

Stochastic Numerics for the Boltzmann Equation

Sergey Blazovskiy
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Lorenzo Pareschi, Giuseppe Toscani



Stochastic Numerics For The Boltzmann Equation:

Stochastic Numerics for the Boltzmann Equation Sergej Rjasanow, Wolfgang Wagner, 2005-11-04 Stochastic numerical methods play an important role in large scale computations in the applied sciences The first goal of this book is to give a mathematical description of classical direct simulation Monte Carlo DSMC procedures for rarefied gases using the theory of Markov processes as a unifying framework The second goal is a systematic treatment of an extension of DSMC called stochastic weighted particle method This method includes several new features which are introduced for the purpose of variance reduction rare event simulation Rigorous convergence results as well as detailed numerical studies are presented

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Computational Methods in Transport: Verification and Validation Frank Graziani, 2008-08-09 The focus of this book deals with a cross cutting issue affecting all transport disciplines whether it be photon neutron charged particle or neutrino transport That is verification and validation In this book we learn what the astrophysicist atmospheric scientist mathematician or nuclear engineer do to assess the accuracy of their code What convergence studies what error analysis what problems do each field use to ascertain the accuracy of their transport simulations

Uncertainty Quantification for Hyperbolic and Kinetic Equations Shi Jin, Lorenzo Pareschi, 2018-03-20 This book explores recent advances in uncertainty quantification for hyperbolic kinetic and related problems The contributions address a range of different aspects including polynomial chaos expansions perturbation methods multi level Monte Carlo methods importance sampling and moment methods The interest in these topics is rapidly growing as their applications have now expanded to many areas in engineering physics biology and the social sciences Accordingly the book provides the scientific community with a topical overview of the latest research efforts

Computational Fluid and Solid Mechanics 2003 K.J Bathe, 2003-06-02 Bringing together the world s leading researchers and practitioners of computational mechanics these new volumes meet and build on the eight key challenges for research and development in computational mechanics Researchers have recently identified eight critical research tasks facing the field of computational mechanics These tasks have come about because it appears possible to reach a new level of mathematical modelling and numerical solution that will lead to a much deeper understanding of nature and to great improvements in engineering design The eight tasks are The automatic solution of mathematical models Effective numerical schemes for fluid flows The development of an effective mesh free numerical

solution method The development of numerical procedures for multiphysics problems The development of numerical procedures for multiscale problems The modelling of uncertainties The analysis of complete life cycles of systems Education teaching sound engineering and scientific judgement Readers of Computational Fluid and Solid Mechanics 2003 will be able to apply the combined experience of many of the world's leading researchers to their own research needs Those in academic environments will gain a better insight into the needs and constraints of the industries they are involved with those in industry will gain a competitive advantage by gaining insight into the cutting edge research being carried out by colleagues in academia Features Bridges the gap between academic researchers and practitioners in industry Outlines the eight main challenges facing Research and Design in Computational mechanics and offers new insights into the shifting the research agenda Provides a vision of how strong basic and exciting education at university can be harmonized with life long learning to obtain maximum value from the new powerful tools of analysis

A Quest Towards a Mathematical Theory of Living Systems Nicola Bellomo, Abdelghani Bellouquid, Livio Gibelli, Nisrine Outada, 2017-07-13 This monograph aims to lay the groundwork for the design of a unified mathematical approach to the modeling and analysis of large complex systems composed of interacting living things Drawing on twenty years of research in various scientific fields it explores how mathematical kinetic theory and evolutionary game theory can be used to understand the complex interplay between mathematical sciences and the dynamics of living systems The authors hope this will contribute to the development of new tools and strategies if not a new mathematical theory The first chapter discusses the main features of living systems and outlines a strategy for their modeling The following chapters then explore some of the methods needed to potentially achieve this in practice Chapter Two provides a brief introduction to the mathematical kinetic theory of classical particles with special emphasis on the Boltzmann equation the Enskog equation mean field models and Monte Carlo methods are also briefly covered Chapter Three uses concepts from evolutionary game theory to derive mathematical structures that are able to capture the complexity features of interactions within living systems The book then shifts to exploring the relevant applications of these methods that can potentially be used to derive specific usable models The modeling of social systems in various contexts is the subject of Chapter Five and an overview of modeling crowd dynamics is given in Chapter Six demonstrating how this approach can be used to model the dynamics of multicellular systems The final chapter considers some additional applications before presenting an overview of open problems The authors then offer their own speculations on the conceptual paths that may lead to a mathematical theory of living systems hoping to motivate future research activity in the field A truly unique contribution to the existing literature A Quest Toward a Mathematical Theory of Living Systems is an important book that will no doubt have a significant influence on the future directions of the field It will be of interest to mathematical biologists systems biologists biophysicists and other researchers working on understanding the complexities of living systems

