

Series in Contemporary Applied Mathematics
CAM 17

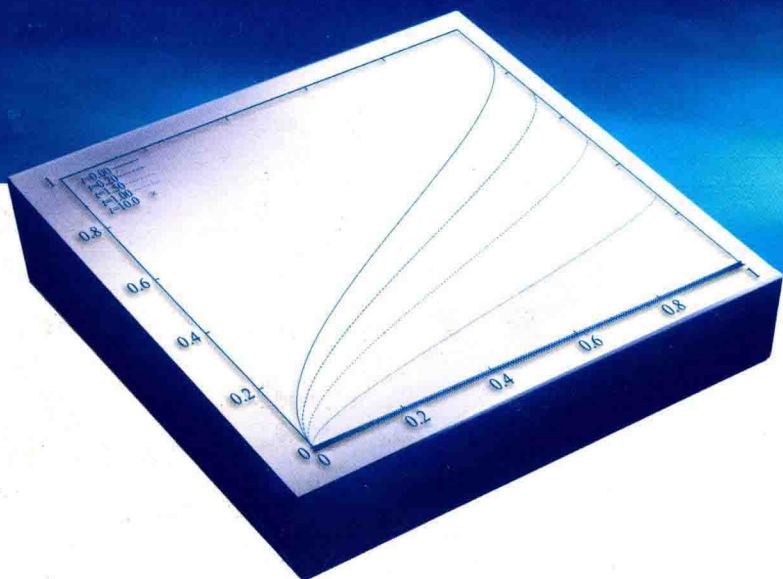
Hyperbolic Problems

Theory, Numerics and Applications

Volume 1

Tatsien Li
Song Jiang

editors



Series in Contemporary Applied Mathematics CAM 17

Hyperbolic Problems

Theory, Numerics and Applications

Volume 1



Higher Education Press



World Scientific

NEW JERSEY • LONDON • SINGAPORE • BEIJING • SHANGHAI • HONG KONG • TAIPEI • CHENNAI

Tatsien Li

School of Mathematical Sciences
Fudan University
Shanghai 200433, China
Email: dqli@fudan.edu.cn

Song Jiang

Institute of Applied Physics and
Computational Mathematics
Beijing 100088, China
Email: jiang@iapcm.ac.cn

Editorial Assistant: Chunlian Zhou

Copyright © 2012 by

Higher Education Press Limited Company

4 Dewai Dajie, Beijing 100120, P. R. China and

World Scientific Publishing Co Pte Ltd

5 Toh Tuch Link, Singapore 596224

All rights reserved. No part of this book may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording or by any information storage and retrieval system, without permission in writing from the Publisher.

ISBN: 978-981-4417-06-8 (set)

ISBN: 978-981-4417-07-5 (v1)

Printed in P. R. China

Hyperbolic Problems

Theory, Numerics and Applications

Volume 1

Series in Contemporary Applied Mathematics CAM

Honorary Editor: Chaohao Gu (*Fudan University*)
Editors: P. G. Ciarlet (*City University of Hong Kong*),
Tatsien Li (*Fudan University*)

