

# CENTRE FOR DISCRETE MATHEMATICS AND COMPUTING

in the  
DISCIPLINE of MATHEMATICS, SCHOOL of PHYSICAL SCIENCES  
and the  
SCHOOL of INFORMATION TECHNOLOGY and ELECTRICAL ENGINEERING  
at  
THE UNIVERSITY OF QUEENSLAND  
October 2003

## 0. PREFACE

This Centre was formed at the beginning of 1998 by the merger of the Centre for Combinatorics (in the then Department of Mathematics) with the Algorithms Group (in the then Department of Computer Science and Electrical Engineering). It promotes research in combinatorics and in algorithm design, and supports the Number Theory Web. It acts as national base for an international body, the Institute of Combinatorics and its Applications (ICA), and as regional base for the Combinatorial Mathematics Society of Australasia (Incorporated) (CMSA(Inc)). In association with the Department of Mathematics, University of Auckland, it publishes an international journal, the *Australasian Journal of Combinatorics*, for CMSA(Inc). It is one of sixteen groups listed on the World Combinatorics Exchange <http://www.combinatorics.org/People/index.html>.

The Centre hosts conferences and workshops, ranging from larger ones, such as the Twenty-third Australasian Conference on Combinatorial Mathematics and Combinatorial Computing in July 1998, with 83 participants from 11 different countries, to comparatively small informal workshops, such as the four-day one held in November 1999, with just 18 talks, 11 of them by local participants. Other meetings have included: a small workshop held in June/July 2001; the Australasian Workshop On Combinatorial Algorithms (AWOCA 2002) organised by members of the Centre and held in July 2002 on Fraser Island, which attracted 40 participants from eight different countries; and a workshop planned for January 2004. This planned workshop has already attracted support from both the Australian Mathematical Sciences Institute and the ICA, and we anticipate that further international collaboration will develop from this meeting.

Members of the Centre already actively collaborate with overseas research groups in Austria, Belgium, Canada, China, Czech Republic, France, Germany, Iran, Italy, New Zealand, Taiwan, Thailand, Turkey, United Kingdom and United States of America. Within Australia, members of the Centre collaborate with research groups at: the Universities of Sydney, Newcastle, Adelaide, Western Australia and Wollongong; Curtin University of Technology, the University of Technology, Sydney, and the Queensland University of Technology; the Australian National University and Charles Darwin University. The Centre also hosts numerous visitors, including a number of Ethel Raybould research fellows. Postgraduate students within the Centre have the benefit of working with such visitors while they are here, and sometimes of visiting them in their home universities.

Members of the Centre have easy access to the Dorothy Hill Physical Sciences and Engineering Library of The University of Queensland, which houses one of the best collections in Australasia of combinatorial literature. They also have access to computing facilities appropriate to their needs, notably including grid computing on 128 Sun Netra X1 machines.

Although both discrete mathematics and computing are areas of much serious research, they include many problems which are easily stated and understood, and consequently of interest to people with little formal background in the area. Some of these problems are immensely difficult, the four colour theorem and Fermat's last theorem being classic examples. Some are relatively easy to solve, at least in small particular cases, and attract students into the area, and often from there into other areas of mathematics as well. Thus many combinatorial questions feature on the Queensland Association of Mathematics Teachers Problem Solving Competitions, the Australian Mathematics Competitions, and the Mathematical Olympiads. Areas where such questions arise include games and puzzles, scheduling and allocation problems, coding and cryptography, structures of woven textiles, and many problems in graph theory. Staff associated with this Centre have contributed consistently to activities for secondary students, including competitions, ExpoUni displays, Winter Schools, a biennial newsletter (Infinity) and the club allied with it (Club Infinity).

Theoretical interests within the Centre include: designs, finite geometries, networks and graphs; universal algebras and their relation to designs and graphs; number theory; finite fields; combinatorial computing, especially algorithm development relevant to these areas, to linear algebra and to parallel and distributed computing. Applications of particular interest include: experimental design; error-correcting codes and cryptography; techniques for drug design, combinatorial chemistry and DNA sequencing; and the production of scientific software now included in such large systems as MAGMA (based at the University of Sydney), GAP (Scotland), LIDIA and KANT (Germany) and PARI (France).

This report describes the research activities of staff associated with the Centre.

## 1. STAFF ASSOCIATED WITH THE CENTRE

**Honorary Professor and Centre Director**

Anne Penfold Street, MSc *Melb*, PhD *Ill*, DMath *UW*, FTICA, (*combinatorial designs and applications*).

**Honorary Professor**

Charles Curtis Lindner<sup>1</sup>, BS *Pres, Clinton, S.C*, MS, PhD *Emory*, FTICA, (*combinatorial designs*).

**Readers**

Peter Adams, BSc (Hons), BComm, PhD, FTICA, (*combinatorial designs, combinatorial computing and applications*).

Elizabeth Jane Billington, MA, DipAdMaths *Oxon*, DipEd, PhD, FTICA, FAustMS, (*combinatorial designs and graph decompositions*).

Diane Margaret Donovan, BA, DipEd *La Trobe*, PhD, FTICA, FAustMS, (*combinatorial designs and computer security schemes*).

George Havas, BA (Hons) *ANU*, PhD *Sydney*, (*algorithm design*).

**Queen Elizabeth II Principal Research Fellow (Level D)**

Darryn Edward Bryant, BSc, MScSt, PhD, FTICA, (*combinatorial designs, graph theory and DNA sequencing*).

**Lecturers**

Kevin Eugene Gates, BS *USCGA*, MS, PhD *UWa*, (*algorithm development in linear algebra*).

Barry Denis Jones, MSc *Tas*, PhD *Exe*, MTICA, (*homological algebra and combinatorics*).

Victor Scharaschkin, BSc Hons *Tas*, PhD *Mich*, (*algebraic number theory, arithmetic geometry*).

**Research Fellow**

Barbara Marguerite Maenhaut, BMath *UW*, BEd *UWO*, PhD, AFTICA, (*combinatorial designs, graph theory*).

**Senior Research Officers**

Gregory Gamble<sup>2</sup>, BSc (Computing), BE (Elec), MMath *UNSW*, PhD *UWA*, (*combinatorial algorithms*).

Kenneth Raward Gray<sup>3</sup>, BA (Hons), DipEd *Macquarie*, PhD, FTICA, (*combinatorial designs and education*).

Nicholas Ahti Hamilton<sup>4</sup>, BSc (Hons), PhD *UWA*, (*finite geometry*).

Abdollah Khodkar<sup>5</sup>, MSc *Sharif*, PhD, (*combinatorial designs*).

**Research Officer**

Colin Ramsay, BCompSci, BSc (Hons) *NTU*, PhD, (*combinatorial computing and algorithm development*).

**Honorary Research Consultants**

Keith Robert Matthews, MSc, PhD, (*number theory*).

Graham Hilton Norton, BSc *Cape Town*, PhD *Cornell*, (*applied algebra, algebraic coding theory*).

Peter Arthur Barry Pleasants, MA, PhD *Cantab*, MSc *Wales*, (*number theory, combinatorics, geometry, quasicrystals*).

Sheila Williams, MA, DPhil *Oxon*, FTICA, (*universal algebra and combinatorial designs*).

**Honorary Research Adviser**

Martin James Sharry<sup>6</sup>, BSc (Hons), PhD, FTICA, (*combinatorial designs and combinatorial computing*).

**Visiting Research Staff**

Ebadollah S Mahmoodian<sup>7</sup>, BS *Tehran*, MS *Shiraz*, AM, PhD *Pennsylvania*, FTICA, (*combinatorial designs*).

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<sup>1</sup>Distinguished Professor, Auburn University

<sup>2</sup>Senior Research Officer (p/t), Research Associate (Curtin University)

<sup>3</sup>Senior Research Officer (p/t); Consultant in educational assessment and testing, with clients including both Education Queensland and non-state schools.

<sup>4</sup>Senior Research Officer, joint position in the Institute for Molecular Bioscience and the Advanced Computational Modelling Centre

<sup>5</sup>Senior Research Officer (p/t)

<sup>6</sup>Manager - Infrastructure Services Unit, Information Solutions and Technology, Corporatelink, Queensland

<sup>7</sup>Professor of Mathematical Sciences, Sharif University of Technology, Tehran, Iran

## 2. RESEARCH STUDENTS

The lists include titles of theses and the names of the relevant research supervisors. Note that \* indicates a thesis placed on the Dean's Commendation List for Outstanding PhD Theses. This list was instituted during 1998, but has not yet been compiled for 2000 onwards.

