

THE AUSTRALIAN NATIONAL UNIVERSITY
CENTRE FOR MATHEMATICAL ANALYSIS

ANNUAL REPORT 1988

Highlights of the year included two special programmes, an impressive research output, and development of new areas of interaction between theoretical and applied groups from within the Centre and from outside bodies.

As recommended in the 1986 review of Commonwealth Special Research Centres, the Centre for Mathematical Analysis continued through 1988 its basic research activity in the fields of partial differential equations, geometric analysis, computational mathematics and applications. An additional feature of the Centre's research plan, to give greater emphasis to the interface of these areas, met with early success. High powered analytical techniques were introduced in the study of discrete approximations of nonlinear elliptic equations by Kuo and Trudinger and a joint project with the Department of Mathematics on computer simulation of curvature flow involving Huisken, Hutchinson and Roberts, was launched with substantial ARC equipment support. A joint project with the Centre for Resource and Environmental Studies on water resource management also received substantial outside support as well as consulting revenue (See Grants.)

Two special programmes were sponsored in 1988. The first of these, on Mathematical Relativity, was organized by Robert Bartnik of the Centre; the second, on Optimization and Functional Analysis, was organized by John Giles of the University of Newcastle. These programmes were highly successful, both in terms of the specific research accomplishments they generated, and the extensive interaction

they fostered between Australian and Overseas participants. The Mathematical Relativity programme was also notable for the interaction promoted between mathematicians and physicists. In all, over 65 individuals, 45 from overseas participated in these special programmes.

During 1988, the Centre maintained its customary high volume of research output, with the production of some 54 research reports and the publication of a further 5 volumes of its Proceedings.

Further details of the above activities, together with descriptions of other achievements are given below, under the "Research Activities" heading.

ADMINISTRATION

The Director is responsible to the Vice-Chancellor, through the Chairman of the Board of the Faculties, for the administration of the Centre. In planning and executing the academic program he is assisted by an advisory group comprising Professor R.P. Brent, Department of Engineering Physics, Research School of Physical Sciences, A.N.U., Professor L.M. Simon, Department of Mathematics, Research School of Physical Sciences, A.N.U., Dr. R.S. Anderssen and Dr. F.R. de Hoog, Division of Mathematics and Statistics, C.S.I.R.O., and Professor A.G.R. McIntosh, School of Mathematics and Physics, Macquarie University

STAFFING MATTERS

Igor Kluvanek, formerly professor of Mathematics at Flinders University, was appointed as a Senior Research Fellow in 1988. Drs.N. Joshi and S. Roberts took up joint appointments as Research Fellows in the Centre and Lecturers in the Department of Mathematics. Dr. K. Ecker commenced as a Postdoctoral Fellow in January and Dr. C. Dietrich as a joint Postdoctoral Fellow with the Centre for Resource and Environmental Studies in March. Drs. R. Beerends and H.J. Kuo completed their Postdoctoral Fellowships in June and December, while Professor C. Amano and Dr. J. Fu completed their Visiting Fellowships in January and September. Professor T. Ohkubo, (from Soka University), Japan, Professor A. Keraychian, (from Mashhad

University, Iran and Dr. David Wall, from the University of Canterbury, New Zealand arrived in March, September and January to spend one year sabbatical leaves as Visiting Fellows in the Centre, while Professor R. Gulliver from the University of Minnesota was a Visiting Fellow from July until December. In addition to these long term Visiting Fellows, forty seven mathematicians and physicists were appointed as short term Visiting Fellows for periods of less than six months.

RESEARCH ACTIVITIES

The research of the Centre in 1988 is largely embodied in its Research Reports listed in Attachment (iii). We indicate below a selection of the research activities and achievements of staff and visitors, and provide reports of the two special programmes.

(i) Partial Differential Equations and Geometric Analysis:

Robert Bartnik's research is concerned with the application of techniques from partial differential equations and differential geometry to general relativity. His work in 1988 focussed on the Einstein Yang-Mills equations and he was successful in obtaining an appropriate definition of local mass (Reports R01, R02, R25, R50).

Klaus Ecker and Gerhard Huisken discovered striking new results pertaining to the mean curvature of hypersurfaces. These included characterization of the asymptotic evolution of graphs under mean curvature flow (Report R06), strong Bernstein type results for the steady state case (Reports R04, R12, R26), and the development of mean curvature flow techniques for the construction of spacelike slices of prescribed mean curvature in cosmological space times (Report R48).

Neil Trudinger continued investigations into the properties of viscosity solutions of uniformly elliptic partial differential equations (Report R20), and adapted the viscosity approach to the treatment of curvature problems, yielding applications to the Dirichlet problem for prescribed curvature equations and inequalities for **quermassintegrals** in integral geometry (Report R39).

John Urbas characterized the outwards flow of convex and starshaped compact hypersurfaces by general curvature functions, (Reports R22, R40). His results, along with similar results of Gerhard Huisken and Claus Gerhardt, provide analogous asymptotic behaviour to the now famous work of Huisken (CMA Report R10, 1984) on inwards mean curvature flow of convex hypersurfaces.

