

Grundlehren der mathematischen Wissenschaften 258
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Joel Smoller

**Shock Waves
and Reaction–Diffusion
Equations**



Springer-Verlag New York Heidelberg Berlin

Shock Waves And Reaction Diffusion Equations

Joel Smoller



Shock Waves And Reaction Diffusion Equations:

Shock Waves and Reaction—Diffusion Equations Joel Smoller, 2012-12-06 For this edition a number of typographical errors and minor slip ups have been corrected In addition following the persistent encouragement of Olga Oleinik I have added a new chapter Chapter 25 which I titled Recent Results This chapter is divided into four sections and in these I have discussed what I consider to be some of the important developments which have come about since the writing of the first edition Section I deals with reaction diffusion equations and in it are described both the work of C Jones on the stability of the travelling wave for the Fitz Hugh Nagumo equations and symmetry breaking bifurcations Section II deals with some recent results in shock wave theory The main topics considered are L Tartar s notion of compensated compactness together with its application to pairs of conservation laws and T P Liu s work on the stability of viscous profiles for shock waves In the next section Conley s connection index and connection matrix are described these general notions are useful in constructing travelling waves for systems of nonlinear equations The final section Section IV is devoted to the very recent results of C Jones and R Gardner whereby they construct a general theory enabling them to locate the point spectrum of a wide class of linear operators which arise in stability problems for travelling waves Their theory is general enough to be applicable to many interesting reaction diffusion systems *Shock Waves and Reaction -Diffusion Equations* Joel Smoller, 1994-10-14

Shock Waves and Reaction—Diffusion Equations Joel Smoller, 2012-12-06 the progress of physics will to a large extent depend on the progress of nonlinear mathematics of methods to solve nonlinear equations and therefore we can learn by comparing different nonlinear problems WERNER HEISENBERG I undertook to write this book for two reasons First I wanted to make easily available the basics of both the theory of hyperbolic conservation laws and the theory of systems of reaction diffusion equations including the generalized Morse theory as developed by C Conley These important subjects seem difficult to learn since the results are scattered throughout the research journals 1 Second I feel that there is a need to present the modern methods and ideas in these fields to a wider audience than just mathematicians Thus the book has some rather sophisticated aspects to it as well as certain textbook aspects The latter serve to explain somewhat the reason that a book with the title Shock Waves and Reaction Diffusion Equations has the first nine chapters devoted to linear partial differential equations More precisely I have found from my classroom experience that it is far easier to grasp the subtleties of nonlinear partial differential equations after one has an understanding of the basic notions in the linear theory This book is divided into four main parts linear theory reaction diffusion equations shock wave theory and the Conley index in that order Thus the text begins with a discussion of ill posed problems *Shock Waves and Reaction-diffusion Equations* Joel Smoller, 1994-01-01 *Reaction-diffusion Equations And Their Applications And Computational Aspects - Proceedings Of The China-japan Symposium* Tatsien Li, M Mimura, Yasumasa Nishiura, Q X Ye, 1997-02-03 The aim of the symposium was to provide a forum for presenting and discussing recent developments and trends in Reaction diffusion Equations and to

promote scientific exchanges among mathematicians in China and in Japan especially for the younger generation The topics discussed were Layer dynamics Traveling wave solutions and its stability Equilibrium solutions and its limit behavior stability Bifurcation phenomena Computational solutions and Infinite dimensional dynamical system

Analytical Approaches to Multidimensional Balance Laws Olga S. Rozanova, 2006 It is difficult to overestimate the importance of mathematical investigation of balance laws They arise in many areas of physics mechanics chemistry biology social sciences In this collective book we concentrate in particular on the equations of continuous medium and related to them As a rule they are very complicated in their primitive form An important feature of such equations is a possible formation of singularities even in initially smooth solution within a finite time The structure of the singularities can be very complex A natural step in the approach to this problem is the transition despite the three dimensionality of our world to spatially one dimensional model Significant progress has been achieved in this direction Unfortunately the methods of the one dimensional theory as usual cannot be adapted to a case of many spatial variables However there are many attempts to deal with multidimensional problems We would like to present some of them All of the papers are written by outstanding experts representing various schools in mathematics and mechanics Each paper is organised as follows it contains an elementary as far as it is possible introduction to a problem a brief review of previously published results and then original results of the authors are presented

