

ENVIRONMENTAL HAZARDS

The Fluid Dynamics and Geophysics of Extreme Events



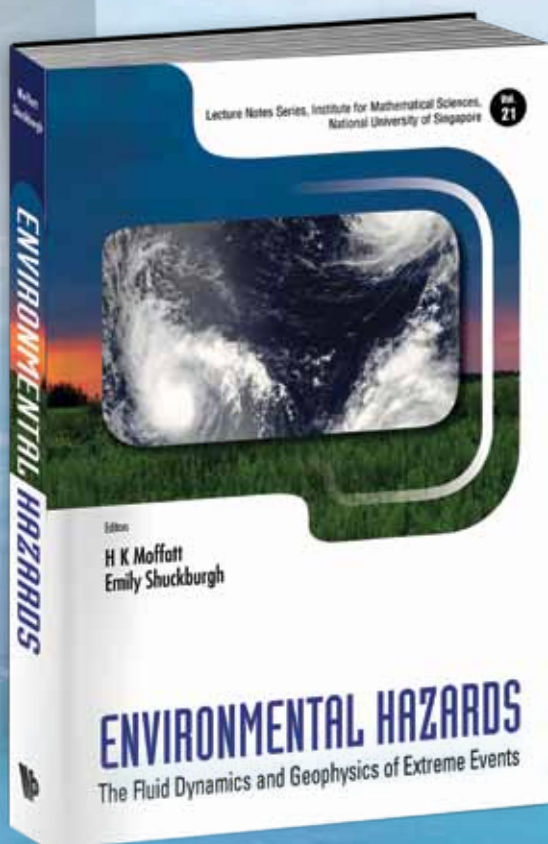
Vol. 21

Lecture Notes Series, Institute For Mathematical Sciences,
National University Of Singapore

edited by

H K Moffatt, FRS Cambridge

Emily Shuckburgh British Antarctic Survey, Cambridge



One of the priority areas of ICSU (The International Council for Science) is "Natural and Human-Induced Environmental Hazards and Disasters". The School — held at the Institute for Mathematical Sciences, Singapore from 20 April to 2 May 2009 — on which this volume is based on was sponsored by ICSU and by its members from IUTAM (the International Union of Theoretical and Applied Mechanics) and IUGG (the International Union of Geodesy and Geophysics). The book provides an in-depth graduate-level introduction to the fluid dynamics and geophysics of hazards such as tropical cyclones, flooding, atmospheric pollution and tsunamis. It also includes discussion of the possible effects of climate change on these phenomena. Indeed, the current importance of this area is of great public concern.

Contents: Elements of Vortex Dynamics and Turbulence (*H K Moffatt*); Geophysical and Environmental Fluid Mechanics (*P Linden & T Y Koh*); Extreme Rain and Wind Storms in Mid-Latitudes (*G Tetzlaff*); Hydro-Meteorological and Environmental Disasters (*A W Jayawardena*); Tropical Cyclones (*K Emanuel*); Tsunamis (*P Tkalich*); Dynamics of the Indian and Pacific Oceans (*S Behera*); Transport of Pollutants in the Atmosphere (*P Haynes*); Aspects of Climate Change (*E Shuckburgh*).

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About the Editors

H K Moffatt

Born and bred in Edinburgh, Professor Keith Moffatt FRS received his PhD on the subject Magnetohydrodynamic Turbulence, under the supervision of George Batchelor in 1962 from Trinity College, Cambridge. He was elected Fellow of the Royal Society in 1986, and has since been elected Foreign Member of the Royal Netherlands and French Academies. In October 1996, he was appointed as Director of the Isaac Newton Institute for Mathematical Sciences in Cambridge. His research interests lie within the broad field of fluid dynamics, particularly in magnetohydrodynamics and the theory of turbulence.

