December 2014
Venue: Port Lincoln Hotel, Eyre Peninsula
Web: http://www.aasc.org.au/

For more information, please see the website, or *Gazette* 41(4), pp. 264–265.

38th Australasian Conference on Combinatorial Mathematics and Combinatorial Computing

Date: 1–5 December 2014
Venue: Victoria University of Wellington, New Zealand
Web: http://msor.victoria.ac.nz/Events/38ACCMC

All registration will close on Monday 10 November.

For more information, please see the website, or *Gazette* 41(3), p. 201.

International mathematical conference at the University of Goroka, PNG

Date: 1–5 December 2014
Venue: University of Goroka, PNG
Web: http://icpam-goroka2014.blogspot.com/

For more information, please see the website, or *Gazette* 41(3), pp. 201–202.

Careers in Bioinformatics

Date: 2 December 2014, 6.30–7.30 pm
Venue: Lecture Theatre K309, Building K, Monash University, Caulfield
Web: http://bis14.amsi.org.au/events/careers-bioinformatics/

Love science, but are unsure about career paths and interested in exploring new and exciting areas? Bioinformatics is an emerging area; it sounds pretty cool, but what is it and where can it take you? Come along to this free public panel discussion and find out.

Speakers include Professor Chris Overall (University of British Columbia), Professor Kate Smith-Miles (MAXIMA) and Dr Mark Cowley (Garvan Institute).

Differential Geometry, Lie theory and Complex Analysis

Date: 5–7 December 2014
Venue: La Trobe University, City Campus, Melbourne
Web: http://purebyteslab.com/workshop/

Invited overseas speakers

- Carolyn Gordon (Dartmouth College, USA)
- Kang-Tae Kim (POSTECH, Korea),
- Dmitry Millionschikov (Moscow University, Russia)
- Tracy Payne (Idaho University, USA)

Registration
Registration is now open, but closes on 23 November. There is no registration fee.

The workshop is a satellite event of the 8th Australia New Zealand Mathematics Convention.

Organisers: Yuri Nikolayevsky (La Trobe University), Grant Cairns (La Trobe University), Gerd Schmalz (University of New England), Vlad Ejov (Flinders University).

Contact person: Yuri Nikolayevsky (y.nikolayevsky@latrobe.edu.au).

For further information, please see the website, or Gazette 41(4), p. 265.

AustMS/NZMS Early Career Workshop

Date: 6–7 December 2014
Venue: Melbourne Parkview Hotel
Web: http://www.austms2014.ms.unimelb.edu.au/early-career-workshop/

The Early Career Workshop of the Australian Mathematical Society will take place in Melbourne on the weekend of 6–7 December 2014. This is immediately prior to the Australia–New Zealand Mathematics Convention (ANZMC).

The workshop will focus on useful career advice for early career researchers in the mathematical sciences. It is an excellent opportunity to learn about your career pathways, discuss issues facing early career researchers, and meet lots of amazing people!

Start at 2:00pm on Saturday 6 December 2014.
Finish at 2:00pm on Sunday 7 December 2014.
Afterwards, participants will have time to make their way to the opening reception of the ANZMC.

8th Australia–New Zealand Mathematics Convention

Date: 8–12 December 2014
Venue: University of Melbourne
Web: http://www.austms2014.ms.unimelb.edu.au/

For more information, please see the website, or *Gazette* 41(3), pp. 202–203.

Applied Statistics and Public Policy Analysis Conference

Date: 11–12 December 2014
Venue: Charles Sturt University
Web: www.csu.edu.au/faculty/business/comp-math/home

For more information, please see the website, or *Gazette* 41(4), p. 266.

2015 AMSI Summer School

Date: 5–29 January 2015
Venue: University of Newcastle
Web: http://wwww.ss15.amsi.org.au

Registration is now open for the 2015 AMSI Summer School. Course information is now online. For more information, and to apply, go to the website.

Second-round registration closes on 20 November.