Geometric Analysis and Nonlinear Partial Differential Equations Stefan Hildebrandt, 2003 This well organized and coherent collection of papers leads the reader to the frontiers of present research in the theory of nonlinear partial differential equations and the calculus of variations and offers insight into some exciting developments In addition most articles also provide an excellent introduction to their background describing extensively as they do the history of those problems presented as well as the state of the art and offer a well chosen guide to the literature Part I contains the contributions of geometric nature From spectral theory on regular and singular spaces to regularity theory of solutions of variational problems Part II consists of articles on partial differential equations which originate from problems in physics biology and stochastics They cover elliptic hyperbolic and parabolic cases

Handbook of Mathematical Fluid Dynamics S. Friedlander, D. Serre, 2004-10-06 The Handbook of Mathematical Fluid Dynamics is a compendium of essays that provides a survey of the major topics in the subject Each article traces developments surveys the results of the past decade discusses the current state of knowledge and presents major future directions and open problems Extensive bibliographic material is provided The book is intended to be useful both to experts in the field and to mathematicians and other scientists who wish to learn about or begin research in mathematical fluid dynamics The Handbook illuminates an exciting subject that involves rigorous mathematical theory applied to an important physical problem namely the motion of fluids

Recent Developments of Soil Mechanics and Geotechnics in Theory and Practice Theodoros

Triantafyllidis, 2019-08-20 This book provides essential insights into recent developments in fundamental geotechnical

engineering research Special emphasis is given to a new family of constitutive soil description methods which take into account the recent loading history and the dilatancy effects Particular attention is also paid to the numerical implementation of multi phase material under dynamic loads and to geotechnical installation processes In turn the book addresses implementation problems concerning large deformations in soils during piling operations or densification processes and discusses the limitations of the respective methods Numerical simulations of dynamic consolidation processes are presented in slope stability analysis under seismic excitation Lastly achieving the energy transition from conventional to renewable sources will call for geotechnical expertise Consequently the book explores and analyzes a selection of interesting problems involving the stability and serviceability of supporting structures and provides new solutions approaches for practitioners and scientists in geotechnical engineering The content reflects the outcomes of the Colloquium on Geotechnical Engineering 2019 Geotechnik Kolloquium held in Karlsruhe Germany in September 2019

Hyperbolic Problems Song Jiang,Tatsien Li,Daqian Li,2012 This two volume book is devoted to mathematical theory numerics and applications of hyperbolic problems Hyperbolic problems have not only a long history but also 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 proposing new mathematical models of various phenomena and related numerical algorithms This book contains 80 original research and review papers which are written by leading researchers and promising young scientists which cover a diverse range of multi disciplinary topics addressing theoretical modeling and computational issues arising under the umbrella of OC Hyperbolic Partial Differential EquationsOCO It is aimed at mathematicians researchers in applied sciences and graduate students

Mathematical Modelling of Heat and Mass Transfer Processes V.G. Danilov,Victor P. Maslov,K.A. Volosov,2012-12-06 In the present book the reader will find a review of methods for constructing a certain class of asymptotic solutions which we call self stabilizing solutions This class includes solitons kinks traveling waves etc It can be said that either the solutions from this class or their derivatives are localized in the neighborhood of a certain curve or surface For the present edition the book published in Moscow by the Nauka publishing house in 1987 was almost completely revised essentially up dated and shows our present understanding of the problems considered The new results obtained by the authors after the Russian edition was published are referred to in footnotes As before the book can be divided into two parts the methods for constructing asymptotic solutions Chapters I V and the application of these methods to some concrete problems Chapters VI VII In Appendix a method for justification some asymptotic solutions is discussed briefly The final formulas for the asymptotic solutions are given in the form of theorems These theorems are unusual in form since they present the results of calculations The authors hope that the book will be useful to specialists both in differential equations and in the mathematical modeling of

physical and chemical processes The authors express their gratitude to Professor M Hazewinkel for his attention to this work and his support