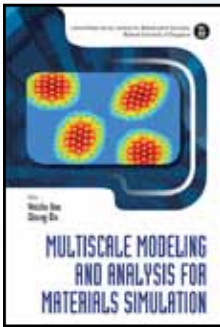


Emily Shuckburgh

Dr Emily Shuckburgh, received her PhD in Atmospheric Dynamics from Cambridge University in 1999, leads the Open Oceans research group at the British Antarctic Survey. She is a climate scientist who has worked at École Normale Supérieure in Paris, MIT and University of Cambridge. Her personal research concerns atmosphere and ocean dynamics and she is currently focusing on understanding the circulation of the Southern Ocean around Antarctica. She is a fellow of the Royal Meteorological Society and presently chair of their scientific publications committee. She is also a fellow of Darwin College, Cambridge.



:: Forthcoming



Vol. 22

MULTISCALE MODELING AND ANALYSIS FOR MATERIALS SIMULATION

edited by **Weizhu Bao** (National University of Singapore) & **Qiang Du** (Pennsylvania State University)

The Institute for Mathematical Sciences at the National University of Singapore hosted a two-month research program on "Mathematical Theory and Numerical Methods for Computational Materials Simulation and Design" from 1 July to 31 August 2009. As an important part of the program, tutorials and special lectures were given by leading experts in the fields for participating graduate students and junior researchers.

This invaluable volume collects four expanded lecture notes with self-contained tutorials. They cover a number of aspects on multiscale modeling, analysis and simulations for problems arising from materials science including some critical components in computational prediction of materials properties such as the multiscale properties of complex materials, properties of defects, interfaces and material microstructures under different conditions, critical issues in developing efficient numerical methods and analytic frameworks for complex and multiscale materials models.

280pp Sep 2011
978-981-4360-89-0 US\$90 £59
978-981-4360-90-6(ebook) US\$117

Vol. 20

MATHEMATICAL HORIZONS FOR QUANTUM PHYSICS

edited by **Huzihiro Araki** (Kyoto University, Japan), **Berthold-Georg Englert** (Centre for Quantum Technologies, National University of Singapore), **Leong-Chuan Kwek** (Centre for Quantum Technologies, National University of Singapore & Nanyang Technological University, Singapore), & **Jun Suzuki** (National Institute of Informatics, Japan)

Quantum theory is one of the most important intellectual developments in the early twentieth century. The confluence of mathematics and quantum physics emerged arguably from Von Neumann's seminal work on the spectral theory of linear operators. This volume arose from a two-month workshop held at the Institute for Mathematical Sciences at the National University of Singapore in July–September 2008 on mathematical physics, focusing specifically on operator algebras in quantum theory.

220pp Jun 2010
978-981-4313-31-5 US\$81 £56
978-981-4313-32-2(ebook) US\$105

Vol. 19

BRAIDS Introductory Lectures on Braids, Configurations and Their Applications

edited by **A Jon Berrick** (National University of Singapore), **Frederick R Cohen** (University of Rochester, USA), **Elizabeth Hanbury** (National University of Singapore & Durham University, UK), **Yan-Loi Wong**, & **Jie Wu** (National University of Singapore)

"The approach to the theory is different from what can be found in the classical literature, which makes this book especially interesting... this book is rich and diverse. It can serve as a textbook to learn the theory, but is also a good complement to the existing classical books on the subject."

Luis Paris, Professor
Université de Bourgogne, France

This book is an indispensable guide for anyone seeking to familiarize themselves with research in braid groups, configuration spaces and their applications. Starting at the beginning, and assuming only basic topology and group theory, the volume's noted expositors take the reader through the fundamental theory and on to current research and applications in fields as varied as astrophysics, cryptography and robotics.

416pp Dec 2009
978-981-4291-40-8 US\$125 £83
978-981-4291-41-5(ebook) US\$163

Vol. 18



RANDOM MATRIX THEORY AND ITS APPLICATIONS Multivariate Statistics and Wireless Communications

edited by **Zhidong Bai** (National University of Singapore & Northeast Normal University, China), **Yang Chen** (Imperial College London, UK), & **Ying-Chang Liang** (Institute for Infocomm Research, Singapore)

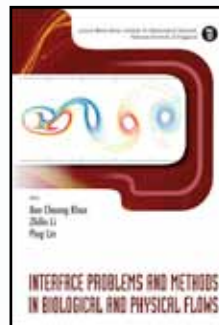
Random matrix theory has a long history, beginning in the first instance in multivariate statistics. It was used by Wigner to supply explanations for the important regularity features of the apparently random dispositions of the energy levels of heavy nuclei. The subject was further deeply developed under the important leadership of Dyson, Gaudin and Mehta, and other mathematical physicists. In the early 1990s, random matrix theory witnessed applications in string theory and deep connections with operator theory, and the integrable systems were established by Tracy and Widom. More recently, the subject has seen applications in such diverse areas as large dimensional data analysis and wireless communications.

