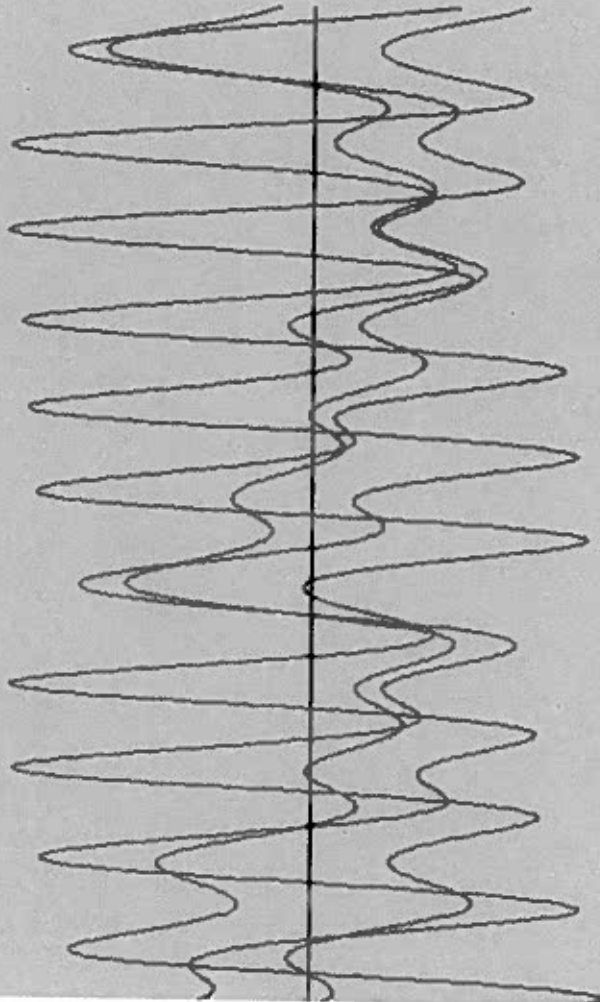


Heriot-Watt University

Department of Mathematics



ANNUAL REPORT 1984-85

Research activities within the Department of Mathematics continue at a high level. During the year two successful one-day symposia were organised by Professor Ball, and a great deal of preparatory work has gone into the organisation for the Symposium Year on Material Instabilities in Continuum Mechanics in 1985-86.

Dr A R Prince and Dr M A Youngson spent terms at the University of California, Santa Cruz and the University of Oregon, Eugene, respectively. Other national and international collaborations continued, with visits of members of the Department to the USA (Professor J M Ball, Mr J Bree, Dr A A Lacey, Dr J Sivaloganathan), to the USSR (Professor J M Ball), to Japan (Dr J C Eilbeck) and to Europe (Professor J M Ball, Dr M van den Berg, Dr M A Youngson). A number of long term visitors over the summer included Professors R J DiPerna, R D James, V J Mizel, M Reed, D G Schaeffer, M Slemrod (USA), J Lewis (Dublin), and M Silhavy (Czechoslovakia).

Several research grants have been awarded to the Department, including a British Gas Research Studentship for work in reaction-diffusion systems. Professor R J Knops has been appointed a member of the Mathematics Sub-Committee of the SERC.

A major development on the teaching side has been the award of a large grant from the Computer Board for a project to develop Computer Aided Learning material for Mathematics for Engineers. This programme, which is partially funded by the University, is aimed initially at first year engineering students. Dr C E Beavers, the co-director of the scheme, is also hoping to develop links with similar work in schools and other Universities and Colleges.

J C Eilbeck

Head of Department

STAFF

Head of Department 1984-86

Dr J Chris Eilbeck

Professors

John M Ball
R J Knops
Oliver Penrose¹

Honorary Professor

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

Visiting Professor

Jerzy W Zabezyk² (Polish Academy of Sciences)

Readers

Jack Carr
J Chris Eilbeck

Greg P Knowles³

Senior Lecturers

C E Beevers
Kenneth J Brown

R N Hills

Lecturers

Michiel van den Berg
James Bree
Douglas E R Clark
Brian P Dodds
Miss E Julie Halton⁴
Andrew A Lacey
George R McGuire
Laurence E Nicholas
Mrs Christine Noble⁵

Alan R Prince
Habib U Rahman
James H Renshaw⁶
David W Reynolds⁶
Amar Sadi⁶
David G Wilkinson
Huw T Williams⁶
Charles J Wood
Martin A Youngson

