

# **OCIAM Report**

**2003-4**

---

## Oxford Centre for Industrial and Applied Mathematics

---

The aims of OCIAM are:

- To pursue collaborative research with industry and with other disciplines, in the widest sense.
- To pursue basic research in applied mathematics.
- To train graduates to work in applications of mathematics.
- To act as a focus for research and dissemination of information in Industrial and Applied Mathematics in the UK and to provide links with similar activities worldwide.

The means by which these aims are achieved include:

- Organizing and participating in regular workshops, industrial visits and study group meetings.
- Providing suitable teaching and other training for industrial and applied mathematicians via Masters Courses and short courses.
- Obtaining funding/support from research councils, industry, EC etc.
- Collaborating, along with many other universities, with the Smith Institute for Applied Mathematics and System Engineering.

---

## OCIAM 2003-4

---

### New Appointments

**Dr Jeff Dewynne** and **Dr Henrik Rasmussen** have both been appointed as part time lecturers on the part time MSc in Mathematical Finance. Jeff has a research position in Sydney and will spend 3 months here each year. Henrik has his own consulting company and will spend approximately two days per week in Oxford.

**Professor L Mahadevan** (Harvard) has been appointed **Schlumberger Visiting Professor** in Mathematics for 3 years. He will spend a few weeks in Oxford each summer.

Two new **Visiting Research Fellows** have been appointed:

**Dr Joyce Aitchison** has recently retired from RMCS Shrivenham, University of Cranfield and will be taking an active part in our industrial workshops and MSc programme.

**Mr Philip Bond** works for Brevan Howard and will be spending occasional days in Oxford collaborating on areas of common interest.

**Dr Tiina Roose** has been appointed to a **Royal Society University Research Fellowship** to work on multiscale modelling of biological branching structures.

---

## **STAFF 2003-2004**

---

<b>Director</b>	Dr S D Howison	
<b>Deputy Director</b>	Dr A C Fowler	
<b>Research Director</b>	Dr J R Ockendon	
<b>Faculty</b>	Professor S J Chapman Dr J N Dewynne Dr B M Hambly Dr P D Howell Dr I M Moroz Dr J Norbury Dr H Ockendon Dr W T Shaw	
<b>Senior Research Fellow</b>	Dr L A Smith	
<b>Royal Society Industry Fellow</b>	Dr C Farmer	
<b>Research Facilitator</b>	Dr C J W Beward	
<b>Post Doctoral Research Assistants</b>	Dr D Challet Dr P Dellar Dr G Kozyreff Dr P E McSharry	Dr M Tindall Dr T Roose Dr R Novokshanov Dr C Reisinger
<b>Nomura Senior Research Fellow</b>	Dr Robert Tompkins (Frankfurt)	
<b>Visiting Research Fellows</b>	Dr J Aitchison Mr P Bond (Brevan Howard) Dr G Sander (Loughborough University) Dr R Tew (Nottingham University) Dr D Prieul (Lehmen Bros) Dr J Andrews (Mindware Solutions)	Dr R Newman (speedtrap.com) Dr D Epstein (Arthur Andersen) Dr E Whalley (Warwick) Dr J Baz (Lehman Bros) Dr T Felici (Photon Design)
<b>Schlumberger Visiting Professor</b>	Professor L Mahadevan (Harvard)	

**Smith Institute:***Director*

Dr R A Leese

*Technology Translators*

Dr D J Allwright

Dr T Boxer

Dr M Brown

Dr H Tewkesbury

**Emeritus**

Professor J E Allen

Professor L Woods

---

**VISITORS 2003-4**

---

Professor Jack Booker	Cornell University
Professor Russell Caflisch	UCLA
Professor Ellis Cumberbatch	Claremont Graduate School
Professor Robert Dodd	San Jose University
Dr Mark McGuinness	Victoria University of Wellington,
Professor Alexander Korobkin	Lavrentyev Institute, Novosibirsk
Professor Michael Mackey	McGill University, Montreal
Dr Bruce Malamud	King's College, London
Professor Bryce Mcleod	University of Pittsburgh
Dr Dhanesh Patel	The Maharaja Sayajirao University of Baroda, India
Dr Raja Sekhar	Indian Institute of Technology, Kharagpur
Professor Ran Shenhong	Chinese Academy of Science, Beijing
Professor Ron Smith	Loughborough University

---

**JOURNALS**

---

**European Journal of Applied Mathematics****Editors in Chief:****Dr S D Howison, Prof A A Lacey, & Prof M J Ward**

This journal, founded in OCIAM in 1990, promotes publication of papers on mathematics applied to the real world.