This volume contains chapters written by the leading participants in the field which will serve as a valuable introduction into this very exciting area of research.

Contents: The Stieltjes Transform and Its Role in Eigenvalue Behavior of Large Dimensional Random Matrices (*J W Silverstein*); Beta Random Matrix Ensembles (*P J Forrester*); Future of Statistics (*Z-D Bai & S-R Zheng*); The η and Shannon Transforms: A Bridge between Random Matrices and Wireless Communications (*A M Tulino*); The Replica Method in Multiuser Communications (*R R Müller*).

176pp Jul 2009
978-981-4273-11-4 US\$87 £57
978-981-4273-12-1(ebook) US\$113

Vol. 17



INTERFACE PROBLEMS AND METHODS IN BIOLOGICAL AND PHYSICAL FLOWS

edited by **Boo Cheong Khoo** (National University of Singapore), **Zhilin Li** (North Carolina State University, USA), & **Ping Lin** (National University of Singapore & University of Dundee, UK)

This volume showcases lecture notes collected from tutorials presented at the Workshop on Moving Interface Problems and Applications in Fluid Dynamics that was held between January 8 and March 31, 2007 at the Institute for Mathematical Sciences, National University of Singapore. As part of the program, these tutorials were conducted by specialists within their respective areas such as Robert Dillon, Zhilin Li, John Lowengrub, Frank Lu and Gretar Tryggvason.

The topics in the program encompass modeling and simulations of biological flow coupled to deformable tissue/elastic structure, shock wave and bubble dynamics and various applications like biological treatments with experimental verification, multi-medium flow or multiphase flow and various applications including cavitation/supercavitation, detonation problems, Newtonian and non-Newtonian fluid, and many other areas.

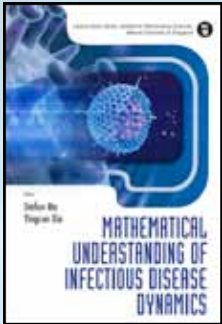
This volume benefits graduate students and researchers keen in the field of interfacial flows for application to physical and biological systems. Even beginners will find this volume a very useful starting point with many relevant references applicable.

188pp May 2009
978-981-283-784-4 US\$87 £57
978-981-283-785-1(ebook) US\$113

Vol. 16

MATHEMATICAL UNDERSTANDING OF INFECTIOUS DISEASE DYNAMICS

edited by **Stefan Ma** (Ministry of Health Singapore) & **Yingcun Xia** (National University of Singapore)



The Institute for Mathematical Sciences at the National University of Singapore hosted a research program on *Mathematical Modeling of Infectious Diseases: Dynamics and Control* from 15 August to 9 October 2005. As part of the program, tutorials for graduate students and junior researchers were given by leading experts in the field.

This invaluable volume is a collection of three expanded lecture notes of those tutorials which cover a wide range of topics including basic mathematical details for various epidemic models, statistical distribution theory, and applications with real-life examples with implications for health policy makers.

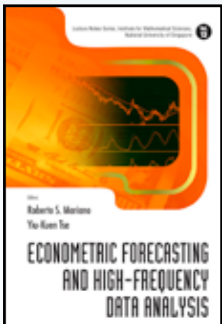
Contents: The Basic Epidemiology Models: Models, Expressions for R_0 , Parameter Estimation, and Applications (*H W Hethcote*); Epidemiology Models with Variable Population Size (*H W Hethcote*); Age-Structured Epidemiology Models and Expressions for R_0 (*H W Hethcote*); Clinical and Public Health Applications of Mathematical Models (*J W Glasser*); Non-Identifiables and Invariant Quantities in Infectious Disease Models (*P Yan*).