**1998**

Robert Coulter, (PhD, *Planar functions and related topics in finite fields*, Havas).  
 Brenton Donald Gray, (PhD, *Trades and defining sets with applications to access schemes*, Street).  
 Adelle Maree Howse, (PhD, *Latin interchanges, critical sets and associated structures*, Donovan).  
 Colin Ramsay\*, (PhD, *Trades and defining sets: theoretical and computational results*, Havas/Street).

**1999**

Nicholas J Cavenagh, (MSc, *Graph decompositions of complete tripartite graphs using trades*, Billington).  
 Philip Michael Hawkes\*, (PhD, *A Markov approach to cryptanalysis of ciphers*, Donovan/Luke O'Connor (IBM Zurich)).  
 Barbara Marguerite Maenhaut\*, (PhD, *Substructures of cycle systems with applications to access schemes*, Street/Sharry).  
 Marks Richard Nester\*, (PhD, *Mathematical investigations of some plant interaction designs*, Street).  
 Sarah Zahrai\*, (PhD, *Varieties of universal algebras generated by finite algebras associated with cycle systems*, S Williams/B Jones).

**2001**

Richard W Bean, (PhD, *Latin squares, critical sets and related structures*, Donovan/Billington).

**2003**

Andrew D Blinco, (PhD, *Graph decomposition, theta graphs and related graph labelling techniques*, Billington/Adams).  
 Sara Cauchie, (PhD, University of Gent, *A study of  $(\alpha, \beta)$ -geometries fully embedded in projective spaces*, Hamilton).  
 Nicholas J Cavenagh, (PhD, *Latin cubes*, Donovan/Billington/Khodkar).  
 Mark Griffin, (PhD, *The computer simulation of electron paramagnetic resonance spectra employing homotopy*, Gates/G R Hanson/K Burrage).  
 Andrew Janke, (PhD, *Cognition driven deformation modelling*, Gates/G Galloway).  
 Annette Masters, (PhD, *Some extensions to support vector machines*, Gates/T Downs (ITEE)).

**Submitted**

Stephen M Long, (PhD, *Combinatorial methods and applications in drug discovery*, Adams/Tran (Chemistry)/Smythe (IMB)).

**Current**

Jenna Appleton, (PhD, *Combinatorial algorithms*, Adams/Bryant).  
 Melinda Buchanan, (MPhil, *Completions of partial latin squares*, Bryant/Adams).  
 Sean Byrnes, (PhD, *Geometric perspectives on noncommutative algebra*, B Jones).  
 Matthew Dean, (PhD, *Hamilton cycle decompositions of Cayley graphs*, Bryant).  
 Peter Jenkins, (PhD, *Embedding partial graph designs*, Billington/Adams/Bryant).  
 James Lefevre, (PhD, *Graph decompositions and trades*, Billington/Adams).  
 Anthony Rasmussen, (PhD, *High performance computational modelling in molecular reaction dynamics*, S C Smith/Gates).  
 S M Sheikholeslami, (PhD, Tarbiat Moallem University of Azarbayjan, *Critical sets in dihedral groups*, M A Shababi, University of Tabriz/Khodkar).  
 Mary Waterhouse, (PhD, *Graph colourings and emerging applications of combinatorial design theory*, Adams/Bryant).

**Current but paused**

Carlo Hamalainen, (PhD, *Critical sets for latin squares and graph colourings*, Donovan/Khodkar).  
 Karen Grace Harris, (PhD, *Small graph designs and their various properties*, Billington/Donovan).

**Planned, 2004**

Melinda Buchanan, (PhD, *Topics on latin squares, edge colourings of graphs and related combinatorial designs*, Bryant).  
 Tristan Freiberg, (MSc, *Rational points on curves of genus  $> 1$* , Scharaschkin).  
 Daniel Horsley, (PhD, *Topics in Steiner triple systems and related combinatorial designs*, Bryant).

## 3. VISITORS

**1998**

Professor Rosemary Bailey (Queen Mary and Westfield College), July, 23ACCMCC.  
 Professor Aiden Bruen (University of Western Ontario), March.  
 Professor Karsten Bueckers (Durham), November.  
 Professor Peter Cameron (Queen Mary and Westfield College), July, 23ACCMCC.  
 Professor Peter Eades (University of Newcastle), April.  
 Professor Saad El-Zanati (Illinois State University), September–December.  
 Professor Chin-Mei Fu (Tamkang University), July–August, 23ACCMCC.  
 Professor Hung-Lin Fu (National Chiao–Tung University) July–August, 23ACCMCC.  
 Professor Zicheng (Jason) Gao (Carleton University), July, 23ACCMCC.  
 Professor Jovan Golic (University of Belgrade), July, 23ACCMCC.  
 Professor Derek Holton (University of Otago), July, 23ACCMCC.  
 Professor Curt Lindner (Auburn University), January and June–July, 23ACCMCC.  
 Professor Ebadollah Mahmoodian (Sharif University of Technology), Raybould Fellow, June–July, 23ACCMCC.  
 Professor R A Mathon (University of Toronto), November–December.  
 Professor Winfried Muller (Klagenfurt, Austria), July, 23ACCMCC.  
 Professor Michael Newman (Australian National University), September.  
 Dr Christine O’Keefe (University of Adelaide), July, 23ACCMCC.  
 Professor Alexander Rosa (McMaster University), July, 23ACCMCC.  
 Professor Jennifer Seberry (University of Wollongong), September.  
 Professor Igor Shparlinski (Macquarie University), August.  
 Professor Joel Spencer (Courant Institute, New York), April.

**1999**

Professor Michael Atkinson (University of St Andrews), January.  
 Professor Robert Blakley (Texas A & M University), August.  
 Professor R G Burns (University of York), October–November.  
 Professor Marston Conder (University of Auckland), October.  
 Professor John Horton Conway (Princeton University), September.  
 Professor J W P Hirschfeld (University of Sussex), August–September.  
 Professor C C Lindner (Auburn University), June–July.  
 Professor Ebadollah Mahmoodian (Sharif University of Technology), August–December, Combinatorics Workshop.  
 Professor R A Mathon (University of Toronto), November–December.  
 Professor P M Neumann (Oxford University), February–March.  
 Dr Christine O’Keefe (University of Gent/University of Adelaide), November, Combinatorics Workshop.  
 Dr Timothy Penttila (University of Western Australia), November, Combinatorics Workshop.  
 Professor Christopher Rodger (Auburn University), November, Raybould Fellow, Combinatorics Workshop.  
 Professor Igor Shparlinski (Macquarie University), May.  
 Professor Charles Sims (Rutgers, the State University of New Jersey), December.  
 Professor R G Stanton (University of Manitoba), March–April.  
 Professor Charles Vanden Eynden (Illinois State University), June.  
 Professor Walter Wallis (Carbondale University), May and December.

**2000**

Dr Paul Bonnington (University of Auckland), August–September.  
 Professor Peter Cameron (Queen Mary and Westfield College, London, UK), July.  
 Professor Frank De Clerck (Universiteit Gent), January–February.  
 Mr Mario Delanote (Universiteit Gent), January–February.  
 Professor Peter Eades (University of Newcastle), April and November.  
 Professor Roger Eggleton (Illinois State University), June–July.  
 Professor Hung-Lin Fu (National Chiao Tung University, Taiwan), August.  
 Professor J W P Hirschfeld (University of Sussex), August–September.  
 Professor D G Hoffman (Auburn University, Alabama), March.  
 Dr Seokhee Hong (University of Newcastle), April and November.  
 Dr Andrei Kelarev (University of Tasmania), July.  
 Dr Peter Kenne (University of Adelaide), September.

Professor Midori Kobayashi (University of Shizuoka), July–September.  
 Professor C C Lindner (Auburn University, Alabama), November.  
 Dr Bruce Litow (James Cook University), September.  
 Professor E S Mahmoodian (Sharif University of Technology, Tehran).  
 Professor Brendan McKay (Australian National University), July.  
 Dr Miwako Mishima (Gifu University, Japan), August.  
 Professor Michael Newman (Australian National University), October–November.  
 Dr Graham Norton (University of Bristol), July–December.  
 Dr Eamonn O’Brien (University of Auckland), January and October–November.  
 Professor Jennie Seberry (University of Wollongong), January.