Selected Topics in Nonlinear Wave Mechanics C.I. Christov, Arde Guran, 2012-12-06 This book gives an overview of the current state of nonlinear wave mechanics with emphasis on strong discontinuities shock waves and localized self preserving shapes solitons in both elastic and fluid media The exposition is intentionally at a detailed mathematical and physical level our expectation being that the reader will enjoy coming to grips in a concrete manner with advances in this fascinating subject Historically modern research in nonlinear wave mechanics began with the famous 1858 piston problem paper of Riemann on shock waves and continued into the early part of the last century with the work of Hadamard Rankine and Hugoniot After WWII research into nonlinear propagation of dispersive waves rapidly accelerated with the advent of computers Works of particular importance in the immediate post war years include those of von Neumann Fermi and Lax Later additional contributions were made by Lighthill Glimm Strauss Wendroff and Bishop Dispersion alone leads to shock fronts of the propagating waves That the nonlinearity can compensate for the dispersion leading to propagation with a stable wave having constant velocity and shape solitons came as a surprise A solitary wave was first discussed by J Scott Russell in 1845 in Report of British Associations for the Advancement of Science He had while horseback riding observed a solitary wave travelling along a water channel and followed its unbroken progress for over a mile

Quasilinear Hyperbolic Systems, Compressible Flows, and Waves Vishnu D. Sharma, 2010-04-29 Filled with practical examples Quasilinear Hyperbolic Systems Compressible Flows and Waves presents a self contained discussion of quasilinear hyperbolic equations and systems with applications It emphasizes nonlinear theory and introduces some of the most active research in the field After linking continuum mechanics and quasilinear partial differential equations

Differential Equations C. M. Dafermos, 2020-08-26 This volume is an outcome of the EQUADIFF 87 conference in Greece It addresses a wide spectrum of topics in the theory and applications of differential equations ordinary partial and functional The book is intended for mathematicians and scientists

Developments in Mathematical and Experimental Physics Alfredo Macias, Francisco Uribe, Enrique Diaz, 2012-12-06 The FIRST MEXICAN MEETING ON MATHEMATICAL AND EXPERIMENTAL PHYSICS was held at EL COLEGIO NACIONAL in Mexico City and Mexico from September 10 to 14 2001 This event consisted of the LEOPOLDO GARCIA COLIN SCHERER Medal Lecture delivered by Prof Nicholas G van Kampen a series of plenary talks by Leopoldo Garcia Colin Ginter Nimtz Luis F Rodriguez Ruoon Barrera and Donald Saari and of three parallel symposia namely Cosmology and Gravitation Statistical Physics and Beyond and Hydrodynamics and Dynamical Systems The response from the Physics community was enthusiastic with over 200 participants and around 80 speakers from all over the world USA Canada Mexico Germany France Holland United Kingdom Switzerland Spain and Hungary The main aim of the conference is to provide a scenario to Mexican researchers on the topics of Mathematical and Experimental Physics in order to keep them in contact with work going on in other parts of the world and at the same time to motivate and support the young and mid

career researchers from our country To achieve this goal we decided to the most distinguished experts in the subjects of the invite as lecturers conference and to give the opportunity to young scientist to communi cate the results of their work The plan is to celebrate this international endeavor every three years

Recent Advances in Kinetic Equations and Applications Francesco Salvarani,2022-01-01 The volume covers most of the topics addressed and discussed during the Workshop INdAM Recent advances in kinetic equations and applications which took place in Rome Italy from November 11th to November 15th 2019 The volume contains results on kinetic equations for reactive and nonreactive mixtures and on collisional and noncollisional Vlasov equations for plasmas Some contributions are devoted to the study of phase transition phenomena kinetic problems with nontrivial boundary conditions and hierarchies of models The book addressed to researchers interested in the mathematical and numerical study of kinetic equations provides an overview of recent advances in the field and future research directions

