

Heriot-Watt University Department of Mathematics



ANNUAL REPORT 1983-84

1.

Research activities within the Department of Mathematics continue to grow. It is gratifying to report the increasing number of successful collaborations with other international centres in the U.K., Europe, and the U.S.A., as demonstrated by the joint publications in this report. It is also encouraging to report a small but growing number of research collaborations with other departments within the University in the Faculties of Engineering and Science. Dr K.J. Brown spent the summer term as Visiting Professor at E.P.F.L. Lausanne. Professor J.M. Ball, Drs. J. Carr, G.P. Knowles and A.A. Lacey paid long-term visits to various institutions in the U.S.A. during the year. The Department was fortunate in attracting a number of eminent mathematicians for extended visits, culminating in the visit in August of Professor J.K. Moser (ETH, Zurich), President of the International Mathematical Union.

Professor J.M. Ball organised a highly successful one-day meeting on nonlinear partial differential equations in June, 1984, with participants from France, Italy and the U.S.A. Various members of the Department have been awarded a number of S.E.R.C. research grants, including one for a Symposium Year on 'Material Instabilities in Continuum Mechanics'.

The Department was awarded a 'New Blood' Lectureship in nonlinear differential equations from the U.G.C., which was filled by Dr Michiel van den Berg from the Dublin Institute for Advanced Studies.

In July 1984 Dr. J.C. Eilbeck returned from his sabbatical at the Center for Nonlinear Studies, Los Alamos National Laboratory. He was appointed Head of Department in September. Professor R.J. Knops was appointed Dean of the Faculty of Science beginning in October 1984.

The quality of applications for undergraduate places in the Department of Mathematics continues to increase, and in consequence entrance qualifications have had to be raised further. The quantity of applications has also held steady, despite a nationwide downward trend.

The Department was shocked to hear in June 1984 that the Head of Department, Professor J.H. Williamson, had suffered a stroke, only months before he was due to take early retirement. All the staff and students wish him well in his recovery. He will be greatly missed for his teaching skills, his research activities in pure mathematics, and for his genial stewardship of the Department over the last year.

J.C. Eilbeck
Head of Department

2.

STAFF

Head of Department 1983-4

Head of Department 1984-6

Professors

John M. Ball
R.J. Knops
John H. Williamson¹

Honorary Professor

Paul H. Roberts (University of
Newcastle-upon-Tyne)

Visiting Professors

Jerzy W. Zabczyk² (Polish Academy of Sciences)
Jamanadas R. Patadia³ (University of Baroda)

Readers

Jack Carr

Greg P. Knowles

Senior Lecturers

David L. Barrow³
Kenneth J. Brown

J. Chris Eilbeck
R.N. Hills

Lecturers

C.E. Reevers
Michiel van den Berg⁴
James Bree
Douglas E.R. Clark
Peter A. Clarkson³
Alexander M. Davie²
Brian P. Dodds
Andrew A. Lacey
George R. McGuire

Laurence E. Nicholas
Alan R. Prince
Habib U. Rahman
Mrs M. Elizabeth Scott⁵
David G. Wilkinson
Huw T. Williams⁶
Charles J. Wood
Martin A. Youngson

Research Associate

Jeyabal Sivaloganathan⁷

Secretaries

Miss Isabel Fraser
Mrs Maureen A. Gardiner

Mrs Patricia B. Hampton⁵
Mrs V.A. McDonald⁵

¹Retired 31.8.84

²1984-85

³1983-84

⁴New Blood Lecturer, from 1.9.84

⁵Part-time

⁶1983-85

⁷1984-86

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Visitors to the Department

The following made long-term visits:

Professor F. Brezzi (University of Pavia)
Professor G. Capriz (University of Pisa)
Professor C.M. Dafermos (Brown University)
Professor L.E. Fraenkel (University of Sussex)
Professor M. Giaquinta (University of Firenze)
Dr. J. Madocks (University of Paris Dauphine)
Professor P.-L. Lions (University of Oxford)
Professor V.J. Mizel (Carnegie-Mellon University)
Professor J.K. Moser (ETH Zurich/President of the International
Mathematical Union)
Professor F. Murat (University Paris VI)