Substantial contributions to these areas of mathematics were also made by Visiting Fellows. Robert Gulliver constructed an important example in minimal surface theory (Report R38) and introduced a computational approach to the angle problem for harmonic mappings (Report R52). Joseph Fu made substantial advances in his work on curvature measure and integral geometry (Report R59-87), leading to the introduction and characterization of important new function classes (Reports R10, R16). Bruce Solomon treated the spectral properties of minimal hypersurfaces of spheres (Reports R30, 31), while Stefan Luckhaus and James Michael pursued their respective investigations into harmonic mappings and obstacle problems. Leon Simon began a general study of growth properties of exterior solutions of quasilinear elliptic equations (to appear in Report R17, 1989) and also completed a joint project with Dr. R. McIntosh on perturbing away singularities of harmonic maps (to appear in Report R18, 1989).

(ii) **Basic Analysis**

Igor Kluvanek completed his monograph on Integration Structures which was published as Volume 18 of the Proceedings of the Centre for Mathematical Analysis. His research continued in the theory of integration, and was related to that of Visiting Fellows, Heinz König (Report R51) and Finbarr Holland.

On the harmonic analysis front, René Beerends treated Chebyshev polynomials in several variables (Report R08), Chris Meaney and Elena Prestini began investigating convergence properties of inverse spherical transforms, with Prestini also completing work on spherical solutions of Schrödinger equations, (Report R54). Le Hung Son completed work on Cousin problems in Clifford Algebras (Report R47).

(iii) Computational Mathematics

As mentioned in the introduction, Hung Ju Kuo and Neil Trudinger considered the discrete approximation of nonlinear elliptic equations. A basic paper on fundamental estimates for elliptic difference equations was completed (Report R43) and future work in preparation yields applications to the stability of difference approximations.

Stephen Roberts completed work on random vortex methods for approximations in fluid mechanics (Report R05). Sum Chow engaged in research on superconvergence phenomena of flux computation procedures (Report R09). A.K. Pani completed several papers on Finite Element Methods for Stefan Problems and Diffusion equations with nonlinear boundary conditions (Reports R13, R14, R15, R18). In a somewhat different computational vein, Yang Lu continued research on algorithms for automated theorem proving, yielding some unexpected theorems in geometry [Report R45].

(iv) Applied Mathematics

The applied strength of the Centre rests substantially on the interaction between theory, computation and applications which the Centre fosters. The link with the CSIRO Division of Mathematics and Statistics, through the leadership and participation of Anderssen and de Hoog, is a key factor in sustaining and harnessing this interaction.

The joint appointment of Claude Dietrich with the Centre for Resource and Environmental Studies (CRES), facilitated a viable research group (Anderssen, Dietrich, Newsam) to study the mathematical analysis and computer simulation of national water resources. Dietrich and Newsam addressed the reduction of instability in the geostatistical approach to aquifer identification (Reports R28, 29) while Anderssen and Dietrich analysed the modelling of flow and sedimentation in ponds in response to a need of the National Capital Development Commission; (see Grants).

Garry Newsam also continued his collaborative work with Ian Enting, of the CSIRO Division of Atmospheric Research, on inverse problems in atmospheric chemistry and commenced research in mathematical economics with a view to practical implementation in the stock market; (see (vi)).

Nalini Joshi continued previous research on the integrability of systems of partial differential equations and began pursuing connections and applications to statistical mechanics.

David Wall carried out research in the direct and inverse time-harmonic wave problems, (Reports R37, R41, R49).

Grant Keady completed a formidable survey on rectangular dams, jointly with John Knight of the CSIRO Division of Environmental Mechanics and Grahame Williams of the University of Wollongong.

Yuriko and Michael Renardy continued research projects in fluid mechanics (Report R46) and elasticity.

(v) **General Relativity Programme (Report by R. Bartnik, organiser)**

The Centre for Mathematical Analysis sponsored a special session and miniconference in the area of mathematical general relativity, timed to precede the Marcel Grossmann meeting in Perth in early August. Over 40 mathematicians and theoretical physicists from Australia and overseas visited over a period of 3 months from June to August. The miniconference was held over 22-24th July, and was considered a great success by the (exhausted) participants. It was particularly gratifying for the Australian participants, to find their work so highly regarded in such a pre-eminent group. The miniconference was the first opportunity for some of the participants to meet fellow Australian relativists. A frequent comment was that the Canberra meeting was extremely useful in fostering contacts and stimulating further research.

The main topic of the meeting was the nature of solutions of the Einstein equations: their singularity structure, the structures at spatial and null infinity and radiation, properties of the evolution equations and the constraint (initial data) equations, and the enigmatic role of the mass function. Some of the work done during the programme is appearing in CMA Research Reports (R24, 25, 27, 35, 44, 48, 50) and in the Miniconference Proceedings, (Proceedings Volume 19, 1988) or will appear in the proceedings of the Marcel Grossman (MG5) meeting, Perth, August, 1988. However, the most important contributions of the meeting will be seen later, as the new ideas and insights gained start to show up in future work. Some research programs started at the meeting are:

L. Anderssen (Stockholm), applying heat flow techniques to study the mass function. This idea arose from numerous conversations with N. O' Murchadha, G. Huiskens, R. Bartnik and others.