**Applied Mathematical Finance****Editors in Chief:****Drs B Hambly and W T Shaw**

This journal aims to encourage novel and inventive ideas in financial mathematics.

**Members of editorial boards**

Hilary Ockendon	Mathematical Scientist, SIAM Review, Proceedings of Royal Society A
John Ockendon	Applied Mathematics Letters, Advances in Mathematical Sciences and Applications, European Journal of Applied Mathematics, Interfaces and Free Boundaries
Sam Howison	SIAM Journal of Applied Mathematics, Applied Mathematical Finance
Jon Chapman	SIAM Review, Quarterly Journal of Mechanics and Applied Mathematics
Ben Hambly	Bulletin, Journal and Proceedings of the London, Mathematical Society
Andrew Fowler	Journal of Geophysical Research (Solid Earth)
Graham Sander	Advances in Water Resources

---

## **DEGREES AWARDED 2003/4**

---

### **DPhil**

<b>Name</b>	<b>Supervisor</b>	<b>Thesis title</b>
James Bosson	S J Chapman J R Ockendon	Asymptotic Approaches to Oscillatory Eigenvalue Problems
Liam Clarke	L A Smith	Nonlinear Time Series Analysis of Data Streams
Andrew Grief	S D Howison S J Chapman	Modelling of Thin-Film Superconductors
David Mortimer	S J Chapman J R Ockendon	Exponential Aysmptotics and Stokes Lines in Partial Differential Equations
John Nolan	R A Leese	Frequency Assignment and Spectrum Trading for Radio Services

### **MSc in Applied and Computational Mathematics**

Nicola Ashbee	Coating Strategies for Virus Particles in Cancer Gene Therapy.
Stefano Giani	Magnus Series Methods for Differential Equations.
Wai Min Jason Goh	Mathematical Modelling of the Carding Machine.
Ioana Gradinescu	New Approaches to the Stochastic Minority Game.
Ben Heineike	Stochastic Epidemic Models Applied to Scrapie.
Peter Hirst	Cluster Analysis of Financial Securities (Royal Bank of Scotland).
Philip Hyde	An Experimental and Mathematical Modelling Study of Delivery of Chemotherapeutical Drugs to Solid Tumours.
Mayank Kanga	Sparse Grid Finite Element Methods.

Pantelis Kotzonis	Alternative Interest Rate models.
Apostolos Kourtis	The Adjoint Approach to Calculating Option Price Sensitivities.
Christian Schroeder	A Generalisation Moment Problem and its Application to Classification.
Martin Vu	Static Parameter Estimation in State Space Models (Royal Bank of Scotland).
Robin Wiseman	Fast Pricing Techniques for European Swaptions.
Rachel Zammett	The Formation & Evolution of Spiral Troughs in the Martian Polar Ice Cap.

Distinctions were awarded to Jason Goh, Peter Hirst, Robin Wiseman and Rachel Zammett.