Research Associates

Mr Jacques E Furter⁷
Mr Tang Qi⁸
Dr Jeyabal Sivaloganathan⁹

Technical Support/Systems Programmer

Ms Brigid S G Cherry¹⁰

Secretaries

Miss Isabel Fraser
Mrs Maureen A Gardiner

Mrs Patricia B Hampton⁵
Mrs V A McDonald⁵

¹from 1 July 1986

²1984-85

³until 1.10.84

⁴1985-87

⁵1984-85

⁶1985-86

⁷1986-88

⁸1986-87

⁹1984-85

¹⁰part-time

Visitors to the Department

The following made long-term visits:

Professor G Cimatti (University of Pisa)
Professor R J DiPerna (Berkeley)
Professor L C Evans (Maryland)
Professor R D James (Minnesota University)
Professor J T Lewis (Dublin Institute for Advanced Studies)
Professor Y J Mizel (Carnegie-Mellon)
Professor I Pence (MRC Madison)
Professor M Reed (Duke University)
Professor D G Schaeffer (Duke University)
Professor M Silhavy (Czechoslovakian Academy of Sciences)
Professor M Slemrod (Rensselaer Polytechnical Institute)

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

Mr J S Anderson (ICI, Engineering Department, Billingham)
Professor L Arnold (Bremen University)
Dr P Baxendale (University of St Andrews)
Dr P K Browning (University of St Andrews)
Mr C Budd (University of Oxford)
Professor J H Conway, FRS (University of Cambridge)
Professor A D D Craik (University of St Andrews)
Professor W O Criminale (Washington University)
Professor E B Davies (King's College)
Dr C M Elliott (Imperial College)
Professor L C Evans (Maryland)
Dr D C Heggie (University of Edinburgh)
Dr J W P Hirschfeld (University of Sussex)
Dr J B McLeod (University of Oxford)
Professor H K Moffat (University of Cambridge)
Dr L W Morland (University of East Anglia)
Dr A I Murdoch (University of Strathclyde)
Professor A Newell (University of Arizona)
Professor W Noll (Carnegie-Mellon University)
Mr J Norris (University College, Swansea)
Professor R W Ogden (University of Glasgow)
Dr D A Rand (University of Warwick)
Professor I Schanbacher (Tubingen)
Professor M E Schonbek (Berkeley)
Professor R Temam (Paris-Sud)
Professor J F Toland (Bath)
Professor S Wojciechowski (University of Warsaw)
Professor L C Young (Wisconsin)

Invited Papers and Seminars

Professor J M Ball

Convegno su 'Metodi di Analisi Matematica e fenomeni naturali', Pisa, Italy.
 Three lectures - International Centre for Theoretical Physics, Trieste.
 Two lectures - Joint Meeting of Pau and Toulouse Universities.
 Mid-West Partial Differential Equations Seminar, Northwestern University
 IMA workshop on 'Metastability and partial differential equations', University of Minnesota.
 Conference on 'Finite thermoelasticity', Acad. Lincei, Rome.
 2nd Gregynog Symposium on differential equations.
 MRC Conference on Partial Differential Equations, University of Wisconsin.
 Tutorial Lecture - IMA, University of Minnesota.
 Seminars at Université Paris VI, Toulouse, Imperial College, IMA Minneapolis.

Dr C E Beevers

Conference at Cambridge on 'Mathematics Teaching 1985'

Dr M van den Bergh

Stochastic Analysis Conference, University of Warwick.
 Mathematical Symposium Dublin Institute for Advanced Studies.
 Seminars at Dublin Institute for Advanced Studies, Universities of Edinburgh, Nottingham and Warwick.

Mr J Bree

Ninth Symposium on Thermophysical Properties, Boulder, Colorado.

Dr J Carr

Conference at Vrije Universiteit, Amsterdam.
 Seminar at Warwick University.

Dr J C Eilbeck

Conference on 'Computer Analysis for Life Science - Progress and Challenges in Biological and Synthetic Polymer Research', Okayama, Japan.
 Seminars at Departments of Physics - Kyoto and Tokyo Universities.
 Seminars at Mathematics Departments - Imperial College, Universities of Dundee and Strathclyde.

Miss E J Halton

British Mathematical Colloquium, Cambridge University.

Dr A A Lacey

Oxford Study Group with Industry meeting, Oxford.

Dr A R Prince

Several lectures at University of California, Santa Cruz.

Dr J Sivaloganathan

Seminars at Universities of Glasgow, and Minnesota.

Dr M A Youngson

Conference on 'Jordan algebras and applications to analysis operator theory and quantum mechanics', University of California at Irvine.

Conference on 'Jordan algebras', Oberwolfach, West Germany.
 Seminars at University of Oregon.