R. Bartnik (CMA) and V. Moncrief (Yale), investigating numerical methods to solve the spherical Einstein-Yang-Mills equations,

C. Clarke (Southampton) and S. Scott (Oxford), a project to investigate conformal singularities and the Weyl curvature hypothesis.

G. Galloway (Florida), investigated the topology of static spacetimes using a technique previously developed by G. Bunting in the CMA in 1985 (Report R04-86).

V. Moncrief began a study of the singularities of a solution of the non-linear wave equation, developing near a spacetime singularity of generalised Taub-NUT type.

D. Singleton (Monash Univ.) developed a finite element algorithm for the integration of the Robinson-Trauman equations and is implementing this code. This work, and his investigations of the stability of the RT Einstein-Maxwell equations, benefitted from discussions with A. Rendall (Munich), Z. Perjes (Budapest) and R. Bartnik.

Other visitors continued previous work and collaborations. Among these were:

P. Chrusciel (Yale), N. O'Murchadha (Cork) and R. Bartnik, investigating optimal conditions for the existence and regularity of maximal slices (CMA report in preparation).

J. Bicak (Prague), on gravitational radiation and boost-symmetric spacetimes (a long report will appear in the miniconference proceedings)

V. Moncrief worked on perturbations of generalised Taub-NUT metrics and interactions of cylindrical Einstein-Maxwell-Higgs cosmic strings (CMA report R24-88, to appear in Phys. Rev.).

Wang Mian (Henan) worked on Kaluza-Klein theories with additional time coordinates.

G. Tauber (Tel Aviv) continued his work on cosmology in conformally flat coordinates.

P. Mansfield (Yale) continued his work (with V. Moncrief) on singularity formation in Gowdy spacetimes.

C. Clarke (Southampton) completed work on maximum entropy solutions of an inverse problem, and on the structure of Bell-Szekeres extensions.

N. O'Murchadha (Cork) continued work on the relation between mass and the Yamabe constant, and on maximal slices

R. Kerr (Canterbury) proved the existence of a simple canonical form for Tomimatsu-Sato metrics (to appear in the miniconference proceedings)

H. Friedrich (Munich) investigated the singularity structure of static spacetimes near infinity, and the problem of formulating boundary conditions for the conformal Einstein equations.

J. Isenberg (Oregon) continued his work on smoothing spacetimes, benefitting from conversations with G. Huisken (ANU).

S. Harris (Oregon) clarified his understanding of the topology of the causal boundary of a spacetime

Y. Choquet-Bruhat (Paris) worked on the Cauchy problem for equations which are hyperbolic, but not globally hyperbolic, and solved this problem for conformally regular equations and the Yang-Mills equation. She also completed a definitive paper on "Gravitation with Gauss-Bonnet terms", which will appear in the miniconference proceedings.

Z. Perjes (Budapest) completed a paper on parametric manifolds, to appear in the MG5 proceedings, and developed a spinor 3+1 decomposition technique.

The organiser would like to thank the Director, Neil Trudinger, for his support, and wishes to give special thanks to the staff at the CMA, Marilyn Gray, Dorothy Nash and Jill Smith for their unstinting and heroic efforts, which ensured the success of the programme.

(vi) **Optimization and Functional Analysis Programme (Report by J. Giles, organizer)**

In 1987 I contacted Neil Trudinger as Director of the Centre for Mathematical Analysis to tell him that Vitali Milman intended visiting Australia. His response was that we should organize a special programme in 1988.

In 1988 I was fortunate to obtain an ARGC Grant to study differentiability properties of distance functions and the grant money enabled a number of colleagues including Jonathan Borwein, Riki Brown, Simon Fitzpatrick, Gar de Barra and Petar Kenderov to visit Australia for some time both before and after the workshop/miniconference period in August.

So in 1988 this happy conjunction of support from the ARGS and CMA enabled ideal circumstances for mathematical research activity - a gathering of like-minded people to work on a common research area over a prolonged period of several months. When the participants gathered in Canberra for the preliminary workshop period, several had already been in collaboration at the University of Newcastle and the workshop period brought that collaboration into sharper focus as we were joined by others with associated interests.

The Centre's policy of holding a workshop before the miniconference turned out to be a very fruitful feature of the August activity. Several problems raised in the workshop period were solved by the end of the miniconference and others are providing stimulus to further enquiry.

I was particularly pleased that we were able to gather a group of mathematicians who had common research interests, who are familiar with each others work but who had not previously met together in one place. The effect was an exhilaration and an explosion of effort which will bear fruit for a long time to come. For me there was great satisfaction that this meeting could be held in Australia and in the ideal setting where the Centre of Mathematical Analysis operates.

It should be mentioned that not all the papers which resulted from the collaboration culminating in the workshop/miniconference in August are published in Volume 20 of the Proceedings of the Centre for Mathematical Analysis; a number of significant papers will be published elsewhere. One such interesting collaboration followed from the presentation of a problem in economics/optimization by Gary Newsam and resulted in a joint paper with Adrian Lewis. Jonathan Borwein and Simon Fitzpatrick worked in collaboration at the University of Newcastle before the workshop/miniconference and three of their papers will be published in journals appropriate to their problem areas.