### **MSc in Mathematical Modelling and Scientific Computing**

Shezhad Ashraf	Foam Filled Towed Sonar Arrays (Thales Underwater Systems).
James Blackman	Sparse Grid Solutions to the Libor Market Model.
Oliver Card	Examining Factors Responsible for Parasitoma Profiles of African Trypanosomes.
Kanika Dhyani	A Computational Investigation of a New Type of Polynomial Time Algorithm.
Alexander Fletcher	Modelling Transport Processes in Spinal Discs.
Nicolas Jeannequin	Modelling of Ionic Currents for Heart Cells.
Mohamed Sadok Lamine	Modelling a Sump Tail in Stratified Two Phase Flow (Schlumberger).
Thushka Maharaj	Transmission Dynamics of HIV.
James Murphy	Extracting Structure from Haplotype Data.
Daniel Okuonghae	Applications of h- and p-Adaptive Discontinuous Galerkin F E Methods to the Rotating Disk Electrode Problem in Electrochemistry.
Sofia Rafailidou	A Multi-species Model of the Impacts of Climate Change.
Matthew Shirley	The Pricing of Discretely Sampled Options
Kavithan Siva	Continuous Auction Market Models (Goldman Sachs)
Julie Spruyt	The Normalised Cut Algorithm for Data Clustering
Paul Walsh	Short Rate Models: Trinomial Trees
Francis Woolfe	Motion-Based Dynamic Texture Recognition.

A distinction was awarded to Nicolas Jeannequin, who was also awarded the Nuclear Electric Prize.

---

## **LECTURES**

---

The Smith Institute  
Prof L. Mahadevan (Harvard)  
[Geometry and Physics of Packing and Unpacking, from DNA to Origami](#)  
24th November 2003, St Catherine's College, Oxford.

Third Nomura Lecture  
Prof P. Embrechts (ETH-Zürich)  
[From Dutch Dykes to Value-at-Risk: Extreme Value Theory and Copulae as Risk Management Tools](#)  
27th April 2004, Martin Wood Lecture Theatre, Clarendon Laboratory

---

## BOOKS AND REVIEWS

---

### *Waves and Compressible Flow*

Hilary Ockendon and John R. Ockendon,  
Texts in Applied Mathematics, **47** Springer-Verlag USA (2004).

### *Geological Modeling and Reservoir Simulation*

C. L. Farmer,  
in Mathematical Methods and Modelling in Hydrocarbon Exploration and Production,  
Armin Iske and Trygve Randen, Springer –Verlag, Heidelberg (2004),

---

## OCIAM RESEARCH REPORTS 2003-2004

---

These are papers that have been added to the list during the academic year 2003-2004. Some of them have already appeared and the others have been accepted for publication.

- 403 Nonlinear Coupling Between Modes in a Low-Dimensional Model of ENSO,  
M. S. Roulston and J. D. Neelin,  
*Atmos. Ocean.* **41**, 217-231 (2003).
- 404 Temporal and spatial patterns of the interannual variability of total ozone in the tropics,  
C. D. Camp., M. S. Roulston and Y. L. Yung,  
*J. Geophys. Res-Atmos.* **108**, 6-17 (2003).
- 405 Free boundary problems in the steel industry,  
A. D. Fitt., J. R. Ockendon. and C. P. Please,  
*Chinese J. Eng. Maths.* **21**, (2004)
- 406 Persistence of memory in drop break-up: the breakdown of universality,  
P. Doshi, I. Cohen, W. Zhang, M. Siegel, P. Howell, O. Basaran and S. Nagel,  
*Science Magazine.* **302**, 1185-1188 (2003).
- 407 Optimisation of hydrophone placement: a dynamical systems approach,  
D. A. Wood and D. J. Allwright,  
*Euro. J. Applied Mathematics* **14**, 1-18 (2003).