### 2001

Professor R G Burns (University of York), July.  
 Professor Francis Chin (University of Hong Kong), July.  
 Professor Peter Eades (University of Sydney), November.  
 Professor Roger Eggleton (University of Calgary), June.  
 Professor Saad El-Zanati (Illinois State University), June.  
 Professor Heather Gavlas (Grand Valley State University, USA), June.  
 Dr Catherine Greenhill (University of California), September.  
 Professor Martin Gutknecht (University of Zurich), April.  
 Professor J W P Hirschfeld (University of Sussex), August–September.  
 Dr Barbara Maenhaut (Open University, UK), May–June.  
 Professor Rudolf Mathon (University of Toronto), January–February.  
 Dr Ian Wanless (Oxford University), March.

### 2002

Dr Angelina Chin (University of Malaya), July–August.  
 Professor Ales Drapal (Charles University, Prague), September.  
 Professor Roger Eggleton (University of Calgary), June–July.  
 Professor Heather Gavlas (Grand Valley State University, USA), June.  
 Dr Marie Henderson (RMIT University), May.  
 Professor J W P Hirschfeld (University of Sussex), August–September.  
 Professor Curt Lindner (Auburn University), July.  
 Dr Barbara Maenhaut (Open University, UK), May–June.  
 Professor Jennifer Seberry (University of Wollongong), February and May.  
 Dr Ian Wanless (Oxford University), January.

### 2003

Professor John Cannon (Computational Algebra Group, University of Sydney), January.  
 Professor Roger Eggleton (University of Calgary), July.  
 Professor Heather Gavlas (Illinois State University), January.  
 Professor J W P Hirschfeld (University of Sussex), August–September.  
 Dr Michael Hoffmann (School of Mathematics and Computer Science, University of Leicester), August.  
 Professor Lily Khadjavi (Loyola Marymount University, Los Angeles), August.  
 Professor Rudolf Mathon (University of Toronto), January.  
 Professor C A Rodger (Auburn University), July, Raybould Fellow.  
 Professor Jennifer Seberry (University of Wollongong), February.  
 Dr Ian Wanless (Oxford University), January.

## 4. RESEARCH INTERESTS

**Combinatorial Designs and Graph Theory.**

Designs as graph decompositions. Trades in graphs. Graph decompositions and colourings. Metamorphosis of designs, including  $G$ -designs. Bipartite and tripartite designs; cycle systems, Hamilton/Waterloo problems.

Triple systems, especially Steiner triple systems. Intersection problems for designs. Blocking sets in designs.

Partitioning families of blocks into collections of disjoint designs, including collections of small planes.

Defining sets of designs and critical sets of Latin squares; trades and Latin interchanges. Defining sets and trades in other combinatorial structures.

Proportionally balanced designs, constructions and properties.

**Finite Geometry.**

Construction, characterisation and embedding problems associated with geometric structures in finite projective spaces. Links between areas such as polar spaces, finite group theory, structures in projective planes, partial geometries and designs. Construction of distance regular covers of complete graphs using sets in finite projective spaces. Relations between strong Steiner trades and projective planes;  $m$ -systems of polar spaces; hyperovals in projective planes.

**Applications of discrete mathematics.**

DNA sequencing using hybridization methods, Encoding/decoding methods for combinatorial chemistry, optimization of combinatorial chemistry techniques. Drug design. Bioinformatics.

Application of combinatorial designs to authentication schemes, to the construction of access schemes for computer security and to the construction of block ciphers. Classes of designs for the study of plant competition, of scheduling and allocation problems, and of problems in cognitive science.

**Combinatorial Designs: relationships with universal algebras.**

Relationships between quasigroups and certain types of neighbourhood designs; when the particular quasigroups involved actually form a variety. Minimal distances of group Latin squares. Universal algebra techniques applied to construct new designs. Small 2-perfect designs. Strongly 2-perfect cycle systems and associated quasigroups.

**Infinite Combinatorics.**

Combinatorial properties of infinite sets.

**Algebra and Number Theory.**

Ramsey varieties of finite groups, the topological group of  $p$ -adic integers, varieties of congruence lattices of groups. Homological algebra and ring theory. Cohomology rings of finite groups. Group representation theory. Formal methods for computing, symbolic computation. Homotopy theory. The Brauer Manin obstruction. The ABC conjecture. Arithmetic geometry. Rational points on varieties.

**Combinatorial Computing and Algorithm Design.**

Abstract algebraic algorithms. Perfect hashing. Fundamental algorithms for parallel and distributed systems. Finite fields and their applications. Computational combinatorics. Algorithm development for linear algebra. Computing canonical forms of matrices. Extended GCD algorithms.

## 5. RECENT AND CURRENT FUNDING

**Adams and Bryant**

*Research Infrastructure Block Grant*, \$67 000, 2000.

**Billington and Adams**

*Automated code generation, parallel algorithms, and a certain type of graph decomposition*, \$16 500, University of Queensland Enabling grant, 1999.

**Billington, Bryant and Adams**

*Trades in graphs*, \$165 000, Australian Research Council Large Grant, 1997–9.

**Bryant**

*Large sets of cycle systems and related designs*, Australian Postdoctoral Research Fellowship, (supervisor Street), \$164 348, ARC, 1996–8.

With Associate Professor P M Diamond (Discipline of Mathematics) and Dr N Kuznetsov (Russian Academy of Science), *Statistical laws for computational collapse of chaotic systems*, \$160 000, Australian Research Council Large Grant, 1997–9.

*Embedding cycle systems of multigraphs*, \$14 600, The University of Queensland New Staff Research Grant Scheme, 1998.

With Dr M Trau (Discipline of Chemistry), *Rapid DNA sequencing by hybridization of a patterned colloidal array*, \$165 000, Australian Research Council Large Grant, 1998–2000.

*Combinatorial graph decomposition techniques and DNA sequencing by hybridization*, \$60 000, University of Queensland Foundation Research Excellence Award, 1999–2000.

#### **Bryant and Adams**

With Mr Keith Mitchelson (Australian Genome Research Facility), *Commercial development of a novel DNA sequencing method*, \$250 000, Biotechnology Innovation Fund Grant, 2002–2003.

With Mr Keith Mitchelson (Australian Genome Research Facility) and Dr Jonathan Keith (Discipline of Mathematics), *DNA sequencing algorithms and the use of mutagenesis to resolve sequencing difficulties caused by repeated motifs*, \$405 000, Uniseed Grant, 2002.

With Mr Keith Mitchelson (Australian Genome Research Facility), *Mutagenesis and combinatorial algorithms for sequencing problematic genomic regions*, \$450 000, Australian Research Council Discovery Grant, 2002–2006.

#### **Donovan**

*The spectrum of critical sets*, \$20 000, Australian Research Council Small Grant, 1999.

*Promoting Women's Fellowship*, \$8 333, The University of Queensland, 2000 (January – June).

With Associate Professor Thompson, Professor Burrage (Discipline of Mathematics) and Tarong Energy, *Modelling, simulation and risk analysis in Australian energy markets*, \$197 000, Australian Research Council SPIRT Grant, 2001, 2002, 2003.

#### **Gates**

With Dr G R Hanson (Centre for Magnetic Resonance), *Comparison of homotopy and least-squares fitting for the computation of resonant field values for randomly oriented paramagnetic spectra*, \$16 576, University of Queensland New Staff Grant, 1998.

With Dr G R Hanson (Centre for Magnetic Resonance) and Professor K Burrage, *Application of virtual reality for visualisation and algorithmic development in magnetic resonance*, \$25 000, Australian Research Council Small Grant, 1998.

With Dr G R Hanson (Centre for Magnetic Resonance) and Professor K Burrage, *Development of an interactive computer simulation/visualisation software environment for the analysis of randomly oriented ESEEM and pulsed ENDOR spectra*, \$248 000, Australian Research Council Large Grant, 1997–9.

With Professor T Downs (Department of Computer Science and Electrical Engineering), *Some extensions to Support Vector Machines*, \$150 000, Australian Research Council Large Grant, 1998–2000.

With Dr G R Hanson (Centre for Magnetic Resonance) and Professor K Burrage, *Development of an interactive computer simulation/visualisation software environment for the analysis of randomly oriented ESEEM and pulsed ENDOR spectra*, \$50 000, Patent Licensing, 1999–2003.