In addition short-term visits were made and seminars given by the following:

Professor L. Berkovitz (Purdue University)
Dr. J. Boyle (Strathclyde University)
Professor F.H. Clarke (University of British Columbia)
Professor W.D. Collins (Sheffield University)
Dr. R. Fletcher (University of Dundee)
Professor J. Harper (Victoria University, New Zealand)
Dr. H.H.W. Hofer (University of Bath)
Dr. D.R. Hughes (University of London)
Professor D. Kinderlehrer (University of Minnesota)
Professor A.R. Mitchell (University of Dundee)
Professor O. Penrose (Open University)
Professor P. Podio-Guidugli (University of Pisa)
Professor D. Rees (University of Exeter)
Professor J.T. Stuart (Imperial College)
Professor C. Surry (University of Lyon)
Dr. A.B. Taylor (University of Oxford)

Invited Papers and Seminars

Professor J.M. Ball

Conference on 'Phase Transformations and Material
Instabilities in Solids', Mathematics Research
Center, University of Wisconsin.
Society for Natural Philosophy Conference, Brown University
Conference on 'Trends and Applications of Pure Mathematics
to Mechanics', Palaiseau, France.
Conference on Statistical Mechanics, Open University.
Conference on 'Ordinary and Partial Differential
Equations', University of Dundee.
Seven invited lectures - Edinburgh Mathematical Society,
St Andrews Colloquium.
Seminars at Collège de France, Paris, Universities of
Aberdeen, St. Andrews, Imperial College, Strathclyde,
Nottingham, Courant Institute for Mathematical Sciences,
New York, University of Maryland, Duke University,
Glasgow

Dr. M. van den Berg

Seminars at Universities of Heidelberg, Swansea,
Dublin Institute for Advanced Studies, Trinity College,
Dublin, Technical University of Eindhoven.

Invited Papers and Seminars (continued)

- Dr. C.E. Beavers
Conference on Fluid Mechanics, Oberwolfach.
- Dr. K.J. Brown
Seminars at Universities of Birmingham, Glasgow, Zurich.
Postgraduate lecture course at Lausanne Polytechnique.
- Dr. J. Carr
Conference on Phase Transitions, Mathematics Research Center, University of Wisconsin.
Conference on Differential Equations, University of Dundee.
Seminars at Brown University, CNLS Los Alamos, Mathematics Research Center, University of Wisconsin, Michigan State University.
- Dr. P.A. Clarkson
Conference on Differential Equations, University of Dundee.
- Dr. J.C. Eilbeck
International Symposium on Selected Topics in Statistical Mechanics, Dubna, USSR.
Workshop on Soliton Creation and Detection in Condensed Matter, Los Alamos National Laboratory.
Workshop on Chaos in Nonlinear Oscillators, University of Durham, North Carolina.
Workshop: Arizona Days at the CNLS - Lectures in Statistical Physics, Iterated Mappings and Stability, Los Alamos National Laboratory.
Meeting of the APS, Detroit.
Seminars at Universities of Tuscon, Southern California, Waterloo, Canada.
- Professor R.J. Knops
Conference at University of Durham.
Conference on Applied Mathematics, Bratislava, Czechoslovakia.
Conference on Fluids Mechanics, Oberwolfach.
Conference on Trends in Mathematics Applied to Mechanics, Paris.
Euromech Conference at Paris.
Seminars at Universities of Bath, Cork, Glasgow, Galway.
- Dr. A.A. Lacey
International Conference on Free Boundary Problems.
Conference on Ordinary and Partial Differential Equations, University of Dundee.
Seminars at University of Dundee, Northwestern University, Rensselaer Polytechnic Institute.
- Dr. A.R. Prince
Conference on Finite Geometries, Lehigh University.
- Dr. H.T. Williams
British Theoretical Mechanics Colloquium.
- Dr. M.A. Youngson
Seminar at University of Edinburgh.
- Professor J.W. Zabczyk
Seminars at University of Warwick.