- 1 Jiongmin Yong, Rama Cont, eds., *Mathematical Finance: Theory and Practice* (2000)
- 2 F. Dubois, Huamo Wu, eds., *New Advances in Computational Fluid Dynamics: Theory, Methods and Applications* (2001)
- 3 Hanji Shang, Alain Tosseti, eds., *Actuarial Science: Theory and Practice* (2002)
- 4 Alexandre Ern, Weiping Liu, eds., *Mathematical Problems in Environmental Science and Engineering* (2002)
- 5 Haïm Brezis, Tatsien Li, eds., *Ginzburg-Landau Vortices* (2005)
- 6 Tatsien Li, Pingwen Zhang, eds., *Frontiers and Prospects of Contemporary Applied Mathematics* (2006)
- 7 Deguan Wang, Christian Duquenois, Alexandre Ern, eds., *Mathematical Methods for Surface and Subsurface Hydrosystems* (2007)
- 8 Rolf Jeltsch, Tatsien Li, Ian H. Sloan, eds., *Some Topics in Industrial and Applied Mathematics* (2007)
- 9 Philippe G. Ciarlet, Tatsien Li, eds., *Differential Geometry: Theory and Applications* (2008)
- 10 Tatsien Li, Pingwen Zhang, eds., *Industrial and Applied Mathematics in China* (2009)
- 11 Zhien Ma, Yicang Zhou, Jianhong Wu, eds., *Modeling and Dynamics of Infectious Diseases* (2009)
- 12 Tomas Y. Hou, Chun Liu, Jianguo Liu, eds., *Multi-Scale Phenomena in Complex Fluids: Modeling, Analysis and Numerical Simulation* (2010)
- 13 Guiqiang Chen, Tatsien Li, Chun Liu, eds., *Nonlinear Conservation Laws, Fluid Systems and Related Topics* (2010)
- 14 A. Damllamian, S. Jaffard, eds., *Wavelet Methods in Mathematical Analysis and Engineering* (2010)
- 15 Tatsien Li, Yuejun Peng, Bopeng Rao, eds., *Some Problems on Nonlinear Hyperbolic Equations and Applications* (2010)
- 16 A. Damllamian, B. Miara, Tatsien Li, eds., *Multiscale Problems: Theory, Numerical Approximation and Applications* (2011)
- 17 Tatsien Li, Song Jiang, eds., *Hyperbolic Problems: Theory, Numerics and Applications*, Vol. 1 (2012)
- 18 Tatsien Li, Song Jiang, eds., *Hyperbolic Problems: Theory, Numerics and Applications*, Vol. 2 (2012)

Scientific Committee

Yann Brenier (France)
Alberto Bressan (USA)
Constantine Dafermos (USA)
Xiaqi Ding (China)
Ling Hsiao (China)
Rolf Jeltsch (Switzerland)
Song Jiang (China)
Kenneth Karlsen (Norway)
Shuichi Kawashima (Japan)
Dietmar Kroener (Germany)
Randall LeVeque (USA)
Tatsien Li (China)
Taiping Liu (USA)
H. J. Nussenzweig Lopes (Brazil)
Pierangelo Marcati (Italy)
Denis Serre (France)
Chi-Wang Shu (USA)
Eitan Tadmor (USA)
Zhouping Xin (China)

Local Organizing Committee

Tatsien Li (Co-Chair)
Song Jiang (Co-Chair)

Feimin Huang
Hailiang Li
Yaguang Wang
Huijiang Zhao
Changjiang Zhu

Preface

The 13th International Conference on Hyperbolic Problems: Theory, Numerics and Applications (HYP 2010) was held in Beijing, China, from June 15 to 19, 2010. Over 200 participants attended the conference and 162 among them came from abroad. There were 10 plenary lectures, 18 invited talks and around 140 contributed talks in parallel sessions.

The objective of the conference is to bring together experts, researchers and students with interest in theoretical analysis, numerical simulations, and applications of hyperbolic partial differential equations and related mathematical models appearing in applied sciences. The conference keeps the traditional balance of the HYP series, blending theory, numerics and applications, and an emphasis is put on nonlinear problems and applications in various fields such as fluid mechanics, elasticity, astrophysics, biomathematics, traffic flow, etc. As has been done in the past, a special effort has been made it possible for young scientists to attend this conference and to promote their interaction with the more senior researchers.