#### **Hamilton**

*Maximal arcs, partial geometries and designs*, Australian Postdoctoral Research Fellowship, (supervisor Billington), \$166 845, Australian Research Council, 1997–9.

Research Fellowship, University of Gent, Belgium, 2000–02.

#### **Havas**

*Computing with finitely presented groups*, \$168 000, Australian Research Council Large Grant, 1998–2000.

*Algorithms and applications in finite fields*, \$150 000, Australian Research Council Large Grant, 1998–2000.

#### **Havas, Bryant, Adams and Street**

*Emerging applications of advanced computational methods and discrete mathematics*, \$290 000, Australian Research Council Discovery project (now rolled into ARC Centre for Complex Systems), 2002–2004.

#### **Scharaschkin**

*Rational Points and the ABC Conjecture*, \$29 000, University of Queensland Early Career Research Grant, 2003.

#### **Street**

With Professor J R Seberry (Centre for Computer Security Research, Department of Computer Science, University of Wollongong), *Access schemes and data protection schemes for computer security and electronic strongboxes from combinatorial structures*, \$156 000, Australian Research Council Large Grant, 1998–2000.

With Professor J R Seberry (Centre for Computer Security Research, Department of Computer Science, University of Wollongong), *Timed-commitment schemes to smooth Internet bottlenecks, defend against denial of service attacks, and bypass some legal problems of encryption*, \$150 000, Australian Research Council Discovery Grant, 2003–2005.

#### **Street, Donovan and Adams**

*Enhanced computer security from inter-relations between combinatorial structures*, \$165 000, Australian Research Council Discovery Grant, 1999–2001.

**Street and Havas**

*Algorithms for combinatorial computation*, \$150 000, Australian Research Council Large Grant, 1997–9.

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**Khodkar** was funded during 2002 partly from grants of Adams, Donovan and Street, partly from teaching relief money for Billington, partly from Ipswich teaching money, and partly from contributions intended to finance him while he was awaiting announcement of an external application. These contributions amounted to \$28 000 from: the School of Physical Sciences (\$5 000); the Faculty of Engineering, Physical Sciences and Architecture (\$7 500); the Deputy Vice-Chancellor (Research) (\$16 000).

## 6. INVITATIONS

The following staff associated with the Centre have given invited talks outside the department, since 1998.

**Billington.**

Invited speaker, *4-cycles: a survey of results*, Department of Mathematics, Memorial University, St John's, Newfoundland, Canada, July, 1999.

Invited speaker, *Some simple graph decompositions*, Advanced Graduate Summer School in Discrete and Statistical Sciences, Auburn University, Alabama, USA, August, 1999.

Invited speaker, *A survey of results on 4-cycles*, Department of Discrete and Statistical Sciences, Auburn University, Alabama, USA, September, 1999.

Three talks in series on 4-cycle and related systems, *The metamorphosis of 4-wheel systems into 4-cycles and into bowties: Gregarious tripartite 4-cycle systems; A survey of 4-cycle results*, University of Catania, January, 2000.

Invited plenary speaker, *Combinatorial trades: in designs, graphs and latin squares*, 26th ACCMCC, Curtin University, Perth, July, 2001.

Invited speaker, *Gregarious 4-cycles: a graph decomposition problem*, 45th Annual Australian Mathematical Society meeting, special session on Applications of Discrete Mathematics, September, 2001.

Invited plenary speaker, *Trades in combinatorial structures*, Fifteenth Mid-West Conference on Combinatorics, Cryptography and Computing (MC 2001), University of Nevada, Las Vegas, October 2001.

Invited seminar, Southern Illinois University, Carbondale, USA, October 2001.

Invited seminars, *5-cycle decompositions of tripartite graphs* and *Gregarious cycle decompositions*, Auburn University, Alabama, USA, March 2003.

**Bryant**

Invited speaker, *Varieties of  $m$ -cycle systems*, Department of Mathematics, University of Illinois, Illinois, USA, March 1999.

Invited speaker, *Combinatorial aspects of DNA sequencing by hybridization*, Department of Mathematics and Department of Biological Sciences, Illinois State University, Illinois, USA, April 1999.

Invited speaker, *Very small embeddings of partial Steiner triple systems*, Open University, Milton Keynes, UK.

Invited speaker, Pacific Institute for the Mathematical Sciences, Workshop on Graph Decompositions, Simon Fraser University, June, 2000.

Invited speaker, DIMACS Connect Institute 2000 Conference on Graph Theory and Its Applications to Problems of Society, Rutgers University, July–August, 2000.

Invited speaker, World Mathematical Year 2000 Conference on Why Mathematics Matters, Australian National University, November 2000.

**Donovan**

Invited speaker, *Completing partial Latin squares*, 24th Australasian Conference on Combinatorial Mathematics and Combinatorial Computing, Darwin, July 1999.

**Donovan and Khodkar**

Invited speakers, *35 hours of research seminars at a workshop held at Ramkhamhaeng University, Bangkok, Thailand, in February, 1999*, The workshop dealt with block designs, cryptology and coding theory.

**Gray**

Invited speaker, *Proportionally balanced designs*, Open University Winter Combinatorics Meeting, January 2004 (planned).

**Hamilton**

Invited speaker, *Baer partitions of projective planes*, Department of Mathematics, Università degli Studi di Roma 'La Sapienza' (May 1998).

**Havas**

Seminar speaker, Northeastern University, Boston (June 1998).

Seminar speaker, Sun Research Labs, Sunnyvale (July 1998).

- Invited speaker, Workshop on Computational and Geometric Aspects of Modern Algebra, Heriot-Watt University, Edinburgh (July 1998).
- Seminar speaker, Beijing University (August 1998).
- Invited speaker, Workshop on Distributed High Performance Computing and Gigabit Wide Area Networks, Essen (Aug-Sep 1998).
- Invited speaker, 18th International Conference on Distributed Computing Systems, Amsterdam (May 1998).
- Invited speaker, 3rd Asian Symposium on Computer Mathematics, Lanzhou University, China (August 1998).
- Invited speaker, *Groups and Computation*, The Ohio State University (June 1999).
- Invited speaker, Symposium on Computation in Group Theory and Geometry, July 1999, The Mathematics Institute, University of Warwick, Coventry, England.
- Invited speaker, Research Seminar Groups, Combinatorics and Computer Science, Department of Mathematical Sciences, University of Oulu, Finland, August 1999.
- Invited speaker, Group Theory and Computation, November–December 1999, University of Sydney.
- Conference speaker, 30th Southeastern International Conference on Combinatorics, Graph Theory, Computing, Florida Atlantic University, Boca Raton, Florida, March 1999.
- Conference speaker, Fifth Annual International Computing and Combinatorics Conference, July 1999, Tokyo, Japan.
- Invited lecturer, Research Seminar on Groups, Combinatorics and Computer Science, University of Oulu, Finland, August 1999.
- Seminar speaker, University of St Andrews, Scotland, Aug 1999.
- Dr Lee Visiting Fellowship, Christ Church, University of Oxford, Sep to Nov, 1999.
- Seminar speaker, University of Wales at Bangor, UK, Oct 1999.
- Seminar speaker, University of Newcastle, UK, Oct 1999.
- Seminar speaker, Mathematical Institute, University of Oxford, UK, Oct 1999.
- Seminar speaker, Royal Holloway College, University of London, UK, Nov 1999.
- Seminar speaker, Computing Laboratory, University of Oxford, UK, Oct 1999.
- Seminar speaker, Queen Mary and Westfield College, University of London, UK, Nov 1999.
- Invited speaker, International meeting on Group Theory and Computation, University of Sydney, Dec 1999.
- Seminar speaker, University of Auckland Mathematics Department, Dec 1999.
- Invited speaker, 107th Annual Meeting of the American Mathematical Society, New Orleans, Jan 2001.
- Seminar speaker, City College of the City University of New York, USA, Feb 2001.
- Invited lecturer, Workshop on Finitely-presented groups: questions and algorithms, Università degli Studi di Trento, Italy, Jul 2001.
- Invited lecturer, Meeting on Computational Group Theory, Mathematisches Forschungsinstitut Oberwolfach, Germany, Aug 2001.
- Plenary lecturer, Groups St Andrews 2001, Oxford University, England, Aug 2001.
- Seminar speaker, University of St Andrews, Scotland, Aug 2001.
- Seminar speaker, University of Auckland Mathematics Department, Sep 2001.
- Seminar speaker, University of Auckland Mathematics Department, Feb 2002.
- Invited speaker, Computing, The Australasian Theory Symposium (CATS2003), Adelaide, Feb 2003.
- Invited lecturer, Groups and Computation, The Ohio State University, Columbus, Ohio, USA, Mar 2003.
- Invited lecturer, NETCA Instructional Workshop on Computational Algebra, Centre for Interdisciplinary Research in Computational Algebra, University of St Andrews, Scotland, Sep 2003.
- Invited lecturer, Computational Group Theory Conference at CCNY, New York, Sep 2003.
- Seminar speaker, University of Auckland Mathematics Department, Oct 2003.
- Seminar speaker, University of St Andrews, Scotland, Nov 2003.
- Invited lecturer, Università degli Studi di Trento, Italy, Nov 2003.