Mathematics in Industry Study Group (MISG) 2015

Date: 27–31 January 2015
Venue: Queensland University of Technology
Web: http://mathsinindustry.com/

For more information, please see the website, or *Gazette* 41(4), pp. 266–267.

ANZIAM 2015

Date: 1–5 February 2015
Venue: Gold Coast
Web: http://anziam15.com/

Registration for the ANZIAM 2015 conference is now open. Early-bird registration and abstract submission closes on 9 January 2015. Availability of accommodation at the Outrigger Surfers Paradise is not guaranteed after 9 December 2014. For a complete description of the conference dates, venue, invited speakers, registration details, etc., please see the conference website.

There is an associated one-day workshop on mathematical biology on 6 February 2015 at QUT in Brisbane.

Please direct any questions to anziam15@qut.edu.au.

Algebraic, Number Theoretic and Graph Theoretic Aspects of Dynamical Systems

Date: 2–6 February 2015
Venue: University of New South Wales
Web: http://web.maths.unsw.edu.au/~jagr/ADS_NT_GT.html

Early registration closes 15 November. For more information, please see the website, or *Gazette* 41(4), p. 267.

South Pacific Continuous Optimization Meeting (SPCOM) 2015

Date: 8–12 February 2015
Venue: University of South Australia
Web: carma.newcastle.edu.au/meetings/spcom/

For more information, please see the website, or *Gazette* 41(4), pp. 267–268.

Symmetries and Spinors: Interactions Between Geometry and Physics

Date: 13–17 April 2015
Venue: University of Adelaide, Conference Room 7.15
Web: www.iga.adelaide.edu.au/workshops/April2015/

For more information, please see the website, or *Gazette* 41(4), p. 268.

ICIAM mini-symposium

Date: 10–14 August 2015
Venue: Beijing, China
Web: http://www.iciam2015.cn/

For more information, please see the website, or *Gazette* 41(3), p. 203.

Visiting mathematicians

Visitors are listed in alphabetical order and details of each visitor are presented in the following format: name of visitor; home institution; dates of visit; principal field of interest; principal host institution; contact for enquiries.

Prof David Allen; Edith Cowan; 1 August 2014 to 31 July 2015; stats; USN; Shelton Peiris

Prof Pere Ara; Universitat Autònoma de Barcelona; 2–14 November 2014; noncommutative algebra; UWS; Roozbeh Hazrat

Dr Dzmitry Badziahin; Durham University; 21 October to 7 November 2014; metric Diophantine approximation; UNC; Wadim Zudilin

Associate Professor Ruth Baker; University of Oxford; 29 September 2014 to 3 October 2014; QUT

Mogens Bladt; IIMAS-UNAM; 1–15 November 2014; applied probability; SMP at UQ; Leonardo Rojas-Nandayapa

José Blanchet; Columbia University; January 2015; applied probability; SMP at UQ; Leonardo Rojas-Nandayapa

Mr Emeric Bouin; École Normale Supérieure de Lyon; 23 October 2014 to 10 November 2014; applied; Peter Sehoon Kim

Dr Vincent Calvez; École Normale Supérieure de Lyon; 23–29 October 2014; applied; Peter Sehoon Kim

A/Prof Xiyou Cheng; Lanzhou University, China; February 2014 to February 2015; nonlinear analysis; UNE; Yihong Du

Prof Timofei Dokchitser; Bristol University; 1 October to 15 December 2014; MAGMA; USN; John Cannon

Prof Vyacheslav Futorny; University of São Paulo; 30 October to 30 November 2014; pure; USN; Alexander Molev

Dr Ganes Ganesalingam; Massey University, NZ; 1 July 2014 to 30 June 2015; statistics; USN; Shelton Peiris

Prof Terry Gannon; University of Alberta; 31 October to 10 November 2014; ANU; Scott Morrison

Dr Tom Hirschowitz; French National Centre for Scientific Research, Le Bourget-du-Lac, France; November to December 2014; theoretical computer science and category theory; MQU; Richard Garner

Prof Derek Holt; University of Warwick; 28 September to 5 December 2014; MAGMA; USN; John Cannon