I congratulate the Director of the Centre for Mathematical Analysis and his staff, particularly the Secretary, Mrs Marilyn Gray, for the efficient way the workshop/miniconference events are organised, especially in the minimizing of formality and the maximizing of collaborative informality. The Centre's style of operation make an organizer's task particularly easy and helped the participants feel comfortable immediately.

I wholeheartedly commend to the Australian mathematical community the workshop/miniconference opportunities provided by the Centre for Mathematical Analysis. Mathematicians have always had more difficulty than others in attracting research funding from research grant bodies and we are at present facing the prospect of further reduction in support for our research efforts. Australian mathematicians in the future will be looking more than ever to the Centre for Mathematical Analysis for support with mathematical research in this country.

CONFERENCES AND TRAVEL

Members of the Centre participated in the following Australian conferences and meetings:

Mathematics and Industry Study Group, Sydney, February;

Annual Conference of the Division of Applied Mathematics of the Australian Mathematical Society, Leura, February;

National Mathematical Sciences Congress, Canberra, May;

Conference on the Murray River Basin, Canberra, May;

Conference on Numerical Solution of Integral Equations, Brisbane, August

The Centre organised two miniconferences on Mathematical Relativity and Optimization and Functional Analysis in conjunction with the special programmes described above. Many participants from around Australia participated in these meetings, in addition to those from overseas and Australia already participating in the special programmes. The Centre also organized in December a one day meeting on computational mathematics in honour of Garry Newsam's appointment at Defence Science and Technology in 1989.

Neil Trudinger was an invited speaker at the International Conference in Memory of Guido Stampacchia in Rome in April. Afterwards he visited universities in Madrid, Granada and Paris for seminars and research collaboration. In June he participated in the Calculus of Variations Meeting at Oberwolfach, Germany, in between brief visits to the Bulgarian Academy of Science and the University of Bonn. In September, he gave an invited address at a Conference in Honour of Alex McNabb at Palmerston North, New Zealand. He also gave seminars and colloquia at the Universities of Queensland and Wollongong.

Igor Kluvanek attended the Sixth International Congress on Mathematics Education in Budapest in July-August and invited the Slovak Academy of Sciences and Komensky University in Bratislava and Safárik University in Kosice, Czechoslovakia. He also gave colloquia at the Universities of Queensland and Newcastle

Robert Bartnik visited the Courant Institute of Mathematical Sciences, New York University, from February to June. During this period he gave invited lectures at New York University, Yale University, Princeton University, Institute for Advanced Study, Harvard University, Rice University, Indiana University, Stanford University as well as Cambridge University and the University of London in the U.K. He organised the Mathematical Relativity Programme and participated in the ensuing Marcel Grossman Conference on General Relativity in Perth in August.

John Urbas visited the University of Bonn from May to July and during this period participated in the Conference on Variational Problems in Paris and the Calculus of Variations Meeting in Oberwolfach in June.

Klaus Ecker also visited the University of Bonn in June, and participated in the Calculus of Variations Meeting. In November and December, he visited the University of Trento in Italy.

The Centre was accorded a great honour at the Calculus of Variations Meeting. A "Canberra" day was set aside exclusively for its contributions, with invited lectures being given by Ecker, Trudinger, Urbas and Gerhard Huisken. The closest comparable honour at the same meeting was another day for contributions from the country of Italy.

PUBLICATIONS

The Centre produced 54 research reports and five volumes of its Proceedings in 1987. Volume 16 contained the proceedings of the second miniconference on Harmonic Analysis and Operator Algebras held in conjunction with the special programme in 1987. Volume 17 consisted of expository papers arising from the special programme on Inverse Problems in 1986. Volume 18 is an important monograph on Integration Structures by Igor Kluvanek. Volumes 19 and 20 are devoted to the proceedings of the two miniconferences held in 1988 in conjunction with the special programmes on Mathematical Relativity and Optimization/Functional Analysis. Details are attached as well as references to publications of Centre personnel which appeared in 1988. (Individual publications in Volumes 19 and 20 will be listed in the 1989 Annual Report).

GRANTS AND OUTSIDE SUPPORT

Claude Dietrich was awarded an Australian Water Research Advisory Council Research Fellowship to be taken up in 1989 jointly with the Centre for Resource and Environmental Studies.

Stephen Roberts, (CMA), Gerhard Huisken and John Hutchinson (Department of Mathematics), were awarded a substantial Australian Research Council grant for Numerical and Theoretical Study of Models of the Evolution of Interfaces.

Robert Anderssen and Claude Dietrich carried out a consulting project for the National Capital Development Commission on Flow and Sedimentation Modelling in Lakes.

Intellectual property rights were successfully negotiated with the CSIRO Division of Mathematics and Statistics and Manufacturing technology for the computer simulation of solidification done in the Centre during 1984 and 1985.

OTHER ACTIVITIES

Professor Trudinger continued as President of the Australian Mathematical Society until May. Dr. Anderssen continued as Chairman of the National Committee for Mathematics and Mathematical Sciences Board Member of the Federation of Australian Scientific and Technological Societies.