The biannual HYP series of international conferences on Hyperbolic Problems was initiated by C. Carasso, P.-A. Raviart and D. Serre with the first conference held in Saint-Étienne, France in 1986. Since then it has been organized in Aachen (Germany, 1988), Uppsala (Sweden, 1990), Taormina (Italy, 1992), Stony Brook (USA, 1994), Hong Kong (China, 1996), Zurich (Switzerland, 1998), Magdeburg (Germany, 2000), Pasadena (USA, 2002), Osaka (Japan, 2004), Lyon (France, 2006), and Maryland (USA, 2008). Throughout these years, it has become one of the highest quality and most successful conference series in applied mathematics.

Hyperbolic problems, which are probably originated from Euler's study on the acoustic wave in 1755, not only have a long history but also have extremely rich physical background. The development is highly stimulated by their applications to Physics, Biology, and Engineering Sciences, in particular by the design of effective numerical algorithms. Due to recent rapid development of computers, more and more scientists use hyperbolic partial differential equations and related evolutionary equations as basic tools when propose new mathematical models of various phenomena and related numerical algorithms. We believe that various fields in science and engineering will bring us further into future interests

in hyperbolic problems.

The scientific committee of this conference consists of Yann Brenier (France), Alberto Bressan (USA), Constantine Dafermos (USA), Xiaqi Ding (China), Ling Hsiao (China), Rolf Jeltsch (Switzerland), Song Jiang (China), Kenneth Karlsen (Norway), Shuichi Kawashima (Japan), Dietmar Kroener (Germany), Randall LeVeque (USA), Tatsien Li (China), Tai-Ping Liu (USA), Helena J. Nussenzveig Lopes (Brazil), Pierangelo Marcati (Italy), Denis Serre (France), Chi-Wang Shu (USA), Eitan Tadmor (USA) and Zhouping Xin (China). We thank all members of the scientific committee for recommending plenary and invited speakers and promoting this conference.

This conference is supported by the Academy of Mathematics and Systems Science, the Institute of Applied Physics and Computational Mathematics, Capital Normal University, Central China Normal University, Fudan University, Shanghai Jiaotong University, and Wuhan University. It is also sponsored by Shanghai Key Laboratory for Contemporary Applied Mathematics, Wuhan Institute of Physics and Mathematics, Chinese Academy of Sciences, National Natural Science Foundation of China, and Tianyuan Foundation for Mathematics.

These two volumes contain 80 original research and review papers which are written by leading researchers and promising young scientists, and cover a diverse range of multi-disciplinary topics addressing theoretical, modeling and computational issues arising under the umbrella of “Hyperbolic Partial Differential Equations”. All the articles are peer-reviewed. We would like to thank all the referees for their efforts done for reading and judging the submitted articles. Special thanks go to Dr. Tao Wang for his laborious job arranging the final layout of articles.

Finally, we are extremely thankful to our colleagues Professors Feimin Huang, Hailiang Li, Yaguang Wang, Huijiang Zhao and Changjiang Zhu, and Dr. Xiaoyun Zhai, Dr. Yi Wang, and many graduate students from the Academy of Mathematics and Systems Science, the Institute of Applied Physics and Computational Mathematics, Capital Normal University, Central China Normal University, Fudan University, Shanghai Jiaotong University and Wuhan University, for their assistance in making this conference successful and comfortable.

June 2011
Tatsien Li, Song Jiang

Contents

Volume 1

Plenary Talks

Stefano Bianchini

SBV Regularity for Scalar Conservation Laws 3

Ulrik S. Fjordholm, Siddhartha Mishra, Eitan Tadmor

Entropy Stable ENO Scheme 12

Feimin Huang

Large Time Behavior of Solutions for Compressible

Navier-Stokes Equations 28

Yoshiyuki Kagei

On Asymptotic Behavior of Solutions of the Compressible

Navier-Stokes Equation around a Parallel Flow 44

Tai-Ping Liu, Yanni Zeng

On Nonlinear Stability of Viscous Shock Waves with

Physical Viscosity 60

Tao Luo, Joel Smoller

Stellar Structure, Dynamics and Stability 72

Evgueni Yu. Panov

On Some Non-strictly Hyperbolic Systems of Conservation Laws .. 86

Denis Serre

Irrotational Flows for Chaplygin Gas: Conical Waves 102

Invited Talks*Boris Andreianov*

Dissipative Coupling of Scalar Conservation Laws across an Interface:
Theory and Applications 123