A/Prof Xian-Jiu Huang; Nanchang University, China; 1 October 2014 to 30 September 2015; ANU; Xu-Jia Wang

Mr Jesper Ipsen; Bielefeld University; 28 September to 22 October 2014; UOM; Peter Forrester

Prof Jesper Jacobsen; Laboratoire de Physique Theorique de Ecole Normale Superieure; 13–24 October 2014; UOM; Tony Guttmann

Prof Moniqu; e Jeanblanc Universite d'Evry; 15–22 December 2014; fin maths; Marek Rutkowski

Dr Zhong Jin; Shanghai Maritime University; August 2014 to August 2015; optimisation; FedUni; David Gao

Yangjin Kim; 12 January to 26 February 2015; applied; USN; Peter Sehoon Kim

Prof Satoshi Koike; Hyogo University, Japan; 8–23 September 2014; pure; USN; Laurentiu Paunescu

A/Prof Simon Kristensen; Aarhus University, Denmark; 19–28 October 2014; analytical number theory; UNC; Wadim Zudilin

A/Prof Sunil Chandran Leela; Indian Institute of Science; 3–23 November 2014; computer science and automation; UOM; Sanming Zhou

Prof Martin Liebeck; Imperial College; 2 October to 10 November 2014; UWA; Cheryl Praeger

A/Prof Si Mei; Shanghai Jiaotong University, China; 9 August 2014 to 8 August 2015; pure; USN; Andrew Mathas

A/Prof Sylvie Monniaux; Université Aix-Marseille; 15 October 2014 to 15 July 2015; ANU; Pierre Portal

Dr Pol Naranjo Barnet; Interdisciplinary Higher Education Centre (CFIS), Spain; 20 August to 11 November 2014; UMB; Lawrence Reeves

A/Prof Alicia Nieto-Reyes; University of Cantabria, Spain; 20 October to 2 December 2014; UOM; Peter Hall

Tim Penttila; Colorado State University, USA; 12–23 January 2015; geometry; UWA; Cheryl Praeger

Dr Alvaro Pelayo; University of California; 12 September to 4 October 2014; UOM; Peter Forrester

Prof Somyot Plubtieng; Naresuan University, Thailand; December 2014; optimisation; FedUni; Alex Kruger

Prof Aixia Qian; Qufu Normal University, China; December 2013 to December 2014; nonlinear analysis; UNE; Yihong Du

Dr Eric Ragoucy-Aubezon; Theoretical Physics Laboratory; 24 October to 3 December 2014; pure; USN; Alexander Molev

Prof Vladimir Rittenberg; Bonn University, Germany; 16 October to 1 December 2014; UOM; Jan de Gier

Dr Natalia Rozhkovskaya; 1–26 November 2014; pure; USN; Alexander Molev

Professor Matías Salibián-Berrera; The University of British Columbia; 7–28 September 2014; ANU; Alan Welsh

Ms Thidaporn Seangwattana; Naresuan University, Thailand; 20 September to 20 December 2014; optimisation; FedUni; Alex Kruger

A/Prof Mei Si; Shanghai Jiaotong University; 28 August 2014 to 8 August 2015; pure; USN; Andrew Mathas

Prof Mihai Tibar; Lile University 1; 25 November to 12 December 2014; pure; USN; Laurentiu Paunescu

Prof Vladimir Vatutin; Steklov Mathematical Institute, Moscow; 3 November to 3 December 2014; UOM; Kostya Borovkov

A/Prof Jerome Vetois; Univeristte de Nice; 14 October to 7 December 2014; pure; USN; Florica Cirstea

Dr Qian Wang; University of Oxford; 1 March to 31 December 2014; ANU; Markus Hegland

A/Prof Lei Wei; Jiangsu Normal University, China; February 2014 to February 2015; nonlinear partial differential equations; UNE; Yihong Du

A/Prof Dongsheng Wu; University of Alabama, USA; 17 August to 15 November 2014; stats; USN; Qiying Wang