Professor Trudinger served on the editorial boards of the international journals, *Annales de L'Institut Henri Poincaré*, and *Proceedings of the Royal Society of Edinburgh*.

FUTURE PLANNING

A special programme on Mathematical Physics, under the direction of Professors Barber of the Department of Mathematics and Baxter, of the Department of Theoretical Physics, Research School of Physical Sciences, was prepared for 1989. Preliminary planning was also undertaken on the special programme for 1990 on The Application and Numerical Analysis of Partial Differential Equations, under the direction of Drs. Anderssen and de Hoog, Dr. Osborne of the Department of Statistics, Research School of Social Sciences and Professor Vidar Thomée of the University of Goteborg, Sweden.

VISITORS COMMENTS

Descriptions of research activities in this and previous reports of the Centre, are extracted from much longer individual reports supplied by Staff and Visiting Fellows. Many reports also praise the Centre for its high quality of its research environment and administrative staff. Typical comments from special programme participants include:

"I have had an extremely productive time during my stay here at the Centre. I couldn't imagine a nicer place to get a lot of work done and interact fruitfully with other visitors and Centre members." (V. Moncrief, Mathematics and Physics, Yale University);

"I found the whole visit extremely stimulating and many of the issues raised (and resolved) during my stay will generate much of my work in the next few years." (N. O'Murchadha, Physics, University College, Ireland);

"Opportunities to devote oneself exclusively to research are extremely important for working mathematicians and in providing them the CMA is making a major contribution to Mathematics." (B. Sims, University of New England).

CENTRE FOR MATHEMATICAL ANALYSIS

(i)

STAFF

Director and Professor	N. S Trudinger, B.Sc. (N.E.), M.Sc., Ph.D. (Stan.), F.A.A.
Senior Research Fellow	I. Kluvanek, Habil.Doc.Safarik Univ.RNDR CSc Slovak Acad.Sciences
Research Fellows	R. Bartnik, B.Sc., M.Sc. (Cant.), A.M., Ph.D. (Princeton)
	* N. Joshi, B.Sc. (Sydney), M.A., Ph.D. (Princeton)
	G. Newsam, B.Sc., M.Sc. (Cant.), A.M., Ph.D. (Harvard)
	* S. Roberts, B.Sc., M.Sc. (Flinders). Ph.D. (Berkeley)
Queen Elizabeth Fellow	J.I.E. Urbas, B.Sc., Ph.D. (ANU)
Postdoctoral Fellows	R. Beerends, Dr. (Leiden)
	** C. Dietrich, B.Appl.Math. (ETH)., M.Eng.Sc.(Sydney) Ph.D. (ANU)
	K. Ecker, Dr.rer.nat. (Heidelberg)
	H-J. Kuo, BS (Tamkang), MS National Tsing Hua Univ., M.A., Ph.D. (Indiana)
Visiting Fellows	C. Amano, BS (Chiba), MS Ph.D. (Tokyo)
	J. Fu, AB (Princeton), Ph.D. (MIT)
	R. Gulliver, BS, MS, Ph.D. (Stanford)
	A. Keraychian, B.Sc. (Tehran) M.Sc. (Southampton) Ph.D. (Colorado)
	T. Ohkubo, DSc (Hokkaido)
	D. Wall, B.E. (Auckland), Ph.D. (Canterbury)
Secretary	M.G. Gray
Wordprocessor Operators	D.M. Nash J.M. Smith
Research Assistant	Y-S Luo, B.Sc., M.Sc. (Jilin)

* joint with Mathematics, Faculty of Science

** joint with Centre for Resource and Environmental Studies

ASSOCIATE MEMBERS

R.S. Anderssen	Div. Maths & Statistics, CSIRO
R.P. Brent	Engineering Physics, R.S.Phys.S.
F. de Hoog	Div. Maths & Statistics, CSIRO
G. Huiskens	Mathematics, Faculty of Science
J. Hutchinson	Mathematics, Faculty of Science
A.G.R. McIntosh	Mathematics, Macquarie University
C. Meaney	Mathematics, R.S.Phys. S.

VISITING FELLOWS* (Short Term)

Professor J. Bicak	Charles University
Professor J. Borwein	Halifax University
Professor R. Brown	Newcastle-upon Tyne University
Professor Y. Choquet-Bruhat	University of Paris
Professor S. Chow	University of Wyoming
Professor P. Chrusciel	Polish Academy of Sciences
Professor C.J.S. Clarke	University of Southampton
Professor G. de Barra	University of London
Dr. S. Fitzpatrick	University of Auckland
Professor H. Friedrich	University of Bundeswehr, Hamburg
Professor G. Galloway	University of Miami
Professor C. Gerhardt	University of Heidelberg
Professor J. Giles	University of Newcastle
Professor S. Harris	Oregon State University
Professor F. Holland	University College, Ireland
Professor J. Isenberg	University of Oregon
Dr. G. Keady	University of Western Australia
Professor P. Kenderov	Bulgarian Academy of Science
Professor R. Kerr	University of Canterbury
Professor H. König	University of Saarbrücken
Professor M. Lambrou	University of Crete
Professor A. Lewis	Dalhousie University
Professor S-L. Liu	Academica Sinica, China