Daniel Balagué, José A. Carrillo

Aggregation Equation with Growing at Infinity Attractive-repulsive
Potentials 136

Gui-Qiang Chen, Marshall Slemrod, Dehua Wang

Mixed Type Problems for Transonic Flow in Gas Dynamics and
Isometric Embedding in Geometry 148

Giuseppe Maria Coclite, Kenneth Hvistendahl Karlsen

Hamiltonian Approximation of Entropy Solutions of the Burgers
Equation 160

Rinaldo M. Colombo

Coupling Hyperbolic Conservation Laws and Ordinary Differential
Equations 172

Jean-François Coulombel

Stability of Finite Difference Schemes for Hyperbolic Initial
Boundary Value Problems 184

Wolfgang Dreyer, Clemens Gohlke

Hysteresis and Phase Transition in Many-particle Storage Systems 196

Volker Elling

Existence of Algebraic Vortex Spirals 203

Franz G. Fuchs, Andrew D. McMurry, Siddhartha Mishra, Knut Waagan

Robust Finite Volume Schemes for Simulating Waves in the
Solar Atmosphere 215

Orhan Mehmetoglu, Bojan Popov

Maximum Principle of Central Schemes with k -monotone
Fluxes 227

Ronghua Pan

Darcy's Law in One-dimensional Isentropic Porous Medium Flow 238

Huijiang Zhao

Diffusive Expansion for Solutions of the Boltzmann Equation in
the Whole Space 251

Contributed Talks

Debora Amadori, Wen Shen

A Nonlocal Conservation Law from a Model of Granular Flow ... 265

David M. Ambrose, Jon Wilkening

Computing Time-periodic Solutions of Nonlinear Systems of
Partial Differential Equations 273

Corentin Audiard

Boundary Value Problem for the Linearized Euler-Korteweg
System on the Half Line 281

Mathieu Bachmann, Siegfried Müller, Philippe Helluy, H el ene Mathis

A Simple Model for Cavitation with Non-condensable Gases 289

Mapundi K. Banda, Michael Herty

Adjoint IMEX-based Schemes for the Numerical Solution of
Optimal Control Problems Governed by Conservation Laws 297

Stefan Berres, Ricardo Ruiz-Baier, Hartmut Schwandt, Elmer M. Tory

A Two-dimensional Model of Pedestrian Flow Generating
Pattern Formation 304

Fernando Betancourt, Raimund B urger, Kenneth H. Karlsen

Well-posedness and Travelling Wave Analysis for a Strongly
Degenerate Parabolic Aggregation Equation 312

Slavko Brdar, Andreas Dedner, Robert Kl ofkorn

CDG Method for Navier-Stokes Equations 320

Manuel J. Castro, Enrique D. Fern andez-Nieto, Jos e M. Gonz alez-Vida

IFCP Riemann Solver for the Pitman-Le System 328

| | |
|---|-----|
| <i>M. Castro, J. T. Frings, S. Noelle, C. Parés, G. Puppo</i> | |
| On the Hyperbolicity of Two- and Three-layer Shallow Water Equations | 337 |
| <i>Christophe Chalons, Frédéric Coquel</i> | |
| Computing Material Fronts with a Lagrange-Projection Approach | 346 |
| <i>Florent Chazel, David Lannes, Fabien Marche</i> | |
| A Numerical Method for a Shallow Water Model with Dispersive Source Terms | 357 |