Theses

- Khalaf, Zakaria Ade1
Systems of differential equations in ecology. (M.Sc.)
Some problems for quasilinear wave equations and phase transitions in one dimensional elasticity. (Ph.D.)
- Sritharan, Kopalasingham

Books

- R.K. Dodd, J.C. EILBECK,
J.D. Gibbon and H.C. Morris
Solitons and Nonlinear Wave Equations.
Academic Press 1984. (reprint and paperback edition).
- G.P. KNOWLES
An Introduction to Applied Optimal Control.
Shanghai Publishing Co. 1984. (Chinese edition).

Papers

- J. Aitchison, A.A. LACEY and M. Shillor
'A model for an electropaint process', *IMA J. Appl. Math.*, 1984, 33, 17-31.
- J.M. BALL
'Minimizers and the Euler-Lagrange equations', in 'Trends and Applications of Pure Mathematics to Mechanics', Proceedings Pataiseau (France), Ed. P.G. Ciarlet and M. Roseau, Lecture Notes in Physics, Springer-Verlag, Berlin, 1984, 195, 1-4.
- J.M. BALL and V.J. Mizel
'Singular minimizers for regular one-dimensional problems in the calculus of variations', *Bull. Amer. Math. Soc.*, 1984, 11, 143-146.
- J.M. BALL and D.G. Schaeffer
'Bifurcation and stability of homogeneous equilibrium configurations of an elastic body under dead-load tractions', *Math. Proc. Camb. Phil. Soc.*, 1983, 94, 315-339.
- D.L. BARROW and P.W. Bates
'Bifurcation and stability of periodic travelling waves for a reaction-diffusion system', *J. Differential Equations*, 1983, 50, 218-233.
- P.M. Bates and K.J. BROWN
'Convergence of equilibrium in a reaction-diffusion system', *Nonlinear Analysis*, 1984, 8, 227-236.
- M. van den BERG
'On finite volume corrections to the equation of state of a free Bose gas', *Helvetica Physica Acta*, 1983, 56, 1151-1157.
'On condensation in the free boson gas and the spectrum of the Laplacian', *Journal of Statistical Physics*, 1983, 31, 623-637.
'A uniform bound on trace $(e^{-\beta H})$ for convex regions in R^n with smooth boundaries', *Commun. Math. Phys.*, 1984, 92, 525-530.
'On the spectrum of the Dirichlet Laplacian for horn-shaped regions in R^n ', *Journal of Functional Analysis*, 1984, 58, 150-156.
- M. van den BERG and J.L. van Hemmen
'On neutral plasmas with quadratic interactions', *Journal of Physics*, 1984, A17, 169-174.
- J. BLAT and K.J. BROWN
'Bifurcation of steady state solutions in predator-prey and competition systems', *Proc. Royal Soc. Edinburgh*, 1984, 97A, 21-34.
- K.J. BROWN
'Spatially inhomogeneous steady state solutions for systems of equations arising describing interacting populations', *Jour. Math. Anal. Applic.*, 1983, 95, 251-264.