Professor J W Zabczyk

IFIP Conference, Budapest.
 Annual Meeting of the Polish Mathematical Society, Kielce.

Seminars at Centro Internazionale per Ricerca Matematica, Trento, Italy and University of Bremen, West Germany.

Research and other grants during the year ended 30 September 1985

- £120,000 from the Computer Board for 2 years from 1st October 1985 for Computer Aided Learning Project under the direction of Dr J C Eilbeck and Dr C E Beevers.
- £270 from the Royal Society to Dr J C Eilbeck for supplementary travel funds for a visit to Japan in July 1985.
- £4400 from the Science and Engineering Research Council, for Visiting Fellowship for Professor A C Scott, to undertake research with Dr J C Eilbeck.
- £17,500 from British Gas to support a Scholarship on reaction-diffusion systems, under the supervision of Dr J C Eilbeck.
- £1000 from U.S. Army for travel between Edinburgh and Madison, for Professor J M Ball's participation at an MRC conference, University of Wisconsin.
- £1300 from Science and Engineering Research Council, a visiting fellowship to Dr M Silhavy for one month to work on Phase Transitions with Dr C E Beevers.
- £35,410 from the Science and Engineering Research Council for three years from 1st October 1985 to give support for research associate working on the programme "Analytic and Computational Investigation of Reaction-Diffusion Equations", under the joint direction of Dr K J Brown and Dr J C Eilbeck.
- £20,800 from the Science and Engineering Research Council for an LMS symposium on "Non-classical continuum mechanics: abstract techniques and applications" in July 1986 under the direction of Professor R J Knops and Dr A A Lacey. (Grant administered by University of Durham).
- £1000 from the Royal Society for travel to Institute for Mathematics and its Applications, University of Minnesota to Dr J Sivaloganathan.
- £250 from Institute for Mathematics and its Applications, University of Minnesota, travel funds to Dr J Sivaloganathan for a visit in spring 1985.
- £660 from National Science Foundation for travel costs for Dr M A Youngson's participation in conference at the University of California at Irvine, July 1985.

PUBLICATIONS OCTOBER 1984 TO SEPTEMBER 1985.

Theses

- Jose-Angel Blat Gimeno Positive solutions of some systems of semilinear elliptic equations (PhD).
- Peter C Dunne Properties of solutions to some systems of reaction diffusion equations (PhD).
- Jeyabal Sivaloganathan Cavitation in nonlinear elasticity and associated problems. (PhD)
- Waadallah T Sulaiman Some classes of linear maps between C^* -algebras. (PhD)

Papers

- B Aupetit and M A YOUNGSON "On symmetry of Banach Jordan algebras", *Proc. Amer. Math. Soc.*, 1984, 91, 364-366.
- J M BALL "Differentiability properties of symmetric and isotropic functions", *Duke Math. J.* 1984, 51, 699-728.
- J M BALL "Material instabilities and the calculus of variations", in "Phase Transformations and Material Instabilities in Solids", ed. M. Gurtin, Academic Press, 1984, 1-19.
- J M BALL "Remarks on the paper 'Basic calculus of variations'", *Pacific J. Math.*, 1985, 116, 7-10.
- J M BALL and J E Marsden "Quasiconvexity at the boundary, positivity of the second variation and elastic stability", *Arch. Rat. Mech. Anal.*, 1984, 86, 251-277.
- J M BALL and F Murat "W^{1,p}-quasiconvexity and variational problems for multiple integrals", *J. Funct. Anal.*, 1984, 58, 225-253.
- C E BEEVERS "Motivating mechanics", *IMA J. of Teaching Math.*, 1985, 4, 52-57.
- C E BEEVERS "Some static problems for elastic bodies with a crust", *Mech.*, 1985, 20, 38-42.
- C E BEEVERS and R E Craine "Wave propagation in thermoelastic dielectrics", *J. de Mec. Theor. et Appliqn.*, 1985, 4, 159-172.
- M van den BERG, J T Lewis and P de Smedt "Condensation in the imperfect boson gas", *J. Statist. Phys.*, 1984, 37, 697-707.