Volume 2

Contributed Talks

| | |
|--|-----|
| <i>Alina Chertock, Jian-Guo Liu, Terrance Pendleton</i> | |
| Convergence Analysis of the Particle Method for the Camassa-Holm Equation | 365 |
| <i>Paolo Corti</i> | |
| Stable Numerical Scheme for the Magnetic Induction Equation with Hall Effect | 374 |
| <i>Andreas Dedner, Christoph Gersbacher</i> | |
| A Local Discontinuous Galerkin Discretization for Hydrostatic Free Surface Flows Using σ -transformed Coordinates | 382 |
| <i>Donatella Donatelli, Pierangelo Marcati</i> | |
| Analysis of Quasineutral Limits | 390 |
| <i>Renjun Duan, Robert M. Strain</i> | |
| On the Full Dissipative Property of the Vlasov-Poisson-Boltzmann System | 398 |
| <i>P. Engel, C. Rohde</i> | |
| On the Space-Time Expansion Discontinuous Galerkin Method | 406 |
| <i>Ulrik Skre Fjordholm</i> | |
| Energy Conservative and Stable Schemes for the Two-layer Shallow Water Equations | 414 |
| <i>Jan Giesselmann</i> | |
| Sharp Interface Limits for Korteweg Models | 422 |
| <i>Nan Jiang</i> | |
| On the Convergence of Semi-discrete High Resolution Schemes with Superbee Flux Limiter for Conservation Laws | 431 |

| | |
|---|-----|
| <i>Song Jiang, Qiangchang Ju, Fucai Li</i> Asymptotic Limits of the Compressible Magnetohydrodynamic Equations | 439 |
| <i>Chunhua Jin, Tong Yang, Jingxue Yin</i> Waiting Time for a Non-Newtonian Polytropic Filtration Equation with Convection | 447 |
| <i>Quansen Jiu, Yi Wang, Zhouping Xin</i> Stability of Rarefaction Waves to the 1D Compressible Navier- Stokes Equations with Density-dependent Viscosity | 453 |
| <i>E. A. Johnson, J. A. Rossmannith</i> Ten-Moment Two-fluid Plasma Model Agrees Well with PIC/Vlasov in GEM Problem | 461 |
| <i>Frederike Kissling, Christian Rohde</i> Numerical Simulation of Nonclassical Shock Waves in Porous Media with a Heterogeneous Multiscale Method | 469 |
| <i>Ujjwal Koley</i> Implicit Finite Difference Scheme for the Magnetic Induction Equation | 478 |
| <i>Anastasia Korshunova, Olga Rozanova</i> On Effects of Stochastic Regularization for the Pressureless Gas Dynamics | 486 |
| <i>Dietmar Kroener</i> Jump Conditions across Phase Boundaries for the Navier- Stokes Korteweg system | 494 |
| <i>Kai Krycki, Martin Frank</i> Numerical Treatment of a Non-classical Transport Equation Modelling Radiative Transfer in Atmospheric Clouds | 502 |
| <i>Harish Kumar</i> Finite Volume Methods for the Two-fluid MHD Equations | 510 |
| <i>Tong Li, Zhi-An Wang</i> Nonlinear Stability of Large Amplitude Traveling Waves to Hyperbolic-parabolic System Modeling Chemotaxis | 519 |
| <i>Yong Li, Song Jiang, Qiangchang Ju, Hailiang Li</i> Quasi-neutral Limits of the Two-fluid Euler-Poisson Systems | 527 |
| <i>Qihua Liang</i> Dynamically Adaptive Simulation of Solute Transport Driven by Shallow Flows | 535 |
| <i>Chunjin Lin</i> Asymptotic Stability of Rarefaction Waves in Radiative Hydrodynamics | 543 |