Dr Fan Yang; Jiangsu University of Science and Technology, China; 1 October 2014 to 30 September 2015; UOM; Sanming Zhou

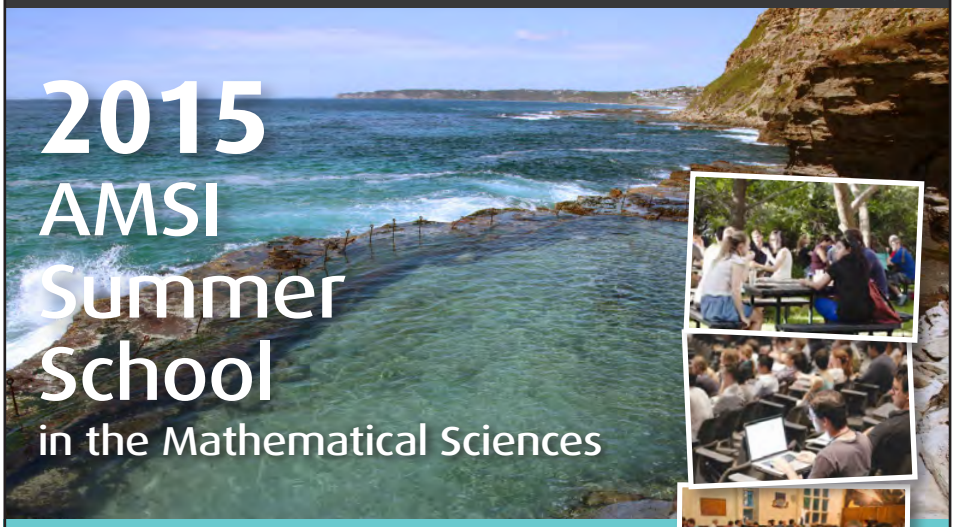
Mr Panu Yimmuang; Naresuan University, Thailand; 20 September to 20 December 2014; optimisation; FedUni; Alex Kruger

Prof Konstantin Zarembo; Nordita Stockholm; 1 October to 12 November 2014; ANU; Vladimir Bazhanov

Assoc Prof Jin-Xin Zhou; Beijing Jiaotong University; 16 November 2013 to 16 November 2014; UWA; Cai Heng Li

Prof Wu Ziku; Qingdao Agricultural University, China; 1 October 2014 to 1 March 2015; applied; UNS; Georg Gottwald

Research & Higher Education
Australian Mathematical Sciences Institute



2015 AMSI Summer School

in the Mathematical Sciences

5–29 January 2015
The University of Newcastle

Subjects & Speakers

Continued Fractions
Wadim Zudilin

Intermediate Probability
Louise Ryan

Geometric Group Theory
Murray Elder & Lawrence Reeves

Computational Bayesian Statistics
Chris Drovandi & Gentry White

Introduction to Nonlinear PDE
Mike Meylan

Mathematical Statistical Mechanics
Jan De Gier, Nathan Clisby & Tim Garoni

Optimisation
Regina Burachik

Nonlinear Control Theory
Zhiyong Chen

Registrations close 20 November 2014

AMSI Australian Mathematical Sciences Institute
The University of Newcastle Australia
Australian Government Department of Education
Aust MS Australian Mathematical Society
ANZIAM

Apply today: www.amsi.org.au/SS

Nominations sought for the 2015 AustMS Medal

The Medal Committee for the 2015 Australian Mathematical Society Medal is now seeking nominations and recommendations for possible candidates for this Medal, which will be awarded to a member of the Society, under the age of forty, for distinguished research in the Mathematical Sciences. These should be sent by email to the Chair of the AustMS Medal Committee. Nominations should be received by 24 April 2015.

For further information, please contact by email the Chair of the 2015 AustMS Medal Committee, Professor N.C. Wormald, School of Mathematical Sciences, Monash University, PO Box 28M, Victoria 3800 (nick.wormald@monash.edu).

See http://www.austms.org.au/AMSInfo/medal.html for a list of past AustMS Medal winners.