Anomalies in Partial Differential Equations Massimo Cicognani,Daniele Del Santo,Alberto Parmeggiani,Michael Reissig,2021-02-03 The contributions contained in the volume written by leading experts in their respective fields are expanded versions of talks given at the INDAM Workshop Anomalies in Partial Differential Equations held in September 2019 at the Istituto Nazionale di Alta Matematica Dipartimento di Matematica Guido Castelnuovo Universit di Roma La Sapienza The volume contains results for well posedness and local solvability for linear models with low regular coefficients Moreover nonlinear dispersive models damped waves p evolution models are discussed from the point of view of critical exponents blow up phenomena or decay estimates for Sobolev solutions Some contributions are devoted to models from applications as traffic flows Einstein Euler systems or stochastic PDEs as well Finally several contributions from Harmonic and Time Frequency Analysis in which the authors are interested in the action of localizing operators or the description of wave front sets complete the volume

Large Time Asymptotics for Solutions of Nonlinear Partial Differential Equations P.L. Sachdev,Ch. Srinivasa Rao,2009-10-29 A large number of physical phenomena are modeled by nonlinear partial differential equations subject to appropriate initial boundary conditions these equations in general do not admit exact solution The present monograph gives constructive mathematical techniques which bring out large time behavior of solutions of these model equations These approaches in conjunction with modern computational methods help solve physical problems in a satisfactory manner The asymptotic methods dealt with here include self similarity balancing argument and matched asymptotic expansions The physical models discussed in some detail here relate to porous media equation heat equation with absorption generalized Fisher s equation Burgers equation and its generalizations A chapter each is devoted to nonlinear diffusion and fluid mechanics The present book will be found useful by applied mathematicians physicists engineers and biologists and would considerably help understand diverse natural phenomena

Partial Differential Equations III Michael E. Taylor,2023-12-06 The third of three volumes on partial differential equations this is devoted to nonlinear PDE It treats a number of equations of classical continuum mechanics including

relativistic versions as well as various equations arising in differential geometry such as in the study of minimal surfaces isometric imbedding conformal deformation harmonic maps and prescribed Gauss curvature In addition some nonlinear diffusion problems are studied It also introduces such analytical tools as the theory of L^p Sobolev spaces Holder spaces Hardy spaces and Morrey spaces and also a development of Calderon Zygmund theory and paradifferential operator calculus The book is targeted at graduate students in mathematics and at professional mathematicians with an interest in partial differential equations mathematical physics differential geometry harmonic analysis and complex analysis The third edition further expands the material by incorporating new theorems and applications throughout the book and by deepening connections and relating concepts across chapters It includes new sections on rigid body motion on probabilistic results related to random walks on aspects of operator theory related to quantum mechanics on overdetermined systems and on the Euler equation for incompressible fluids The appendices have also been updated with additional results ranging from weak convergence of measures to the curvature of Kahler manifolds Michael E Taylor is a Professor of Mathematics at the University of North Carolina Chapel Hill NC Review of first edition These volumes will be read by several generations of readers eager to learn the modern theory of partial differential equations of mathematical physics and the analysis in which this theory is rooted Peter Lax SIAM review June 1998

Hyperbolic Conservation Laws in Continuum Physics

Constantine M. Dafermos, 2006-01-16 The seeds of continuum physics were planted with the works of the natural philosophers of the eighteenth century most notably Euler by the mid nineteenth century the trees were fully grown and ready to yield fruit It was in this environment that the study of gas dynamics gave birth to the theory of quasilinear hyperbolic systems in divergence form commonly called hyperbolic conservation laws and these two subjects have been traveling hand in hand over the past one hundred and fifty years This book aims at presenting the theory of hyperbolic conservation laws from the standpoint of its genetic relation to continuum physics Even though research is still marching at a brisk pace both fields have attained by now the degree of maturity that would warrant the writing of such an exposition In the realm of continuum physics material bodies are realized as continuous media and so called extensive quantities such as mass momentum and energy are monitored through the fields of their densities which are related by balance laws and constitutive equations A self contained though skeletal introduction to this branch of classical physics is presented in Chapter II The reader may wish it out with the help of a specialized text on the subject

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