Professor Yang Lu	Academica Sinica, China
Professor S. Luckhaus	University of Heidelberg
Dr. R. Mattheij	Technical University Eindhoven
Dr. J. Michael	University of Adelaide
Professor V. Milman	Tel Aviv University
Professor V. Moncrief	Yale University
Professor N. Murchadha	University College, Ireland
Dr. J. Murray	University of New South Wales
Dr. A. Pani	Indian Institute of Technology, Bombay
Professor J-P. Penot	University de Pau
Professor Z. Perjes	Hungarian Academy of Sciences
Professor E. Prestini	University of Milan
Professor M. Renardy	Virginia Polytechnic
Professor Y. Renardy	Virginia Polytechnic
Dr. S. Scott	University of Oxford
Professor L. Simon	Stanford University
Dr. B. Sims	University of New England
Dr. D. Singleton	Monash University
Professor B. Solomon	Indiana University
Professor Le Hung Son	Dai Hoc Bach Khoa, Hanoi
Professor G. Tauber	Tel Aviv University
Professor J. Wick	University of Kaiserslautern
Dr. R. Womersley	University of New South Wales
Professor X. Yu	Academica Sinica, China

* Visiting Fellows appointed for more than six months are shown as staff

- January 21 Professor R. Kerr (University of Canterbury)
"Exact Solutions of Einstein's Theory of Relativity"
- January 28 Professor S-S Chow (University of Wyoming)
"Well Singularities in Reservoir Simulation"
- February 18 Professor P. Erdős (Budapest)
"Problems in Number Theory"
- February 25 Dr. K. Ecker (Centre for Mathematical Analysis)
"Mean Curvature Evolution of Entire Graphs"
- March 10 Dr. J. Chabrowski (University of Queensland)
"On the multiple solutions of the Dirichlet problem for elliptic quasilinear equations"
- March 17 Professor R. Haberman (Southern Methodist University)
"Modulations of the Phase Shift for Perturbed, Strongly Nonlinear, Slowly Varying Oscillators and Dispersive Waves"
- March 24 Dr. D. Wall (University of Canterbury)
"On Inverse Problems involving boundary measurements"
- March 31 Professor B.C. Berndt (University of Illinois at Urbana-Champaign)
"Infinite Series in Ramanujan's Notebooks"
- April 7 Dr. U. Dierkes (Dept. of Mathematics, R.S.Phys.Sciences)
"Plateau's problem for surfaces with prescribed mean curvature spanned over obstacles"
- April 14 Dr. J. Fu (University of Georgia and Centre for Maths Analysis)
"Algebraic and Analytic Foundations of Integral Geometry"
- April 28 Professor K.E. Atkinson (University of Iowa)
"The Discrete Galerkin Method for Solving Linear and Nonlinear Integral Equations"
- May 5 Professor T. Ohkubo (Soka University, Japan)
"Initial-boundary value problems for hyperbolic equations with characteristic boundary"
- May 12 Dr. R. Beerends (Centre for Mathematical Analysis)
"Analysis on root systems"
- May 26 Professor H. Stetter (Technische Hochschule Wien)
"Computing enclosures for solutions of initial value problems in o.d.e."
- June 2 Professor Gabor T. Herman (University of Pennsylvania)
"Image Reconstruction From Projections"
- June 9 Dr. R.M.M. Mattheij (Technische Universiteit Eindhoven)
"The Numerical Solution of Boundary Value Problems for Ordinary Differential Equations"

- June 16 Dr. Robert Bartnik (Centre for Mathematical Analysis)
"Local Mass"
- June 23 Dr. Jim Michael (University of Adelaide)
"Monotone Operators and Obstacle Problems"
- June 30 Professor Vincent Moncrief (Yale University)
"Reduction of Einstein's Equations for $U(1)$ Symmetric Spacetime"
- July 7 Professor Robert P. Gilbert (University of Delaware)
"Generalized Hyperanalytic Function Theory with an
Application to the Theory of Elastic Shells"
- July 14 Professor Yvonne Choquet-Bruhat (Universite Paris VI)
"Global Existence Theorems for Hyperbolic Harmonic Maps"
- July 28 Professor Helmut Friedrich (Max-Planck Institute, Munich)
"On Static and Radiative Space-Times"
- August 4 Professor Jim Isenberg (University of Oregon)
"On Ricci Flow for Spaces with Indefinite Ricci Curvature"
- August 11 Professor Vitali Milman (Tel Aviv University)
"High-Dimensional Spaces; Some Unexpected Phenomena"
- August 25 Professor Petar Kenderov (Institute of Mathematics, Sofia, Bulgaria)
"Fragmentable Topological Spaces"
- September 8 Professor R. Gulliver (University of Minnesota)
"Maps of Minimum Energy into Spheres"
- September 15 Dr. K. Gopalsamy (Flinders University of South Australia)
"Dynamical Systems Modelling Cooperation"
- September 29 Professor Neil S. Trudinger (Centre for Math. Analysis)
"Graphs with Prescribed Curvature"
- October 13 Professor Yang Lu (Academia Sinica, Sichuan, China)
"A New Method of Automated Theorem Proving"
- October 27 Professor Heinz König (Universität des Saarlandes, Saarbrücken)
"Theory and Applications of Superconvex Spaces"
- November 10 Professor F. Holland (University College, Cork, Ireland)
"Some aspects of Besov spaces of analytic functions"
- November 17 Dr. John Urbas (Centre for Mathematical Analysis)
"Expansion of Starshaped Hypersurfaces by Their Curvature"
- November 24 Professor Garth Gaudry (Flinders University)
"Heat Kernel Maximal Functions on Lie Groups"
- November 25 Dr. Alex McNabb (Massey University)
"Diffusion Reaction Models for Cellular Absorption"