- J. CARR and R.G. Muncaster
'The application of centre manifolds to amplitude expansions. I', J. Differential Equations, 1983, 50, 260-279.
'The application of centre manifolds to amplitude expansions. II', J. Differential Equations, 1983, 50, 280-288.
- J. CARR and J.C. EILBECK
'One-dimensional approximations for a quadratic Ikeda map', Phys. Lett., 1984, 104A, 59-62.
- R.J. Duffin and G.P. KNOWLES
'Optimal phase shift filters for temperature control of buildings', Proceedings of I.E.E.E. Midwest Circuits and Systems Symposium, 1984.
- J.C. EILBECK
'The Sine-Gordon equation - from solitons to chaos', IMA Bulletin, 1984, 40, 77-81.
- C. Karanikas and J.H. WILLIAMSON
'Norms and spectra for certain subalgebras of $M(G)$ ', Math. Proc. Camb. Phil. Soc., 1984, 95, 109-122.
- R.J. KNOPS and C.A. Stuart
'Quasiconvexity and uniqueness of equilibrium solutions in nonlinear elasticity', Arch. Rat. Mech. Anal., 1984, 86, 233-249.
- A.A. LACEY
'Initial motion of the free boundary for a nonlinear diffusion equation', IMA J. Appl. Math., 1983, 31, 113-119.
- A.A. LACEY and A.B. Taylor
'A mushy region in a Stefan problem', IMA J. Appl. Math., 1983, 30, 303-313.
- L.E. NICHOLAS et al.
'Encouraging Enthusiasm', in 'Generating Mathematical Mastery', Ed. Ron McLone. Shell Centre for Mathematical Education, 1983, 29-35.
- A.R. PRINCE
'Local algebras and finite projective planes', Proc. Roy. Soc. Edinburgh Sect. A., 1984, 96, 95-96.
- H.T. WILLIAMS
'Single integral representations in ice mechanics', Cold Regions Science and Technology, 1984, 9, 89-95.
- M.A. YOUNGSON
'Completely contractive projections on C^* -algebras', Quart. J. Math., 2, 1983, 34, 507-511.
- J. ZABCZYK
'Stationary distribution for linear equations driven by general noise', Bull. Polish Acad. Sciences, 1983, 31, 197-209.
'Stopping games for symmetric Markov processes', Probability and Mathematical Statistics, 1984, 4, 185-196.
'Structural properties and limit behaviour of linear stochastic systems in Hilbert spaces', Banach Center Publication, 1984, Vol. 14 (Mathematical Control Theory), 593-611.
'Stopping problems in stochastic control', Proceedings of the International Congress of Mathematicians, 1984, 1425-1437.

Reports submitted for publication

- B. Aupetit and M.A. YOUNGSON
'On symmetry of Banach-Jordan algebras'.
- J.M. BALL
'Material instabilities and the calculus of variation', Proceedings of conference on 'Phase Transitions and Material Instabilities in Solids', Mathematics Research Center, University of Wisconsin, October 1983.

- J.M. BALL
'Differentiability properties of symmetric and isotropic functions', Duke Math. J., 51, 1984.
'Remarks on the paper "Basic Calculus of Variations"', Pacific J. Math., 1984.
- J.M. BALL and J.E. Marsden
'Quasiconvexity at the boundary, positivity of the second variation and elastic stability', Arch. Rat. Mech. Anal., 1984.
- J.M. BALL and F. Murat
' W , P -quasiconvexity and weak convergence in the calculus of variations', J. Functional Analysis, 1984.
- C.E. BEEVERS
'Static problems in elastic materials with a crust', Mecc.
- C.E. BEEVERS and R.E. Craïne
'Wave propagation in dielectrics', J. de Méc.
- C.E. BEEVERS and G. Kremer
'Extended thermodynamics on dense gases', Proceedings on Recent Developments in Non-Equilibrium Thermodynamics, Barcelona, 1983.
- C.E. BEEVERS and M. Siihavý
'Asymptotic stability in nonlinear viscoelasticity', Quart. Appl. Math., 1984.
- M. van den BERG, J.T. Lewis and J.V. Pulé
'General theory of Bose-Einstein condensation', J. Math. Anal. Appl.
- M. van den BERG and J.T. Lewis
'Brownian motion on hypersurfaces in R^n ', Bull. London Math. Soc.
- M. van den BERG, J.T. Lewis and Ph. de Smedt
'Condensation in the imperfect boson gas', J. Statist. Phys.
- A.R. Bishop, J.C. EILBECK, J. Satiya and G. Wysin
'Pattern Selection and Low-dimensional Chaos in Dissipative Many Degree-of-Freedom Systems', Report No. LA-UR-84-1725.
- J. BLAT and K.J. BROWN
'A reaction-diffusion system modelling the spread of bacterial infections'.
- R. Burley, G.R. MCGUIRE and P. Mai
'Numerical simulation of an axial dyeing machine', Applied Mathematical Modelling.
- J.G. Burnell, A.A. LACEY and G.C. Wake
'Steady-states of the reaction-diffusion equations. III: Questions of multiplicity and uniqueness of solutions'.
- J. CARR, S.N. Chow and J.K. Hale
'Abelian integrals and bifurcation', J. Differential Equations.
- J. CARR, M. Gurtin and M. Slemrod
'Structured phase transitions on a finite interval', Arch. Rat. Mech. Anal.
'One-dimensional structured phase transformations under prescribed loads', J. Elasticity.
- P.A. CLARKSON
'The Painlevé Conjecture and Inverse Scattering - is it a sufficient condition?', Proceedings of Dundee Conference on Differential Equations, 1984.
- P.A. CLARKSON and J.B. McLeod
'A connection formula for the Second Painlevé Transcendent'.
'Similarity reductions of the two-dimensional nonlinear Schrödinger and the Modified Kadomtsev-Petviashvili Equation'.
'Is the Painlevé Conjecture a sufficient condition for a system of partial differential equations to be solvable in inverse scattering?'