- 408 Circulation in inviscid gas flows with shocks,  
D. J. Allwright and K. Kaouri,  
*App. Math. Lett.* **17**, 767-770 (2004).
- 409 On the rheology of till,  
A.C. Fowler,  
*Ann. Glaciol.* **37**, 55-59 (2003).
- 410 A model for water uptake by plant roots,  
T. Roose, A.C. Fowler,  
*J.Theoretical Biology* 228, **2**, 155-171 (2004).
- 411 A mathematical model for water and nutrient uptake by plant root systems,  
T. Roose, A.C. Fowler,  
*J. Theoretical Biology* 228, **2**, 173-184 (2004).
- 412 Field probe for low-pressure capacitively coupled radio-frequency, discharge plasmas.  
A.Dyson, J.E. Allen,  
*Meas. Sci. Technol.* **14**, 107-113 (2003).
- 413 On the Earth's magnetic field and the Hall effect,  
J.E. Allen,  
*Nonlinear Processes in Geophysics* **10**, 437-440 (2003).
- 414 Diffusion processes on fractal fields: heat kernel estimates and large deviations,  
B.M. Hambly and T. Kumagai,  
*Probab. Theory and Related Fields* **127**, 305-352 (2003).
- 415 Law of the iterated logarithm for oscillating random walks conditioned to stay positive,  
B.M. Hambly, G. Kersting and A.E. Kyprianou,  
*Stoch. Proc. Applic.* **108**, 327-343 (2003).
- 416 Thick and thin points for random recursive fractals,  
B.M. Hambly and O.D. Jones,  
*Adv. Appl. Probab.* **35**, 251-277 (2003).
- 417 Finitely ramified graph directed fractals, spectral asymptotics and the multidimensional renewal theorem,  
B.M. Hambly and S.O. Nyberg,  
*Proc. Edin. Math. Soc.* **46**, 1-34 (2003).
- 418 A note on the Bohm criterion for electronegative gases,  
J.E. Allen,  
*Plasma Sources Science and Technology*, **13**, 48-49 (2004).
- 419 Monte Carlo methods for the valuation of multiple exercise options,

- N. Meinshausen and B.M. Hambly.  
*Math. Finance* **14**, 557-583 (2004).
- 420 Random fractal strings: their zeta functions, complex dimensions,  
and spectral asymptotics,  
B.M. Hambly and M.L. Lapidus,  
*Trans. Amer. Math. Soc.* (2004)
- 421 The extended Malkus-Robbins dynamo with a nonlinear motor,  
I.M. Moroz,  
*Int. J. of Bifurcat. Chaos* **14**, 2885—2892 (2004).
- 422 \*\*\*\*\*
- 423 Selection of Saffman-Taylor fingers by small kinetic under-cooling,  
S.J. Chapman,  
*J.Eng.Math* **46**, 1-32 (2003).
- 424 A hierarchy of models for superconducting thin films,  
S.J. Chapman,  
*SIAM J.Appl.Math.* **63**, 2087-2127 (2003).
- 425 Wave packet pseudomodes of twisted Toeplitz matrices,  
L.N. Trefethen, S.J. Chapman,  
*Comm. Pure Appl. Math.* **57**,1233-1264 (2004).
- 426 Prediction of epileptic seizures:are nonlinear methods relevant?  
P.E. McSharry, L.A. Smith, L.Tarassenko,  
*Nature Medicine* **9**, 241-242 (2003).
- 427 Comparison of predictability of epileptic seizures by a linear and a nonlinear method,  
P.E. McSharry, L.A. Smith, L. Tarassenko,  
*IEEE Transactions on Biomedical Engineering* **50**, 628-633 (2003).
- 428 Consistent nonlinear dynamics:identifying model inadequacy,  
P.E. McSharry, L.A. Smith,  
*Physica D* **192**, 1-22(2004).
- 429 Asymptotic angular stability in non-linear systems: rotation numbers and winding numbers,  
P.E. McSharry, Paulo R.C. Ruffino,  
*Dynamical Systems* **18**, 191-200(2003).
- 430 Quenching Lorenzian chaos,  
R.Hide, P.E. McSharry, C.C. Finlay, G.D. Peskett,  
*Int. J. of Bifurcat. Chaos* **14**, 2875-2884(2004).
- 431 Delay differential equations for mode-locked semiconductor lasers,  
A.G. Vladimirov, D. Turaev, G. Kozyreff,