### **Khodkar**

- Invited speaker, Defence Center, University of Manitoba, Winnipeg, 1997.
- Invited speaker, Department of Mathematics, University of Manitoba, Winnipeg, 1997.
- Invited speaker, Department of Discrete and Statistical Sciences, Auburn University, 1997.
- Invited speaker, Department of Mathematics, University of Illinois, USA, 1997.
- Invited speaker, Department of Mathematics, Illinois State University, USA, 1997.
- Invited speaker, Department of Mathematics, Sharif University of Technology, Tehran, Iran, 1999.
- Invited speaker, Department of Mathematics, Sharif University of Technology, Tehran, Iran, 2001.
- Invited speaker, Department of Mathematics, University of Illinois, USA, 2001.
- Invited speaker, Department of Mathematics, Illinois State University, USA, 2001.

Invited speaker, Department of Mathematics, Sharif University of Technology, Tehran, Iran, 2002.

### Pleasants

Invited seminar, *Quasicrystals, symmetry and algebraic numbers*, Department of Mathematics and Applied Statistics, University of Wollongong, September 2001.

Invited seminar, *Almost disjoint families of 3-term arithmetic progressions*, Department of Information Technology and Computer Science, University of Wollongong, September 2002.

Invited talk, *Measures of complexity for Delone sets*, Workshop on ‘Between order and disorder’, University of Greifswald, October 2002.

Invited talk, *Dense layers in quasicrystals*, Meeting on ‘Problèmes ouverts dans la théorie des quasi-cristaux’, CIRM, Luminy, October 2002.

Invited seminar, *The entropy of the English language and other sequences*, Department of Mathematics, Université de Bourgogne, October 2002.

Two invited seminars, *Almost disjoint families of 3-term arithmetic progression* and *Local inflation in cut-and-project quasicrystals*, Department of Pure Mathematics, University of Cardiff, November 2002.

### Street

Invited speaker, Two talks in series on applications of designs, University of Catania, June 1998.

Invited speaker, Two talks on applications of designs, University of Malaya, February 1999.

Invited speaker, *Access schemes and defining sets of designs*, 24th Australasian Conference on Combinatorial Mathematics and Combinatorial Computing, Darwin, July 1999.

Invited speaker, Australian Mathematical Society Conference, Canberra, September, 2001.

Plenary speaker, *Pigeonholes and two-way counting*, World Federation of National Mathematics Competitions Congress 4, Melbourne, August, 2002.

Invited speaker, *HAHA designs*, Department of Discrete and Statistical Sciences, Auburn, Alabama, October 2002.

Invited speaker, *Proportionally balanced designs*, Department of Pure Mathematics, Open University, United Kingdom, June 2003.

Special speaker, *Defining sets in combinatorics: a survey*, Nineteenth British Combinatorial Conference, Bangor, Wales, June/July, 2003.

Invited speaker, *Proportionally balanced designs*, Conference on Recent Advances in Statistical Designs and Related Combinatorics (in honour of Stratis Koulias), University of Athens, July, 2003.

## 7. EDITORIAL WORK

In association with the Department of Mathematics, University of Auckland, the Centre publishes the *Australasian Journal of Combinatorics*, an international journal, for the Combinatorial Mathematics Society of Australasia (Incorporated). Billington is Editor-in-Chief, Dr C Paul Bonnington (Auckland) is Managing Editor and Adams is Financial Manager. Bryant, Donovan, Professor Peter Gibbons (Auckland), Havas, B Jones and S Williams are Associate Editors. Of the 20 members of the Editorial Board, nine work within Australia and New Zealand, and the remaining 11 form an international network of combinatorialists in Canada, Germany, Greece, Sultanate of Oman, Slovakia, United Kingdom and United States of America. For more details, see Section 9, under ‘Edited journal’.

The Centre also publishes a Research Report Series, edited by Donovan.

Matthews maintains a World Wide Web site called The Number Theory Web. The site provides links to nearly 500 number theorists’ home pages throughout the world, centres, book descriptions, surveys, recent theses, conference information and libraries with good holdings in the number theory field.

CMAT and CALC are exact arithmetic matrix and number theory packages developed by Matthews for use mainly in teaching. For more information see the WWW address <http://www.maths.uq.edu.au/~krm/>

Hamilton maintains a web site on recent theses in geometry. See Section 9, under ‘Web Sites’.

The following staff associated with the Centre have served in other editorial capacities during the period since January 1998.

Billington is an Associate Editor of the *Bulletin of the Australian Mathematical Society* and a member of the Editorial Boards of *Utilitas Mathematica* and *Journal of Combinatorial Mathematics and Combinatorial Computing*. She reviews for *Mathematical Reviews* and referees for *Journal of Combinatorial Designs*, *Ars Combinatoria*, *Discrete Mathematics*, *Bulletin of the Institute of Combinatorics and its Applications*, *Journal of Graph Theory* and *Journal of Algebraic Combinatorics*.

Donovan is a member of the Editorial Board of *Ars Combinatoria*. She referees for the *Bulletin* and the *Gazette* of the Australian Mathematical Society, and for *Discrete Mathematics*, *European Journal of Combinatorics*, *Journal of Combinatorial Mathematics and Combinatorial Computing* and *Utilitas Mathematica*.

Hamilton referees for *European Journal of Combinatorics, Designs, Codes and Cryptography, Utilitas Mathematica, Australasian Journal of Combinatorics* and the *Bulletin of the Australian Mathematical Society*.

B Jones is an Associate Editor of the *Bulletin of the Australian Mathematical Society*.

Khodkar referees for *Ars Combinatoria, Australasian Journal of Combinatorics, Discrete Mathematics and Utilitas Mathematica*.

Norton reviews for *Zentralblatt* and referees for *IEEE Transactions on Information Theory, Discrete Mathematics, Mathematica Applicandae, Applicable Algebra in Engineering, Computing and Communications, Journal of Symbolic Computation*.

Pleasants referees for *American Mathematical Monthly, Australasian Journal of Combinatorics, Bulletin of the Australian Mathematical Society* and *Theoretical Computer Science*. He is also reporting on a book for Springer–Verlag New York, who are considering it for publication.

Street is a member of the editorial boards of *Ars Combinatoria, Ars Textrina, Bulletin of the Institute of Combinatorics and its Applications* and *Scientia Iranica*. She also referees for *Discrete Mathematics, Journal of Combinatorial Mathematics and Combinatorial Computing* and *Utilitas Mathematica*.

S Williams reviews for *Zentralblatt* and *Mathematical Reviews*, and referees for the *Bulletin of the Australian Mathematical Society*.

## 8. COLLABORATION

The following staff members have collaborated in research with people outside the Centre for Discrete Mathematics and Computing during the time since January 1998. The list includes the names and affiliations of all collaborators. Inter-disciplinary collaboration is indicated by an asterisk.

### Adams

Professor K Basford\*, *School of Land and Food, The University of Queensland*.

Professor Saad I El-Zanati, *Department of Mathematics, Illinois State University*.

Dr A Galbraith\*, *The Prince Charles Hospital*.

Professor D G Hoffman, *Department of Discrete and Statistical Sciences, Auburn University*.

Professor C C Lindner, *Department of Discrete and Statistical Sciences, Auburn University*.

Dr D C McGiffen\*, *The Prince Charles Hospital*.

Professor G J McLachlan, *Discipline of Mathematics, The University of Queensland*.