- M van den BERG and J T Lewis
"Brownian motion on a hypersurface", *Bull Lond. Math. Soc.*, 1985, 17, 144-15.
- R Burley, G R MCGUIRE and P-C Wai
"Numerical simulation of an axial flow package dyeing machine", *Applied Mathematical Modelling*, 1985, 9, 33-39.
- J CARR and J C EILBECK
"Stability of stationary solutions of the discrete self-trapping equation", *Phys. Lett.*, 1985, 109A, 201-204.
- J CARR, M Gurtin and M Slemrod
"Structural phase transitions on a finite interval", *Arch. Rat. Mech. Anal.*, 1984, 86, 317-351.
- J CARR, M Gurtin and M Slemrod
"One-dimensional structured phase transformations under prescribed loads", *J. Elasticity*, 1985, 15, 133-142.
- B S G CHERRY
"The stochastic simulation of arctic temperature data", *Comp. Stat.* 1984, *Proceedings in Computational Statistics*, Physica-Verlag, Vienna.
- R J Duffin and G P KNOWLES
"Use of layered walls to reduce building temperature swings", *Solar Energy*, 1984, 33, 543-549.
- R J Duffin and G P KNOWLES
"A simple design method for the Trombe wall", *Solar Energy*, 1984, 34, 69-72.
- J C EILBECK, P S Lomdahl and A C Scott
"Soliton structure in crystalline acetanilide", *Phys. Rev. B.*, 1984, 30, 4703-4712.
- 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.*, 1985, 57, 861-866.
- J C EILBECK, P S Lomdahl and A C Scott
"Stationary solitons on finite lattices", *Proceedings of the III International Symposium on Selected Topics in Statistical Mechanics*, Dubna, USSR, 22-26 August 1984, 2, 328-339.
- J C EILBECK, P S Lomdahl and A C Scott
"The discrete self-trapping equation", *Physica D: Nonlinear Phenomena*, 1985, 16, 318-338.
- G P Galdi, R J KNOPS and S Rionero
"Asymptotic behaviour in the nonlinear elastic beam", *Arch. Rat. Mech. Anal.*, 1985, 87, 305-318.
- E J HALTON and W A Light
"Minimal projections in L_p -spaces", *Math. Proc. Cambridge Philos. Soc.*, 1985, 97, 127-136.
- E J HALTON and W A Light
"Projections on tensor product spaces", *Trans. Amer. Math. Soc.*, 1985, 287, 161-165.

- A A LACEY
"The form of blow-up for nonlinear parabolic equations", *Proc. Roy. Soc. Edinburgh Sect. A*, 1984, 98, 183-202.
- A A LACEY, J Aitchison and M Shillor
"A model for an electroplating process", *IMA JI. Appl. Math.*, 1984, 33, 17-31.
- A A LACEY, J G Burnell and G C Wake
"Steady-states of the reaction-diffusion equations, part III: Questions of multiplicity and uniqueness of solutions", *J. Aus. Math. Soc. B.*, 1985, 27, 88-110.
- P S Lomdahl, O H Olsen, J C EILBECK and M R Samuelsen
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"Pattern selection and low-dimensional chaos in the driven damped two-dimensional sine-Gordon equation", *J. Phys. C. (Solid State Physics)*, 1985, 18, L511-L517.
- J R PATADIA
"Local theorems for the absolute convergence of multiple lacunary Fourier series", *Math. Ann.*, 1985, 271, 81-89.
- A R PRINCE
"The commutative ring of a finite projective plane", *Proc. Roy. Soc. Edinburgh Sect. A*, 1985, 101, 57-59.
- D W REYNOLDS
"On the equipartition of energy in a linear viscoelastic body", *Q. Appl. Math.*, 1985, 42, 325-336.
- D W REYNOLDS
"On the linearised theory of buckling for a compressed viscoelastic rod", *Proc. Roy. Soc. Edinburgh*, 1985, 99A, 371-386.
- A C Scott, P S Lomdahl and J C EILBECK
"Between the local mode and normal mode limits", *Chem. Phys. Letts.*, 1985, 113, 29-36.
- W T SULAIMAN
"A moments proof of Er^2 ", *Math. Gaz.*, 1985, 69, 123-124.
- J ZABCZYK
"Stability under small perturbations", *Proceedings of the 3rd Bad Honer Conference on Stochastic Systems*, Bonn, 1985, 1985, 6 pages.
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"Stopping problems in stochastic control", *Proceedings of the International Congress of Mathematicians*, 1983, 1985, 1425-1437.