- Optics Letters*. **29**, 1221-1223(2004).
- 432 Inertial Levitation,  
A.D. Fitt, G. Kozyreff, J.R. Ockendon,  
*Journal of Fluid Mechanics* **508**, 165-174 (2004).
- 433 Towards coherent estimation of correlation dimension,  
A. Guerrero, L.A. Smith,  
*Physics Letts.A*. **318**, 373-379 (2003).
- 434 Quasi-two-dimensional liquid metal magnetohydrodynamics and the anticipated vorticity method,  
P.Dellar.  
*J.Fluid.Mech.* (2004)
- 435 Optical patterns with different wavelengths,  
G.Kozyreff,  
*Physical Review E* **69**, 066202 (2004).
- 436 Solution of the kinematic wave equation with an accelerating point source,  
K. Kaouri,  
*Wave Motion* (2004).
- 437 Modeling dimethylsulfide production in the upper ocean  
R.Cropp, J Norbury, A. Gabric and R.Braddock,  
*Global Biogeochem Cycles* **18**, 1-21 (2004).
- 438 The Malkus-Robbins Dynamo with a Nonlinear Series Motor,  
I.M.Moroz,  
*Int. J. of Bifurcat. Chaos* **14**, 2885-2892 (2004).
- 439 Computation of Capillary Surfaces for the Laplace-Young Equation,  
C.F. Scott, G.C.Sander, J.Norbury,  
*Quarterly Journal of Mechanics and Applied Mathematics* (2004).
- 440 Corner solutions of the Laplace-Young equation,  
J.Norbury, G.C.Sander, C.F.Scott,  
*Quarterly Journal of Mechanics and Applied Mathematics* (2004).
- 441 Chaotic Root-Finding for a Small Class of Polynomials,  
M.Little, D.Heesch,  
*Journal of Difference Equations and Applications*, **10**, 949-953, (2004).
- 442 Stylized facts in minority games with memory: a new challenge  
D.Challet, M. Marsili, A.De Martino,  
*Physica A* **338**, 143-150 (2004).
- 443 Minority mechanisms in models of agents learning collectively at a resource level,

- D.Challet,  
*Physica A* **334**, 24-29 (2004).
- 444 Optimal static and dynamic recycling of defective binary devices,  
D.Challet, I.P. Castillo,  
*J. Stat.: Th. Exp*, (2004)
- 445 The floating potential of spherical probes and dust grains. II: Orbital motion theory,  
R.V. Kennedy, J.E. Allen,  
*J. Plasma Physics* **69**, 485-506 (2003).
- 446 Some Researches in Plasma Physics,  
J.E.Allen,  
*Plasma Phys.* **44**, 371-381, (2004).
- 447 The fragmentation of wires by pulsed currents: beyond the first fracture,  
D.P.Wall, J.E. Allen, S. Molokov,  
*J.Phys.D:Appl.Phys.* **36**, 2757-2766 (2003).
- 448 Bistability between different localized structures in nonlinear optics,  
U.Bortolozzo, L.Patur, P.L. Ramazza, M.Tlidi, G.Kozyreff,  
*Physical Review Letters* (2004).
- 449 Intermittency in the transition to turbulence,  
A.C Fowler and P.D. Howell,  
*SIAM J. Appl. Math.* **63**, 1184-1207 (2003)
- 450 Rheology of subglacial till,  
A.C Fowler,  
*J. Glaciol.* **48**, 631-632 (2003).
- 451 Periodic breathing at high altitude,  
A.C Fowler and G.P. Kalamangalam,  
*IMA J. Appl. Math. Med. Biol.* **19**, 293-313 (2003)
- 452 Lithospheric failure on Venus.  
A.C Fowler and S.B.G. O'Brien  
*Proc. R. Soc. A***459**, 2663-2704 (2003).
- 453 Dissolution/precipitation mechanisms for diagenesis in sedimentary basins.  
A.C Fowler and Xinshe Yang.  
*J. Geophys. Res.* **108**, 1-14, (2003).
- 454 A continuum model for entangled fibres  
M.E. Lee and H Ockendon  
*Euro. J. Appl. Math.* (2004)
- 455 Asymptotic approximation of eigenvalues of vector equations,

S,J Chapman & D. Salazar,  
*Europ. J. Appl. Math* (2004).