Professor C A Rodger, *Department of Discrete and Statistical Sciences, Auburn University*.

Professor C Vanden Eynden, *Illinois State University*.

### Billington.

Professor I J Dejter, *Faculty of Natural Sciences, University of Puerto Rico*.

Professor Saad I El-Zanati, *Department of Mathematics, Illinois State University*.

Professor Chin–Mei Fu, *Tamkang University, Tamsui, Taipei Shien, Taiwan*.

Professor Hung–Lin Fu, *National Chiao–Tung University, Hsin–Chu, Taiwan*.

Professor M Gionfriddo, *Dipartimento di Matematica, Universita di Catania*.

Professor D G Hoffman, *Department of Discrete and Statistical Sciences, Auburn University*.

Professor D L Kreher, *Department of Mathematical Sciences, Michigan Technological University, Houghton, Michigan*.

Professor C C Lindner, *Department of Discrete and Statistical Sciences, Auburn University*.

Professor Giovanni Lo Faro, *Dipartimento di Matematica, Messina, Italy*.

Professor E S Mahmoodian, *Department of Mathematical Sciences, Sharif University of Technology, Tehran, Iran*.

Dr D A Pike, *Department of Mathematics, Memorial University, St Johns, Newfoundland*.

Professor Gaetano Quattrocchi,, *Department of Mathematics, University of Catania, Italy*.

Professor C A Rodger, *Department of Discrete and Statistical Sciences, Auburn University*.

### Bryant

Dr B J Battersby\*, *Department of Chemistry, The University of Queensland*.

Dr Duncan Cochrane, *Australian Genome Research Facility*.

Professor Saad I El-Zanati, *Department of Mathematics, Illinois State University*.

Professor Hung–Lin Fu, *National Chiao–Tung University, Hsin–Chu, Taiwan*.

Dr Heather Gavlas, *Department of Mathematics, Illinois State University*.

Professor Mike Grannell, *Department of Pure Mathematics, The Open University*.

Professor Terry Griggs, *Department of Pure Mathematics, The Open University*.

Professor D G Hoffman, *Department of Discrete and Statistical Sciences, Auburn University*.

Ms Gita Lala, *Australian Genome Research Facility*.

Professor C C Lindner, *Department of Discrete and Statistical Sciences, Auburn University.*

Dr Alan Ling, *Department of Mathematics, University of Vermont.*

Dr Keith Mitchelson, *Australian Genome Research Facility.*

Professor C A Rodger, *Department of Discrete and Statistical Sciences, Auburn University.*

Dr M Smythe\*, *Centre for Drug Design and Development, The University of Queensland.*

Dr T Tran\*, *Centre for Drug Design and Development, The University of Queensland.*

Dr M Trau\*, *Discipline of Chemistry, The University of Queensland.*

Professor C Vanden Eynden, *Department of Mathematics, Illinois State University.*

#### **Donovan**

Dr Nicholas Cavenagh, *Charles University, Czech Republic.*

Dr Joan Cooper\*, *Department of Information and Communication Technology, University of Wollongong.*

Dr E P Dawson\*, *Information Security Research Centre, Queensland University of Technology.*

Professor Aleš Drápal, *Charles University, Czech Republic.*

Dr Rebecca A H Gower, *Numbercraft, Oxford.*

Professor D G Hoffman, *Department of Discrete and Statistical Sciences, Auburn University.*

Professor Saad I El-Zanati, *Department of Mathematics, Illinois State University.*

Professor E S Mahmoodian, *Department of Mathematical Sciences, Sharif University of Technology, Tehran, Iran.*

Professor C E Praeger, *Department of Mathematics, University of Western Australia.*

Professor Jennifer Seberry\*, *Department of Computer Science, University of Wollongong.*

Dr Somporn Sutinuntopas, *Department of Mathematics, Ramkhamhaeng University, Bangkok, Thailand.*

Professor John van Rees, *Department of Computer Science, The University of Manitoba.*

Professor C Vanden Eynden, *Department of Mathematics, Illinois State University.*

#### **Gamble**

Professor R Mathon\*, *Department of Computer Science, University of Toronto.*

Professor C E Praeger, *Department of Mathematics, University of Western Australia.*

Professor Jennifer Seberry\*, *Department of Computer Science, University of Wollongong.*

#### **Hamilton**

Dr A Blockhuis, *Department of Mathematics, Technische Universiteit Eindhoven and Vrije Universiteit Amsterdam.*

Prof K Burrage, *Advanced Computational Modelling Centre, The University of Queensland.*

Dr S Cauchie, *Vakgroep Zuivere Wiskunde en Computeralgebra, Universiteit Gent.*

Professor F De Clerck\*, *Vakgroep Zuivere Wiskunde en Computeralgebra, Universiteit Gent.*

Dr T Huber, *Computational Biology and Bioinformatics Environment, The University of Queensland.*

Professor R Mathon\*, *Department of Computer Science, University of Toronto.*

Dr C M O'Keefe\*, *Vakgroep Zuivere Wiskunde en Computeralgebra, Universiteit Gent.*

Dr T Penttila, *Department of Mathematics, University of Western Australia.*

Dr I Pinneri, *Dipartimento di Matematica, Universita degli Studi di Roma 'La Sapienza'.*

Dr C Quinn, *Department of Pure Mathematics, University of Adelaide.*

Prof M Ragan, *Institute for Molecular Biosciences, The University of Queensland.*

Professor M J de Resmini, *Dipartimento di Matematica, Universita degli Studi di Roma 'La Sapienza'.*

Dr S D Stoichev\*, *Department of Computer Science, Technical University, Bulgaria.*

Professor V D Tonchev, *Department of Mathematical Science, Michigan Technological University.*

Dr H Wilbrink, *Department of Mathematics, Technische Universiteit Eindhoven.*

#### **Havas**

Professor J-Y Cai, *SUNY Buffalo.*

Dr C M Campbell\*, *St Andrews University.*

Professor G Cooperman, *Northeastern University.*

Professor Z J Czech, *Silesia University.*

Dr X G Fang\*, *Beijing University.*

Dr S Feisel, *Paderborn University.*

Professor J von zur Gathen, *Paderborn University.*

Dr H W Gollan\*, *Essen University.*

Professor D G Hoffman\*, *Auburn University.*

Dr D F Holt\*, *University of Warwick.*

Assistant Professor Alexander Hulpke, *Department of Mathematics, Colorado State University.*

Dr W Liang, *Australian National University.*

Dr S A Linton, *St Andrews University*.  
 Dr B Mans, *Macquarie University*.  
 Dr A Nerurkar, *SUNY Buffalo*.  
 Professor M F Newman\*, *Australian National University*.  
 Dr A C Niemeyer\*, *University of Western Australia*.  
 Dr E A O'Brien\*, *University of Auckland*.  
 Professor C E Praeger, *Department of Mathematics, University of Western Australia*.  
 Dr S E Rees\*, *University of Newcastle (UK)*.  
 Professor E F Robertson\*, *St Andrews University*.  
 Professor J-P Seifert, *Frankfurt University*.  
 Professor X Shen, *University of Missouri*.  
 Dr I Shparlinski, *Macquarie University*.  
 Professor C C Sims\*, *Rutgers University*.  
 Dr L H Soicher\*, *University of London*.  
 Professor M R Vaughan-Lee\*, *Oxford University*.  
 Dr C Wagner, *Siegen University*.  
 Professor J Wang\*, *Beijing University*.  
 Professor R A Wilson\*, *Birmingham University*.

#### **Khodkar**

Professor E S Mahmoodian, *Department of Mathematical Sciences, Sharif University of Technology, Tehran, Iran*.  
 Dr M A Shahabi, *Department of Mathematics, University of Tabriz, Tabriz, Iran*.  
 Professor Saad I El-Zanati, *Department of Mathematics, Illinois State University*.  
 Professor C Vanden Eynden, *Department of Mathematics, Illinois State University*.  
 Professor D G Hoffman, *Department of Discrete and Statistical Sciences, Auburn University*.  
 Professor Hung-Lin Fu, *National Chiao-Tung University, Hsin-Chu, Taiwan*.  
 Professors Chin-Mei Fu, *Department of Mathematics, Tamkang University, Taiwan*.  
 Dr S. Sutinuntopas, *Ramkhamhaeng University, Bangkok, Thailand*.  
 Professor John van Rees, *Department of Computer Science, The University of Manitoba*.