| | |
|--|-----|
| <i>Jun Luo, Kun Xu</i> A Symplecticity-preserving Gas-kinetic Scheme for Hydrodynamic Equations under External Forcing Field | 551 |
| <i>Andrea Mentrelli, Tommaso Ruggeri, Masaru Sugiyama, Nanrong Zhao</i> Shock Wave Admissibility and Shock-induced Phase Transitions in a van der Waals Fluid | 559 |
| <i>Magali Mercier</i> L^1 Stability for Scalar Balance Laws; Application to Pedestrian Traffic | 568 |
| <i>Gino Montecinos, Eleuterio Toro</i> Solver for the Generalized Riemann Problem for Balance Laws with Stiff Source Terms: The Scalar Case | 576 |
| <i>Thomas Mueller, Dietmar Kroener</i> Related Problems for TV-estimates for Conservation Laws on Surfaces | 584 |
| <i>María Luz Muñoz-Ruiz, Carlos Parés Madroñal</i> Properties of Path-conservative Schemes for Hyperbolic Systems of Balance Laws | 593 |
| <i>Martin Nolte</i> A Fast Sweeping Method for Computing the Effective Hamiltonian..... | 601 |
| <i>Martina Pawlak, Thomas Sonar</i> A Spectral Difference Method with Dubiner Polynomials on Triangulations | 610 |
| <i>G. Puppo, M. Semplice</i> Adaptive Grids and the Entropy Error Indicator | 617 |
| <i>Xiaohong Qin, Yi Wang</i> Large-time Behavior of Solutions to the Inflow Problem of Full Compressible Navier-Stokes Equations | 625 |
| <i>Peng Qu</i> Mechanism of Singularity Formation for Linearly Degenerate Quasilinear Hyperbolic Systems | 634 |
| <i>Olivier Rouch, Paul Arminjon</i> Extension of Harten's Artificial Compression Method and of an Entropy-based Detector of Discontinuity to Unstructured Triangular Grids, using Arminjon-Viallon's Staggered Central Scheme | 642 |
| <i>Roman Semenko</i> Layered Structures: Instability of the Shock Waves and Electrodynamical Instability | 651 |
| <i>Zhi-Qiang Shao</i> Global Classical Discontinuous Solutions to the Generalized Riemann Problem for Linearly Degenerate Hyperbolic Conservation Laws under Small BV Perturbations of the Initial Data | 659 |

| | |
|--|------------|
| <i>V. M. Shelkovich</i> One Class of Systems of Conservation Laws Admitting Delta-shocks | 667 |
| <i>Wen Shen, Tianyou Zhang</i> A Conservation Law with Nonlocal Flux for Erosion Profiles | 675 |
| <i>Keh-Ming Shyue</i> A Moving-mesh Relaxation Scheme for One-dimensional Barotropic Two-phase Flow with Cavitation | 684 |
| <i>Yuri Trakhinin</i> Well-posedness of the Free Boundary Problem for Non-relativistic and Relativistic Compressible Euler Equations with a Vacuum Boundary Condition | 692 |
| <i>Yoshihiro Ueda</i> Convergence Rate to the Stationary Waves for Viscous Conservation Laws with Non-convexity on the Half Space | 700 |
| <i>M. A. Ullah, Wenbin Gao, De-Kang Mao</i> Numerical Simulation of Shock-bubble Interactions Using Conservative Front Tracking Method | 707 |
| <i>Jing Wang, Feng Xie</i> Asymptotic Stability of Viscous Contact Wave for the 1D Radiation Hydrodynamics System | 715 |
| <i>Kung-Chien Wu, Chi-Kun Lin</i> Dispersive Limits of the Nonlinear Klein-Gordon Equation | 723 |
| <i>Hao Yan, Li Chen</i> Semiclassical Limit of Quantum Semiconductor Models | 731 |
| <i>Penghong Zhong, Shu Wang, Ke Wang, Ronghui Yang</i> A Result on Global Solutions to 3D Complex Ginzburg-Landau Equation | 739 |
| <i>Penghong Zhong, Shu Wang, Ke Wang, Ronghui Yang</i> Exact Configuration for 3D Ginzburg-Landau Equation Based on Some ODEs | 748 |
| Author Index | 757 |

Plenary Talks