Reports submitted for publication

- J M BALL
"Minimizing sequences in thermomechanics", *Proc. of Conference on "Finite thermoelasticity"* Rome, June 1985.
- J M BALL
"Does rank-one convexity imply quasiconvexity?", *Proc. of Workshop on "Metastability and partial differential equations"*, IMA University of Minnesota.
- J M BALL, J CARR and O Penrose
"The Becker-Döring cluster equations; basic properties and asymptotic behaviour of solutions", *Comm. Math. Phys.*
- J M BALL and G P KNOWLES
"Lyapunov functions for thermomechanics with spatially varying boundary temperatures", *Arch. Rat. Mech. Anal.*
- J M BALL and V J Mizel
"One-dimensional variational problems whose minimizers do not satisfy the Euler-Lagrange equation", *Arch. Rat. Mech. Anal.*
- A R Bishop, J C EILBECK, I Satija and G Wysin
"Pattern Selection and Low-dimensional Chaos in Dissipative Many Degree-of-freedom Systems", *Proceedings of the AMS-SIAM Workshop on Nonlinear Partial Differential Equations*, Sante Fe, July 22 - August 3, 1984.
- M van den BERG
"On the asymptotics of the heat equation and bounds on traces associated with the Dirichlet Laplacian", *Journ. Func. Anal.*
- M van den BERG
"On a classical two-component plasma with a logarithmic interaction", *Proc. Royal Soc. Edinburgh A.*
- M van den BERG
"On traces associated with the Dirichlet Laplacian", *Journ. Math. Anal. and Applications.*
- M van den BERG, J T Lewis and M Lunn
"On the general theory of Bose-Einstein condensation II", *Helvetica Physica Acta.*
- C E BEEVERS
"Micros in Mechanics", *International Conference on Mathematical Modelling*, Exeter University, July 1985.
- C E BEEVERS and D E R CLARK
"The Micro-Revolution in Mathematical Education", *Workshop on Computer Based Teaching*, Cambridge University, September 1985.
- K J BROWN
"Non-trivial solutions of predator-prey equations with small diffusion",
- K J BROWN and J A BLAT
"A reaction-diffusion system modelling the spread of bacterial infections", *Math. Methods in the Applied Sciences.*
- K J BROWN and J A BLAT
"Global bifurcation of positive solutions in some systems of elliptic equations", *SIAM Journal on Mathematical Analysis.*

- J CARR, S A van Gils and J A Saunders
"Nonresonant bifurcations with symmetry".
- J CARR, S N Chow and J K Hale
"Abelian integrals and bifurcations", *J. Differential Equations.*
- A M DAVIE
"Singular minimisers in the calculus of variations",
- J C EILBECK
"Numerical simulations of the dynamics of polypeptide chains and proteins, Proceedings of the conference "Computer Analysis for Life Science - Progress and Challenges in Biological and Synthetic Polymer Research", July 9-12, 1985, Okayama, Japan.
- J C EILBECK and V S Manoranjan
"A comparison of basis functions for the pseudo-spectral method for a model reaction-diffusion problem", *J. Comp. Appl. Math.*
- G P Galdi, R J KNOPS and S Rionero
"Uniqueness and continuous dependence in the linear elastodynamic exterior and half-space problems", *Math. Proc. Camb. Phil. Soc.*
- E J HALTON and W A Light
"Minimal projections on bivariate function spaces", *Journal of Approximation Theory.*
- R H Hunter and G R MCGUIRE
"Bituminous materials cooling profiles", *J. of Ass. Pav. Tech.*
- R H Hunter and G R MCGUIRE
"A fast and efficient method for predicting cooling profiles in bituminous materials", *J. of Ass. Pav. Tech.*
- A A LACEY
"Design of a cathode for an electromachining process", *IMA Jl. Appl. Math.*
- A A LACEY
"Tool design for electrochemical machining in the presence of overpotentials", *IMA Jl. Appl. Math.*
- A A LACEY
"A limiting solution for an ill-posed membrane problem", *Proc. Roy. Soc. Edin. A.*
- G R MCGUIRE
"Simulation of oil reservoirs using the finite element method", *Teaching Maths and its Appl.*
- G Mazziotto, L Stettner, J Szpirglas and J ZABCZYK
"On impulse control with partial observation", *SIAM J. on Control.*
- A R PRINCE
"A commutative ring associated with any finite projective plane", *J. Algebra.*
- A R PRINCE
"Steiner triple systems of order 19 associated with a certain type of projective plane of order 10", *Periodica Mathematica Hungarica.*
- A R PRINCE
"Biplanes and Near Biplanes".

J SIVALOGANATHAN

"Uniqueness of regular and singular equilibria in radial elasticity".

J SIVALOGANATHAN

"A field theory approach to stability of radial equilibria in nonlinear elasticity", *Math. Proc. of Cambridge Phil. Soc.*

W T SULAIMAN

"On $\{V, \lambda\}_k$ summability factors of ultraspherical series", *Jñānābhā, 15*, (1985).

"On strong approximation to a function by its Jacobi series", *Jñānābhā, 15*, (1985).

"On $\{C, 1\}$ -summability of Laplace series".

J ZABCZYK

"Exit problem and control theory", *Systems and Control Letters*.

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