#### **Maenhaut**

Professor C Vanden Eynden, *Department of Mathematics, Illinois State University, USA*.  
 Professor Saad I El-Zanati, *Department of Mathematics, Illinois State University, USA*.  
 Professor M J Grannell, *Open University, Milton Keynes, United Kingdom*.  
 Professor T S Griggs, *Open University, Milton Keynes, United Kingdom*.  
 Professor D G Hoffman, *Department of Discrete and Statistical Sciences, Auburn University, USA*.  
 Dr K A S Quinn, *Pure Mathematics Department, Open University, United Kingdom*.  
 Professor Jennifer Seberry, *Department of Computer Science, University of Wollongong*.  
 Professor R G Stanton, *Department of Computer Science, University of Manitoba, Canada*.  
 Dr I M Wanless, *Christ Church College, Oxford University, United Kingdom (now at ANU, Canberra)*.  
 Dr B S Webb, *Pure Mathematics Department, Open University, United Kingdom*.

#### **Matthews**

Dr T H Jackson, *Department of Mathematics, University of York, United Kingdom*.

#### **Norton**

Professor T D Blackmore, *University of Loughborough, United Kingdom*.  
 Professor A Salagean, *University of Loughborough, United Kingdom*.

#### **Pleasants**

Dr H Ardal, *Department of Mathematics, Boğazici University, Istanbul*.  
 Professor M Baake, *Mathematics Institute, Greifswald University*.  
 Professor T C Brown, *Department of Mathematics, Simon Fraser University*.  
 Professor V Fournée\*, *CNRS, Ecole des Mines, Nancy*.  
 Professor C J Jenks\*, *Ames Laboratory, Iowa State University*.  
 Dr G Kasner\*, *Theoretical Physics Institute, Magdeburg University*.  
 Dr J C Lagarias, *AT&T Laboratories, Florham Park*.  
 Professor J Ledieu\*, *Surface Science Research Centre, University of Liverpool*.  
 Professor R McGrath\*, *Surface Science Research Centre, University of Liverpool*.  
 Mr H Ray, *Department of Mathematics and Statistics, Curtin University of Technology*.  
 Dr J Simpson, *Department of Mathematics and Statistics, Curtin University of Technology*.

Dr Z Papadopolos\*, *Theoretical Physics Institute, Tübingen University.*

**Ramsay**

Dr I T Roberts\*, *Department of Mathematics, Northern Territory University.*

**Scharaschkin**

Dr Lily Khadjavi, *Loyola Marymount University, Los Angeles.*

Dr Wayne Raskind, *University of Southern California.*

**Sharry**

Professor D G Hoffman, *Department of Discrete and Statistical Sciences, Auburn University.*

Professor C C Lindner, *Department of Discrete and Statistical Sciences, Auburn University.*

**Street.**

Professor L M Batten, *Department of Computing Science and Mathematics, Deakin University.*

Dr Kris Coolsaet, *Department of Mathematics, University of Ghent, Belgium.*

Professor Chin-Mei Fu, *Tamkang University, Tamsui, Taipei Shien, Taiwan.*

Professor Hung-Lin Fu, *National Chiao-Tung University, Hsin-Chu, Taiwan.*

Professor M J Grannell, *Open University, Milton Keynes, United Kingdom.*

Professor T S Griggs, *Open University, Milton Keynes, United Kingdom.*

Professor D G Hoffman, *Department of Discrete and Statistical Sciences, Auburn University.*

Professor C C Lindner, *Department of Discrete and Statistical Sciences, Auburn University.*

Professor E S Mahmoodian, *Department of Mathematical Sciences, Sharif University of Technology, Tehran, Iran.*

Professor R Mathon\*, *Department of Computer Science, University of Toronto.*

Professor Jennifer Seberry\*, *Department of Computer Science, University of Wollongong.*

Dr Nasrin Soltankhah, *Department of Mathematics, Azzahra University, Tehran, Iran.*

Professor R G Stanton\*, *Department of Computer Science, The University of Manitoba.*

Associate Professor Deborah J Street, *Department of Mathematical Sciences, University of Technology, Sydney.*

**S Williams.**

Professor A M Brunner, *University of Wisconsin-Parkside.*

Professor R G Burns, *York University, Toronto.*

Professor Karl H Hoffmann, *Technische Hochschule, Darmstadt.*

Professor S A Morris, *The University of New England*, (with Associate Professor H B Thompson of this department).

Dr V N Obraztov, *Kostroma Teachers' Training Institute, Russia.*

Professor C E Praeger, *Department of Mathematics, University of Western Australia.*

Professor M R Vaughan-Lee, *University of Oxford.*

## 9. HONOURS AND AWARDS

The Institute of Combinatorics and its Applications, an international body, was set up in 1990, based in Canada, with Professor W T Tutte as president and Professor R G Stanton as Registrar. Street is one of the two Australians invited to become Founding Fellows of the ICA and served as its President from 1996–2002; Billington, Donovan and S Williams are Foundation Fellows; Adams, Bryant, K Gray, Hamilton and Sharry are Fellows; Maenhaut, Moran and Nester are Associate Fellows; B Jones is a Member. Billington is on the ICA Council.

The ICA awards Kirkman Medals, recognising outstanding achievement by combinatorialists in the early stages of their careers; Adams, Bryant and Hamilton are Kirkman Medallists. Bryant's medal was awarded in 1994.

Adams was awarded a 1998 Kirkman Medal for work in combinatorial computing. He developed fast efficient computing techniques for finding graph decompositions. Many combinatorial problems can be solved recursively; often the hardest part of the solution is the construction of the 'small' special cases needed to start the recursions and the larger special cases needed to fill 'gaps' left by the recursive argument. Adams developed a *metaprogram* (generic software package) which, given details of any such problem, uses automated code generation to produce a second program tailored to the case at hand. This approach allows comparison of search algorithms and the adoption of the most suitable method for solving any specific problem. Adams' thesis, based on 18 of his published papers, shows the success of this approach. Adams is also the only person to have received both a UQ Teaching Excellence Award (2001) and a UQ Foundation Research Excellence Award (2000).

Bryant held an Australian Postdoctoral Research Fellowship from 1996–8 and now holds a QEII Fellowship, 2002–2006. He was one of seven recipients of the inaugural University of Queensland Foundation Research

Excellence Awards in 1999. These awards recognise the outstanding performance and leadership potential of early career researchers. Bryant received a \$60,000 grant for his research project entitled ‘Combinatorial Graph Decomposition Techniques and DNA Sequencing by Hybridization’. The project has two aims: first, to develop novel graph decomposition techniques and use them to provide solutions to numerous open problems in graph theory; secondly, to apply combinatorial mathematics in a new approach to DNA sequencing, namely, DNA sequencing by hybridization. In 2002 he received an Australian Academy of Science J G Russell Award.

Hamilton held an Australian Postdoctoral Research Fellowship for 1997–2000 and a Research Fellowship at the University of Gent for 2000–2002. He was awarded a 1999 Kirkman Medal for his outstanding work in finite geometry, where he gave several excellent new characterisations of known maximal arcs, and many beautiful constructions of new classes of maximal arcs and unitals. His elegant proofs (in a few cases with T Penttila) were mainly geometrical, though sometimes algebraic and group theoretical tools were used. Hamilton excels in using computer algebra to obtain results in small planes which then provide a starting point for computer-free constructions and proofs. With C Quinn, and using their new results on  $m$ -systems of polar spaces, he constructed new strongly regular graphs and new linear projective two-weight codes. With R Mathon, again studying  $m$ -systems, he found a new bound on the dimension of the elements of the system and classified several  $m$ -systems for small fields. This collaboration also produced important results on non-classical Baer partitions of small projective planes. With M J de Resmini, he worked on hyperovals and unitals in Figueroa planes, and on partitioning hyperovals in  $PG(2, 64)$ , again obtaining outstanding results.