Rules for the Australian Mathematical Society Medal

1. There shall be a Medal known as "The Australian Mathematical Society Medal".
2. (i) This will be awarded annually to a Member of the Society, under the age of 40 on 1st January of the year in which the Medal is awarded, for distinguished research in the Mathematical Sciences. The AustMS Medal Committee may, in cases where there have been significant interruptions to a mathematical career, waive this age limit by normally up to five years.

   (ii) A significant proportion of the research work should have been carried out in Australia.

   (iii) In order to be eligible, a nominee for the Medal has to have been a member of the Society for the calendar year preceding the year of the award; back dating of membership to the previous year is not acceptable.
3. The award will be approved by the President on behalf of the Council of the Society on the recommendation of a Selection Committee appointed by the Council.
4. The Selection Committee shall consist of three persons each appointed for a period of three years and known as "Incoming Chair", "Chair" and "Outgoing Chair" respectively, together with a fourth person appointed each year for one year only.
5. The Selection Committee will consult with appropriate assessors.
6. The award of the Medal shall be recorded in one of the Society's Journals along with the citation and photograph.

7. The Selection Committee shall also prepare an additional citation in a form suitable for newspaper publication. This is to be embargoed until the Medal winner has been announced to the Society.
8. One Medal shall be awarded each year, unless either no one of sufficient merit is found, in which case no Medal shall be awarded; or there is more than one candidate of equal (and sufficient) merit, in which case the committee can recommend the award of at most two Medals.

Nominations sought for the 2015 Gavin Brown Prize

The 2015 Gavin Brown Prize Selection Committee is now seeking nominations and recommendations for possible candidates for this prize, to be awarded for an outstanding and innovative piece of research in the mathematical sciences published by a Member or Members of the Society. The award will be for a single article, monograph or book consisting of original research, and published in the nine calendar years preceding the year of the award.

Nominators should provide a brief (1–2 pages) summary of what makes the nominated publication important and original, with appropriate references to prior or subsequent work in the field. These should be sent by email to the Chair of the Gavin Brown Prize Selection Committee. Nominations should be received by 24 April 2015.

For further information, please contact by email, the Chair of the 2015 Gavin Brown Prize Selection Committee, Professor J.M. Borwein, School of Mathematical and Physical Sciences, The University of Newcastle, Callaghan, NSW 2308 (jon.borwein@gmail.com).

Rules for the Gavin Brown Prize

1. The Gavin Brown Prize will be awarded annually for an outstanding and innovative piece of research in the mathematical sciences published by a Member or Members of the Society.
2. Each award will be for a single article, monograph, or book, consisting of original research, and published in the 9 calendar years preceding the year of the award.
3. To be eligible for the award of the Gavin Brown Prize, a publication must have at least one author who meets the following conditions:
   (i) he/she must be a member of the Society, and must have been a member of the Society for the calendar year at the time of publication of the paper (back-dating of membership is not allowed);
   (ii) he/she must be normally resident in Australia, and must have been normally resident in Australia at the time when the research was carried out.
4. In the case of publications with multiple authors, the prize will be shared by all authors. The existence of authors who do not meet the conditions in

Rule 3 will not preclude this award, although the Selection Committee may take it into account in assessing the achievement of the author(s) who do meet those conditions.

5. The Selection Committee may deem a publication ineligible if an author has previously received an award from the Australian Mathematical Society for a body of research which included the publication in question.
6. Nominations for the Gavin Brown Prize will be called for in the first half of each year. A publication may be nominated for the award by any member of the Society who is not an author of that publication.
7. The award will be decided by a Selection Committee appointed by the Council.
8. The Selection Committee will consist of 4 persons:
   (i) 3 persons each appointed for a period of 3 years, namely a Chair, an Incoming Chair who will become the Chair in the following year, and an Outgoing Chair who has been the Chair in the preceding year;
   (ii) 1 person appointed for one year only.
9. The Selection Committee may consult with appropriate external assessors.