December 1 Professor Elena Prestini (Universita di Milano)
 "Convolution Operators with Oscillating Kernels"

December 15 Professor Le Hung Son (Polytechnical University, Khoa Toan)

PROCEEDINGS

- Volume 16 Miniconference on Harmonic Analysis and Operator Algebras
(Canberra 5-8 August and 2-3 December, 1987)
Edited by M. Cowling, C. Meaney and W. Moran
- Volume 17 Special Program on Inverse Programs
Edited by R.S. Anderssen and G.N. Newsam
- Volume 18 Integration Structures
Igor Kluvanek
- Volume 19 Conference on Mathematical Relativity
(Canberra, July, 1988)
Edited by Robert Bartnik
- Volume 20 Workshop/Miniconference on Functional Analysis/Optimization
(Canberra August 8-24, 1988)
Edited by Simon Fitzpatrick and John Giles

RESEARCH REPORTS

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|------------|----------------------------------|---|
| CMA-R01-88 | Robert Bartnik and John McKinnon | Nonsingular solutions of the Einstein Yang-Mills equations |
| CMA-R02-88 | Robert Bartnik | A quantitative Hopf principle and the lapse of a maximally sliced spacetime |
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PUBLICATIONS 1988

(iv)

- 1 Amano, C. "The Dirichlet problem for degenerate elliptic 2-dimensional Monge-Ampère equation" *Bull. Austral. Math. Soc.* **37** (1988) 389-410.
- 2 Bartnik, R. "Remarks on cosmological spacetimes and constant mean curvature surfaces" *Comm. Math. Phys.* **117** (1988) 615-624.
- 3 Bartnik, R. and McKinnon, J. "A particle-like solution of the Einstein-Yang-Mills equations" *Phys. Rev. Lett.* **61** (1988) 141-144.
- 4 Beerends, R.J. "A transmutation property of the generalized Abel transform associated with root system A_2 " *Proc. Centre Math. Analysis* **16** (1988) 1-3.
- 5 Brown, G. and Dooley, A.H., "A class of ergodic measures" *Proc. Centre Math. Analysis* **16** (1988) 8-14.
- 6 Brown, G. and Wilson, D.C. "Trigonometric sums and polynomial zeros" *Proc. Centre Math. Analysis* **16** (1988) 15-20.
- 7 Carey, A.L., "Representations of infinite dimensional groups and applications" *Proc. Centre Math. Analysis* **16** (1988) 21-28.
- 8 Christ, M. and Sogge, C.D. "On the L^1 behaviour of eigenfunction expansions and singular integral operators" *Proc. Centre Math. Analysis* **16** (1988) 29-50.
- 9 Cowling, M. "Rigidity, Von Neumann algebras and semisimple groups" *Proc. Centre Math. Analysis* **16** (1988) 51-57.
- 10 Davies, A.R. "Optimality in numerical differentiation" *Proc. Centre Math. Analysis* **17** (1988) 1-12
- 11 Davis, K.M., Gilbert, J.E. and Kunze, R.A. "Harmonic analysis and exceptional representations of semisimple groups" *Proc. Centre Math. Analysis* **16** (1988) 58-78.
- 12 Davis, K.M., Gilbert, J.E. and Kunze, R.A. "Invariant differential operators in harmonic analysis on real hyperbolic space" *Proc. Centre Math. Analysis* **16** (1988) 79-91.