Havas held a Dr Lee Visiting Fellowship at Christ Church, Oxford University, September to November, 1999. Havas also received an award from the Polish National Minister for Education for his contribution to the 147 page monograph ‘Perfect Hashing’ which appeared in the international journal ‘Theoretical Computer Science’ in 1997. The monograph was jointly authored by Havas, Prof Zbigniew Czech of the Institute of Computer Science, Silesia University of Technology and Dr Bohdan Majewski, a PhD graduate of this University. It is one of the outcomes of an international collaboration which came about through Majewski starting his PhD research under the supervision of Czech in Poland and finishing it under Havas at The University of Queensland. The reason for describing work published in 1997 in the current report is that it has just attracted another distinction: from January to May of this year, it was the most frequently downloaded paper in ‘Theoretical Computer Science’. The monograph provides a comprehensive, fundamental study of perfect and minimal perfect hash functions. These have many applications in computing, the best known of which is the dictionary problem. The work provides practical solutions to fundamental questions and is used by researchers, professionals and teachers in computer science.

Street received, in July, 1999, the inaugural award of CMSA (Inc) for Outstanding Service and, in August, 2001, an award for 20 years service with the Australian Mathematics Trust. She has been Honorary Editor of the *Australasian Journal of Combinatorics* since December, 2002.

S Williams received, in April, 2002, a Bernhard H Neumann Award for Excellence in Mathematics Enrichment, from the Australian Mathematics Trust, after serving on the Problems Committee of the Australian Mathematics Competition since 1990.

The Dean’s Commendation List for Outstanding PhD Theses was instituted in 1998. Ramsay was placed on the List in that year. 1999 PhD graduates placed on the List include Hawkes, Maenhaut, Nester and Zahrai. Note that the Dean’s List for 2000 onwards has not yet been compiled.

## 10. THE CENTRE AND THE WIDER COMMUNITY

Staff associated with this Centre have been involved in the following outreach programs.

**National and International Activities.**

*Australian Mathematics Competition Problems Committee:* Between them, Street and S Williams have almost 30 years service as members of this committee, which develops questions to challenge and extend young mathematicians.

*QAMT (Queensland Association of Mathematics Teachers) Problem Solving Competition:* This is an annual competition with over 3000 students participating each year. Until 2001, N Williams (a past member of the Centre from the time it was set up) and Donovan co-ordinated the competition. S Williams was much involved in checking and assessing papers.

*Australian Mathematical Olympiad Committee:* N Williams served as State Director for this program from its inception till 2001, running a training program for talented Queensland mathematics students to foster their interests. He was assisted in this by S Williams. Street served as President of AMOC and as a Board member of the Australian Mathematics Trust for six years, till 2001. Currently Scharaschkin is working with the new State Director on this program.

*TV appearances on Channel 9 program 'Y':* Donovan worked with a Channel 9 film crew to develop a segment on modern cryptographic techniques. This program went to air in early 2002. Howse also worked with Channel 9 to develop a segment on the discrete mathematics underpinning barcodes.

**University and Cross-Faculty Activities.**

*Enhanced Studies Program:* Billington (previously) and Donovan (currently) co-ordinate the delivery of MATH1061 to Enhanced Studies Students. MATH1061 is an introductory discrete mathematics course which exposes Year 12 students to both the theory and application of discrete mathematics.

*EXPO Uni:* Centre members have developed and staffed numerous exhibits which stress the importance of discrete mathematics; for example, displays on secret key distribution schemes and error detection techniques for barcodes.

*Biological and Chemical Sciences Faculty Science Days:* This recent initiative is part of the Bright Minds program. In October 2003, Year 12 students attended special sessions on campus. Donovan was the co-ordinator of the mathematics sessions, which were delivered by two talented mathematics graduate students. It is planned to run such sessions four times per year.

**Engineering, Physical Science and Architecture Faculty Activities.**

*EPSA School Liaison Program:* A number of Centre staff and students have delivered talks on applications of discrete mathematics and on career prospects to high school students.

*Brainwaves Festival (National Science Week):* Donovan has been responsible for organising interactive displays which have attracted much interest. Adams has delivered well-received talks to large audiences. Once again these activities are based around applications of discrete mathematics.

**School of Physical Sciences Activities.**

*Infinity:* This is a biennial newsletter which is edited by Donovan, with two members of this department, namely, Cathy Holmes and Helen Grey. Mailed to every high school in Queensland, it provides a link between the University and the broader community and has had great success in developing strong ongoing communications between interested individuals and University staff.

*Club Infinity:* Currently this club has around 400 members. It provides a means for the University to communicate directly with mathematically-minded community members, including school students. It is also an excellent vehicle for advertising University events. Club members receive a welcome pack, copies of Infinity, and individual invitations to club events, such as public lectures. See the website <http://www.maths.uq.edu.au/~infinity/>

*Winter School:* This event has been held three times, in 1997, 1998 and 2002. It involves high school students attending special mathematics interest days at The University of Queensland. Centre staff have developed cryptographic and discrete mathematics activities for these days, and then participated in the delivery of these activities.

## 11. PUBLICATIONS AND WEB SITES

The names of authors, associated with the Centre while the work was carried out, appear in upper case.

**Refereed papers in journals and chapters in books.**

**1998**

- Peter ADAMS, Darryn E BRYANT and A KHODKAR, *3,5-cycle decompositions*, Journal of Combinatorial Designs **6**, 91–110.
- Elizabeth J BILLINGTON and D G Hoffman, *The intersection problem for star designs*, Discrete Mathematics **179**, 217–222.
- Elizabeth J BILLINGTON and C C Lindner, *Maximum packings of bowtie designs*, Journal of Combinatorial Mathematics and Combinatorial Computing **27**, 227–249.
- Elizabeth J BILLINGTON and C C LINDNER, *Embedding partial even-cycle systems into resolvable maximum packings*, Journal of Combinatorial Mathematics and Combinatorial Computing **28**, 41–54.
- Elizabeth J BILLINGTON and Giovanni Lo Faro, *Repeated blocks in indecomposable twofold extended triple systems*, Australasian Journal of Combinatorics **18**, 209–218.
- Elizabeth J BILLINGTON and David Pike, *Decomposing block intersection graphs of Steiner triple systems*, Australasian Journal of Combinatorics **18**, 51–64.
- T D Blackmore and Graham H NORTON, *On the state complexity of some long codes*, In R C Mullin and G L Mullen (eds), Finite Fields: Theory, Applications and Algorithms, # 225 of Contemporary Mathematics. American Mathematical Society, 203–214.
- T D Blackmore and Graham H NORTON, *On the trellis structure of GRM codes*, In Algebraic and Combinatorial Coding Theory. Sixth International Workshop, 26–29.
- Aart Blokhuis, Nicholas HAMILTON and Henny Wilbrink, *The non-existence of Thas maximal arcs in projective planes of odd order*, European Journal of Combinatorics **19** (4), 413–417.
- Darryn E BRYANT, *Large sets of Hamilton cycle and path decompositions*, Congressus Numerantium **135**, 147–151.
- Darryn E BRYANT, Phil Diamond and I G Vladimirov, *Generalised optimal lattice covering of finite-dimensional Euclidean space*, Linear Algebra and its Applications **282**, 311–324.
- Darryn E BRYANT and A KHODKAR, *On orthogonal double covers of graphs*, Designs, Codes and Cryptography **13**, 103–105.
- Darryn E BRYANT and A KHODKAR, *5-cycle systems of  $K_v \setminus F$  with a hole*, Utilitas Mathematica **54**, 59–73.
- Darryn E BRYANT, Hung-Lin Fu and A KHODKAR,  *$(m, n)$ -cycle systems*, Journal of Statistical Planning and Inference **74**, 365–370.
- Darryn E BRYANT and Barbara M MAENHAUT, *Defining sets of  $G$ -designs*, Australasian Journal of Combinatorics **17**, 257–266.
- C M Campbell, George HAVAS, S A Linton and E F Robertson, *Symmetric presentations and orthogonal groups*, The Atlas of Finite Groups Ten Years On, vol. 249, London Mathematical Society Lecture Notes Series, Cambridge University Press, pp. 1–10.
- Nicholas CAVENAGH, *Decompositions of complete tripartite graphs into  $k$ -cycles*, Australasian Journal of Combinatorics **18**, 193–200.
- R S COULTER, *Further evaluations of Weil sums*, Acta Arithmetica **86** (3), 217–226.
- R S COULTER, *Explicit evaluations of Weil sums*, Acta Arithmetica **83** (3), 241–251.
- Robert COULTER, George HAVAS and Marie HENDERSON, *Functional decomposition of a class of wild polynomials*, Journal of Combinatorial Mathematics and Combinatorial Computing **28**, 87–94.
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