240pp Dec 2008
978-981-283-482-9 US\$108 £72
978-981-283-483-6(ebook) US\$140

Vol. 13

ECONOMETRIC FORECASTING AND HIGH-FREQUENCY DATA ANALYSIS

edited by **Roberto S Mariano** (Singapore Management University, Singapore) & **Yiu-Kuen Tse** (University of Pennsylvania, USA)



This important book consists of surveys of high-frequency financial data analysis and econometric forecasting, written by pioneers in these areas including Nobel laureate Lawrence Klein. Some of the chapters were presented as tutorials to an audience in the Econometric Forecasting and High-Frequency Data Analysis Workshop at the Institute for Mathematical Science, National University of Singapore in May 2006. They will be of interest to researchers working in macroeconometrics as well as financial econometrics. Moreover, readers will find these chapters useful as a guide to the literature as well as suggestions for future research.

Contents: Forecasting Uncertainty, Its Representation and Evaluation (*K F Wallis*); The University of Pennsylvania Models for High-Frequency Macroeconomic Modeling (*L R Klein & S Ozmuur*); Forecasting Seasonal Time Series (*P H Franses*); Car and Affine Processes (*C Gourieroux*); Multivariate Time Series Analysis and Forecasting (*M Deistler*).

200pp Mar 2008
978-981-277-895-6 US\$118 £78
978-981-277-896-3(ebook) US\$153

COMPUTATIONAL PROSPECTS OF INFINITY

edited by **Chitat Chong** (National University of Singapore), **Qi Feng** (Chinese Academy of Sciences, China & National University of Singapore), **Theodore A Slaman**, **W Hugh Woodin** (University of California, Berkeley, USA), & **Yue Yang** (National University of Singapore)



Vol. 14

Part I: Tutorials

This volume presents the written versions of the tutorial lectures given at the *Workshop on Computational Prospects of Infinity*, held from 18 June to 15 August 2005 at the Institute for Mathematical Sciences, National University of Singapore. It consists of articles by four of the leading experts in recursion theory (computability theory) and set theory. The survey paper of Rod Downey provides a comprehensive introduction to algorithmic

randomness, one of the most active areas of current research in recursion theory. Theodore A Slaman's article is the first printed account of the ground-breaking work of Slaman–Woodin and Slaman–Shore on the definability of the Turing jump. John Steel presents some results on the properties of derived models of mice, and on the existence of mice with large derived models. The study was motivated by some of the well-known Holy Grails in inner model theory, including the Mouse Set Conjecture. In his presentation, W Hugh Woodin gives an outline of an expanded version (unpublished) on suitable extender sequences, a subject that was developed in the attempt to understand inner model theory for large cardinals beyond the level of superstrong cardinals.

The volume serves as a useful guide for graduate students and researchers in recursion theory and set theory to some of the most important and significant developments in these subjects in recent years.

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978-981-279-405-5(ebook) US\$178

Vol. 15

Part II: Presented Talks

This volume is a collection of written versions of the talks given at the *Workshop on Computational Prospects of Infinity*, held at the Institute for Mathematical Sciences from 18 June to 15 August 2005. It consists of contributions from many of the leading experts in recursion theory (computability theory) and set theory. Topics covered include the structure theory of various notions of degrees of unsolvability, algorithmic randomness, reverse mathematics, forcing, large cardinals and inner model theory, and many others.

Contents: Prompt Simplicity, Array Computability and Cupping (*R Downey et al.*); A Simpler Short Extenders Forcing — Gap 3 (*M Gitik*); The Strength of Some Combinatorial Principles Related to Ramsey's Theorem for Pairs (*D R Hirschfeldt et al.*); Absoluteness for Universally Baire Sets and the Uncountable II (*I Farah et al.*); Modaic Definability of Ordinals (*I Neeman*); Eliminating Concepts (*A Nies*); Rigidity and Biinterpretability in the Hyperdegrees (*R A Shore*); Some Fundamentals Issues Concerning Degrees or Unsolvability (*S G Simpson*); A tt Version of the Posner–Robinson Theorem (*W H Woodin*); and other papers.

432pp Jun 2008
978-981-279-654-7 US\$170 £112
978-981-279-655-4(ebook) US\$221