AustMS Accreditation

- Professor Terry Mills of La Trobe University has been accredited as a Fellow (FAustMS).
- Associate Professor David Pask of the University of Wollongong has been accredited as a Fellow (FAustMS).
- Mr Julio Perez of Benowa State High School has been accredited as a Graduate Member (GAustMS).

Peter Stacey
AustMS Secretary
Email: P.Stacey@latrobe.edu.au

Peter Stacey joined La Trobe as a lecturer in 1975 and retired as an associate professor at the end of 2008. Retirement has enabled him to spend more time with his family while continuing with some research and some work on secondary school education. He took over as secretary of the Society at the start of 2010.

Higher Education
Australian Mathematical Sciences Institute

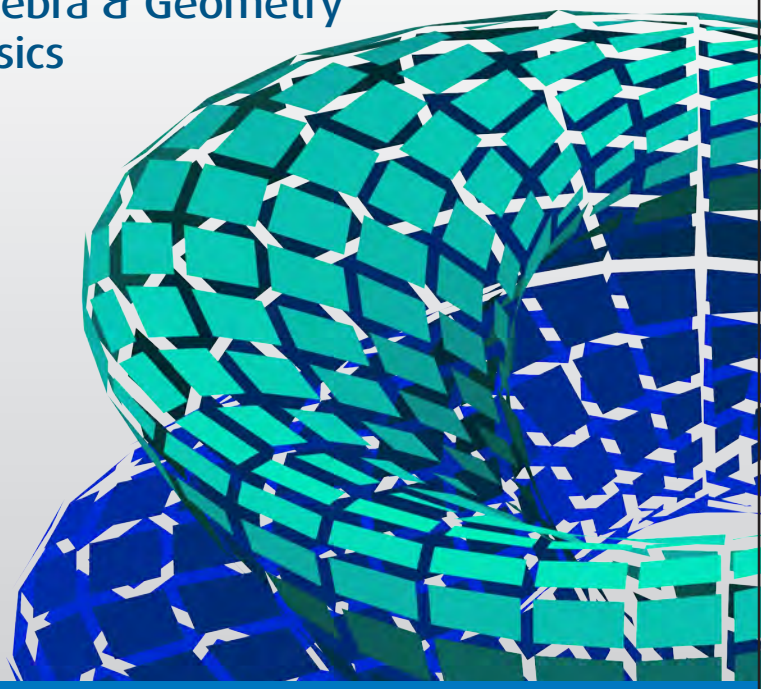
AMSI
AUSTRALIAN MATHEMATICAL SCIENCES INSTITUTE

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

Australian National University

Winter School 2015

on Algebra & Geometry in Physics



29 June – 10 July 2015

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Membership and Correspondence

Applications for membership, notices of change of address or title or position, members' subscriptions, correspondence related to accounts, correspondence about the distribution of the Society's publications, and orders for back numbers, should be sent to the Treasurer. All other correspondence should be sent to the Secretary. Membership rates and other details can be found at the Society web site: www.austms.org.au.

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Publications

The Journal of the Australian Mathematical Society

Editors: Professor J.M. Borwein and Professor G.A. Willis
School of Mathematical and Physical Sciences
University of Newcastle, NSW 2308, Australia

The ANZIAM Journal

Editor: Professor A.P. Bassom
School of Mathematics and Statistics
The University of Western Australia, WA 6009, Australia

Editor: Associate Professor G.C. Hocking
School of Chemical and Mathematical Sciences
Murdoch University, WA 6150, Australia

Bulletin of the Australian Mathematical Society

Editor: Professor John Loxton
University of Western Sydney, Penrith, NSW 2751, Australia

The *Bulletin of the Australian Mathematical Society* aims at quick publication of original research in all branches of mathematics. Two volumes of three numbers are published annually.

The Australian Mathematical Society Lecture Series

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ISSN: 0311-0729

Published by The Australian Mathematical Publishing Association Incorporated
Typeset in Australia by TechType, ACT
Printed in Australia by Union Offset Printers, ACT