- P.A. CLARKSON, P.J. Oliver and A. Ramani
'Integrability of Klein-Gordon equations', University of Minnesota Mathematics Report 83-159.
- R.J. Duffin and G.P. KNOWLES
'A passive wall design to minimize building temperature swings', Solar Energy.
'Use of layered walls to reduce building temperature swings', Solar Energy.
'A simple design method for the Trombe wall', Solar Energy.
'Optimal phase shift filters for temperature control of buildings', I.E.E.E. Midwest Circuits and Systems Symposium, 1984.
- J.C. EILBECK
'The pseudo-spectral method and path following in reaction-diffusion bifurcation studies', SIAM J. Sci. Stat. Comp.
- J.C. EILBECK, P.S. Lomdahl, O.H. Olsen and M.R. Samuelsen.
'Comparison between 1D and 2D models for Josephson junctions of overlap type', J. Appl. Phys., 1984.
- J.C. EILBECK, P.S. Lomdahl and A.C. Scott
'Soliton structure in crystalline acetanilide', Phys. Rev. B, 1984.
'Stationary Solitons on Finite Lattices', Proceedings of the III International Symposium on Selected Topics in Statistical Mechanics, Dubna, USSR, August 1984.
'The Discrete Self-Trapping Equation', submitted to Physica D.
- G.P. Galdi, R.J. KNOPS and S. Rionero
'Asymptotic behaviour in the nonlinear elastic beam', Arch. Rat. Mech. Anal.
- S.D. Howison, A.A. LACEY and J.R. Ockendon
'Singularity development in moving boundary problems'.
- A.A. LACEY
'The form of blow-up for nonlinear parabolic equations'.
'Singularity formation in moving boundary problems'.
- A.A. LACEY and J.R. Ockendon
'Ill-posed free boundary problems'.
- P.S. Lomdahl, O.H. Olsen and J.C. EILBECK
'How good are 1-D Josephson Junction Models?', J. Appl. Phys.
- G. Mazzotto, L. Stettner, J. Szpirglas and J. ZABCZYK
'On impulse control with partial observation', Proceedings of the IFAC Workshop on Stochastic Systems, Marseille, 1984.
- A.R. PRINCE
'A commutative ring associated with any finite projective plane', J. Algebra.
'Steiner triple systems of order 19 associated with a certain type of projective plane of order 10'.
'The commutative ring of a finite projective plane'.
- R. Quintanilla and H.T. WILLIAMS
'An existence and uniqueness theorem for incremental viscoelasticity', Quarterly of Applied Mechanics.
- A.C. Scott, P.S. Lomdahl and J.C. EILBECK
'Between the Local Mode and Normal Mode Limits', Chem. Phys. Letts.

Copies of any of the above reports or reprints can be obtained by writing to the authors or to the Departmental Secretary.