- 456 Recovering holomorphic functions from their real or imaginary parts without the Cauchy-Riemann equations.  
W. Shaw  
*Siam Review*, **46**, 717-728 (2004)
- 457 Global existence, singular solutions, and ill-posedness for the Muskat problem  
M. Siegel, R. Caflisch, and S. Howison,  
*Comm. Pure. Appl Maths*, **57**. 1-38 (2004)
- 458 Straining flow of a micellar surfactant solution  
C.J.W Breward and P.D. Howell,  
*Euro. J. Appl Math* (2004)

## **EPSRC**

### **CASE Studentships**

Macroscopic models of unstable flow through porous media (Schlumberger) (JR Ockendon and SD Howison)	£67,456
Mathematical modelling of polymer-surfactant mixtures (CCLRC, RAL) ( PD Howell and CJW Breward)	£67,456
Optimisation of portfolio-related functions with parameter uncertainty and complex constraints (Nomura) (WT Shaw)	£67,456
Models of order-book markets, from discrete to continuous time (Deutsche Bank) (SD Howison)	£67,456

## **BBSRC**

Understanding modification of biological surfaces using polymer coating: Mathematical and Experimental models (SJ Chapman)	£97,099
--	---------

## **Royal Society**

India-UK science network (JR Ockendon)	£3,500
---	--------

## **UKAEA Culham**

Simulation of solid surface behaviour exposed to fusion (support for A. Caloutsis)	£16,000
---	---------

## **MSc Sponsorship**

Schlumberger Cambridge Research	£5,000
Thales Underwater Systems	£5,000
Royal Bank of Scotland	£5,000
Goldman Sachs	£5,000

---

## OCIAM WORKSHOPS 2003-2004

---

### Michaelmas Term 2003

17 October	Dr Angus Wilkinson (Materials)	Dislocation patterning in fatigue
24 October	Dr Duncan Wingham (UCL)	Ice sheets and grounding lines
24 October	Dr Kerry Fisher (Clinical Pharmacology)	Polymer modified adenovirus for gene delivery
31 October	Dr Peter Griffiths (Physiology)	Time-resolved X-ray diffraction studies of the mechanism of the molecular motor myosin
7 November	Prof. Edmund Rolls (Center for Computational Neuroscience)	Computational Neuroscience
14 November	Dr. Jill Urban, (Physiology)	Transport Processes in Spinal Discs
5 December	Dr Rosie Halles (Centre for Ecology and Hydrology)	The ecology and dynamics of insect baculoviruses

### Hilary Term 2004

6th February	Jeff Price and Neil Irving (Unilever, Port Sunlight)	Unilever Problems
13th February	Dr Pedro Jordan (U.S Naval Research Academy)	Waves in porous media
20th February	Prof J Armitage (Biochemistry)	How did that get there? Signalling in bacterial chemotaxis
5th March	Prof Z Cui (Chemical Engineering)	Cryopreservation of Living Cells and Tissues I
12th March	Dr R Voskoboynikov (OCIAM)	Dislocations and other defects
19th March	Dr Marchant and Dr Lark (Silsoe Research Institute)	Risk assessment methods in bioremediation
16 <sup>th</sup> April	Prof Z Cui	Cryopreservation of living cells II

## Trinity Term 2004

23 <sup>rd</sup> April	Mr. Adrian Casey (National Hospital for Neurology and Neurosurgery)	Syringomyelia - An interesting problem in spinal fluids
30 <sup>th</sup> April	T.R. Field (QinetiQ, Malvern) and R.J.A. Tough (T.W. Research)	Anomaly detection in a non-Gaussian noise background: a diffusive model based approach
14 <sup>th</sup> May	Prof C Gilligan (Cambridge)	Pathogens and Plants
21 <sup>st</sup> May	Prof P Probert-Smith (Engineering)	Bubbles and ultrasound: some applications in baking and medicine
28 <sup>th</sup> May	Dr P Buckley (Engineering)	Physical ageing and rejuvenation of glassy polymers
4 <sup>th</sup> June	Dr Y Buckley (NERC Centre for Population Biology, UCL)	The spread of invasive pines over complex landscapes: wave speed and wind dispersal
18 <sup>th</sup> June	Dr B Holtzman and (University of Minnesota) Prof P England (Earth Sciences)	Melt bands and plastic flow
2 <sup>nd</sup> July	Giles Wiggs (Sheffield)	Aeolian formation of sand dunes
15 <sup>th</sup> July	Prof C Gilligan (Cambridge)	Spatio-Temporal Models in Epidemiology
23 <sup>rd</sup> July	Dr Bernard Rapson (Platform Designs)	Capillary Agglutination Technology