- 13 Dietrich, C.R., Jakeman, A.J. and G.A. Thomas, "Prediction of solute concentration in streams subject to groundwater inflow" *Hydrology and water resources symposium National Conference Publication No. 88/1*, Australian National University, Canberra, 1988, pp.
- 14 Dietrich, C.R., Jakeman, A.J. and F. Ghassemi, "Modelling for surface and subsurface hydrological management" *Institute for Mathematics and Computers in Simulation, 12th IMACS World Congress on Scientific Computation*, July 18-22, Vol. 2, Paris, 1988, pp.
- 15 Dietrich, C.R., Newsam, G.N., Anderssen, R.S., Ghassemi F. and Jakeman, A.J., "The nature of some ill-posed problems arising in aquifer modelling" *River Murray Basin 88, sponsored by the Groundwater Working Group of the Murray-Darling Basin Ministerial Council and the Australian Geoscience Council*, May, 1988.
- 16 Dietrich, C.R., and Anderssen, R.S. *Flow and sedimentation modelling in lakes: an assessment of alternatives*, a report to the National Capital Development Commission, 20 pages (plus appendices), November, 1988.
- 17 Eldén, L. "Some remarks on algebraic inverse problems" *Proc. Centre Math. Analysis* 17 (1988) 13-16.
- 18 Engl, H.W. and Groetsch, G.W. "Projection-regularization methods for linear operator equations of the first kind" *Proc. Centre Math. Analysis* 17 (1988) 17-31.
- 19 Hald, O.H. and McLaughlin, J.R. "Inverse problems using nodal position data-uniqueness results, algorithms and bounds" *Proc. Centre Math. Analysis* 17 (1988) 32-59.
- 20 Hoffman, K-H. and Sprekele, J. "Towards the identification of ordinary differential equations from measurements" *Proc. Centre Math. Analysis* 17 (1988) 60-79.
- 21 Hoog, F. de and Anderssen, R.S., "Convergence of kernel functions for cubic smoothing splines on non-equispaced grids" *Aust. J. Stats* 30A (1988) 90-99.
- 22 Huisken, G., "The volume preserving mean curvature flow" *J. Reine Angew. Math.* 382 (1987) 35-48.
- 23 Jonca, K. and Vogel, C.R. "Numerical solution of the magnetic relief problem - a preliminary report" *Proc. Centre Math. Analysis* 17 (1988) 117-131.
- 24 Joshi, N. and Kruskal, M.D. "An asymptotic approach to the connection problem for the first and second Painleve equations" *Physics Letters A* 130 (1988), 129-137.

- 25 Julg, P. and Valette, A. "Fredholm modules associated to Bruhat-Tits buildings" *Proc. Centre Math. Analysis* 16 (1988) 143-155.
- 26 Kaniuth, E. "Irreducible representations that cannot be separated from the trivial representation" *Proc. Centre Math. Analysis* 16 (1988), 156-160.
- 27 Kawakami, S. "A remark on the relative entropy" *Proc. Centre Math. Analysis* 16 (1988) 161-168.
- 28 Kluvanek, I. "Scalar operators and integration" *J. Austral. Math. Soc. (Series A)* 45 (1988), 401-419.
- 29 Kurtz, D.S. "Singular integrals on BMO" *Proc Centre Math. Analysis* 16 (1988) 169-172.
- 30 Lizhong, P. "Hankel operators on the Paley-Wiener space in disk" *Proc. Centre Math. Analysis* 16 (1988), 172-180.
- 31 McIntosh, A. "Clifford algebras and the higher dimensional Cauchy integral" *Approximation theory and Function Spaces, Banach Central Publications*, 22 Warsaw, Poland, (1988).
- 32 (with A. Pryde and W. Ricker) "Comparison of joint spectra for certain classes of commuting operators" *Studia Math.* 88 (1988) 23-36.
- 33 (with A. Pryde and W. Ricker) "Systems of operator equations and perturbation of spectral subspaces of commuting operators, *Michigan Math. Journal*, 35 (1988) 43-65.
- 34 Moncrief, V. "Reduction of Einstein's equations for nonstationary cylindrical cosmic strings" *Phys. Rev. D.*, 39 429-433 (1989).
- 35 Moran, W. and Pearce, C.E.M. "Discrepancy results for normal numbers" *Proc. Centre Math. Analysis* 16 (1988) 203-210.
- 36 Newsam, G.N. "On the asymptotic distribution of the eigenvalues of discretizations of a compact operator" *Proc. Centre Math. Analysis* 17 (1988), 92-105.
- 37 Newsam, G.N. and Enting, I.G., "Inverse problems in atmospheric constituent studies: I. Determination of surface sources under a diffusive transport approximation" *Inverse Problems* 4 1037-1054.
- 38 Overton, M.I. "Some remarks on inverse and extremal eigenvalue problems" *Proc. Centre Math. Analysis* 17 (1988) 80-91.
- 39 Picardello, M.A. and Sjörgen, P. "The minimal Martin boundary of a cartesian product of trees" *Proc. Centre Math. Analysis* 16 (1988) 226-246.
- 40 Poguntke, D. "Spectral synthesis of orbits of compact groups" *Proc. Centre Math. Analysis* 16 (1988) 247-261.

- 41 Renault, J. and Moran, W. "Ideal structure of groupoid crossed product C^* algebras" *Proc. Centre Math. Analysis* **16** (1988) 267-268.
- 42 Rosenberg, J. "Applications of analysis on Lipschitz manifolds" *Proc. Centre Math. Analysis* **16** (1988) 269-283.
- 43 Soardi, P.M. "Random walks on a discrete semigroup and Chebyshev polynomials" *Proc. Centre Math. Analysis* **16** (1988), 312-316.
- 44 Trudinger, N.S. "Hölder gradient estimates for fully nonlinear elliptic equations" *Proc. Roy. Soc. Edinburgh Sect. A* **108** (1988) 57-65.
- 45 Urbas, J. "Global Hölder estimates for equations of Monge-Ampère type" *Invent. Math.* **91** (1988), 1-29.
- 46 Urbas, J. "Regularity of generalized solutions of Monge-Ampère equations" *Math. Zeit.* **197** (1988), 365-393.
- 47 Zimmer, R.J. "Orbit equivalence, Lie groups, and foliations" *Proc. Centre Math. Analysis* **16** (1988) 341-349.