

Preface

This book collects together a selection of refereed expository articles and original research papers which stem from the Workshop on Hyperbolic Conservation Laws and Related Analysis with Applications hosted at the International Centre for Mathematical Sciences (ICMS), Edinburgh, UK, on September 19–23, 2011. There were 28 plenary lectures given by 24 distinguished mathematicians, including three introductory crash courses which surveyed and summarized the state of the art in the area of hyperbolic conservation laws and its important applications/connections to other areas, 18 research lectures which presented some recent important results, and 1 public lecture entitled *What Can Mathematics Say about Liquid Crystals?* delivered by Prof. Sir John Ball (Oxford). Most of the papers appearing in this book are authored by the leading mathematicians who spoke at the workshop.

Thirteen papers comprise this work, representing a cross section of the most significant recent advances and current directions in nonlinear hyperbolic conservation laws and related analysis with applications. The general theory of hyperbolic conservation laws emerged just 50 years ago, even though the seeds of the field were originally planted in the eighteenth and nineteenth centuries, especially by the leading scientists of the times: Euler, Cauchy, Poisson, Challis, Stokes, Rayleigh, Kelvin, Riemann, Clausius, Rankine, Hugoniot, and Mach, among many others. In recent years, the field has experienced a vigorous growth, and the research is marching on at a brisk pace.

This book presents a survey of recent analytical and numerical advances, as well as phenomena and theories likely to be important for future developments in the field, through discussing fundamental mathematical problems in nonlinear hyperbolic conservation laws arising in fluid mechanics, elasticity, solid mechanics, and differential geometry, including questions of existence, uniqueness, regularity, formation of singularities, and asymptotic behaviour of solutions. It contains two introductory papers:

- *Multi-dimensional Systems of Conservation Laws: an Introductory Lecture*
by Denis Serre

- *The Nash-Moser Iteration Technique with Application to Characteristic Free-Boundary Problems*
by Ben Stevens

In addition, the book's contributions offer two other perspectives:

Papers on the general analytical treatment of the theory and related analysis. These include:

- *The Semigroup Approach to Conservation Laws with Discontinuous Flux*
by Boris Andreianov
- *SBV Regularity Results for Solutions to 1D Conservation Laws*
by Laura Caravenna
- *Existence and Stability of Global Solutions of Shock Diffraction by Wedges for Potential Flow*
by Gui-Qiang G. Chen & Wei Xiang
- *Some Well-Posedness Results for the Ostrovsky-Hunter Equation*
by Giuseppe Maria Coclite, Lorenzo di Ruvo & Kenneth Karlsen
- *Divergence-Measure Fields on Domains with Lipschitz Boundary*
by Hermano Frid

Papers on applications originating from significant realistic mathematical models of natural phenomena. These include:

- *On Numerical Methods for Hyperbolic Conservation Laws and Related Equations Modelling Sedimentation of Solid-Liquid Suspensions*
by Fernando Betancourt, Raimund Bürger, Ricardo Ruiz-Baier, Héctor Torres & Carlos A. Vega
- *A Generalized Buckley-Leverett System*
by Nikolai Chemetov & Wladimir Neves
- *The Quasineutral Limit for the Navier-Stokes-Fourier-Poisson System*
by Donatella & Pierangelo Marcati
- *On Strong Local Alignment in the Kinetic Cucker-Smale Model*
by Trygve K. Karper, Antoine Mellet & Konstantina Trivisa

Also included are articles that bridge the gap between these two perspectives, seeking synergetic links between theory, analysis, and applications:

- *Entropy, Elasticity, and the Isometric Embedding Problem: $M^3 \rightarrow \mathbb{R}^6$*
by Gui-Qiang G. Chen, Marshall Slemrod & Dehua Wang
- *An Overview of Piston Problems in Fluid Dynamics*
by Min Ding & Yachun Li

These papers cover a wide range of topics, including shock reflection-diffraction, stability of nonlinear viscous/inviscid waves, free boundary problems, transonic flow, isometric embedding, formation and dynamics of singularities, well-posedness and regularity of entropy solutions, piston problems, kinetic models,

weak convergence methods, singular limits, divergence-measure fields, semigroup approach, approximations, and numerical methods. They are at the forefront of current exciting developments.

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