Hyperbolic and Kinetic Models for Self-organised Biological Aggregations Raluca Eftimie, 2019-01-07 This

book focuses on the spatio temporal patterns generated by two classes of mathematical models of hyperbolic and kinetic types that have been increasingly used in the past several years to describe various biological and ecological communities Here we combine an overview of various modelling approaches for collective behaviours displayed by individuals cells bacteria that interact locally and non locally with analytical and numerical mathematical techniques that can be used to investigate the spatio temporal patterns produced by said individuals cells bacteria Richly illustrated the book offers a valuable guide for researchers new to the field and is also suitable as a textbook for senior undergraduate or graduate students in mathematics or related disciplines *Crowd Dynamics by Kinetic Theory Modeling* Bouchra Aylaj,Nicola Bellomo,Livio Gibelli,Damián Knopoff,2022-06-01 The contents of this brief Lecture Note are devoted to modeling simulations and applications with the aim of proposing a unified multiscale approach accounting for the physics and the psychology of people in crowds The modeling approach is based on the mathematical theory of active particles with the goal of contributing to safety problems of interest for the well being of our society for instance by supporting crisis management in critical situations such as sudden evacuation dynamics induced through complex venues by incidents **Interacting Multiagent Systems** Lorenzo Pareschi,Giuseppe Toscani,2014 Mathematical modelling of systems constituted by many agents using kinetic theory is a new tool that has proved effective in predicting the emergence of collective behaviours and self organization This idea has been applied by the authors to various problems which range from sociology to economics and life sciences *Advances in Numerical Methods for Hyperbolic Balance Laws and Related Problems* Giacomo Albi,Walter Boscheri,Mattia Zanella,2023-06-02 A broad range of phenomena in science and technology can be described by non linear partial differential equations characterized by systems of conservation laws with source terms Well known examples are hyperbolic systems with source terms kinetic equations and convection reaction diffusion equations This book collects research advances in numerical methods for hyperbolic balance laws and kinetic equations together with related modelling aspects All the contributions are based on the talks of the speakers of the Young Researchers Conference Numerical Aspects of Hyperbolic Balance Laws and Related Problems hosted at the University of Verona Italy in December 2021 **Theory, Numerics and Applications of Hyperbolic Problems II** Christian Klingenberg,Michael Westdickenberg,2018-06-27 The second of two volumes this edited proceedings book features research presented at the XVI International Conference on Hyperbolic Problems held in Aachen Germany in summer 2016 It focuses on the theoretical applied and computational aspects of hyperbolic partial differential equations systems of hyperbolic conservation laws wave equations etc and of related mathematical models PDEs of mixed type kinetic equations nonlocal or and discrete models found in the field of applied sciences *Energy Deposition for High-Speed Flow Control* Doyle D. Knight,2019-02-21 Written by a leading expert in the field this book presents a novel method for controlling high speed flows past aerodynamic shapes using energy deposition via direct current DC laser or microwave discharge and describes selected applications in supersonic and hypersonic flows

Emphasizing a deductive approach the fundamental physical principles provided give an understanding of the simplified mathematical models derived therefrom These features along with an extensive set of 55 simulations make the book an invaluable reference that will be of interest to researchers and graduate students working in aerospace engineering and in plasma physics

Hyperbolic Problems: Theory, Numerics, Applications. Volume II Carlos Parés,Manuel J. Castro,Tomás Morales de Luna,María Luz Muñoz-Ruiz,2024-06-05 The present volume contains a selection of papers from the XVIII International Conference on Hyperbolic Problems Theory Numerics and Applications HYP2022 which was held on June 20 24 2022 in M laga Spain The goal of this series of conferences is to bring together scientists with interests in the theoretical applied and computational aspects of hyperbolic partial differential equations systems of hyperbolic conservation laws wave equations etc and of related mathematical models The chapters in this volume correspond to selected contributions related to numerical aspects and applications

Seminar on Stochastic Analysis, Random Fields and Applications VII Robert C. Dalang,Marco Dozzi,Francesco Russo,2013-09-05 This volume contains refereed research or review articles presented at the 7th Seminar on Stochastic Analysis Random Fields and Applications which took place at the Centro Stefano Franscini Monte Verit in Ascona Switzerland in May 2011 The seminar focused mainly on stochastic partial differential equations especially with jump processes construction of solutions and approximations Malliavin calculus and Stein methods and other techniques in stochastic analysis especially chaos representations and convergence and applications to models of interacting particle systems stochastic methods in financial models especially models for power markets or for risk analysis empirical estimation and approximation stochastic control and optimal pricing The book will be a valuable resource for researchers in stochastic analysis and for professionals interested in stochastic methods in finance

Parallel Processing and Applied Mathematics Roman Wyrzykowski,Jack Dongarra,Konrad Karczewski,Jerzy Waśniewski,2014-05-07 This two volume set LNCS 8384 and 8385 constitutes the refereed proceedings of the 10th International Conference of Parallel Processing and Applied Mathematics PPAM 2013 held in Warsaw Poland in September 2013 The 143 revised full papers presented in both volumes were carefully reviewed and selected from numerous submissions The papers cover important fields of parallel distributed cloud computing and applied mathematics such as numerical algorithms and parallel scientific computing parallel non numerical algorithms tools and environments for parallel distributed cloud computing applications of parallel computing applied mathematics evolutionary computing and metaheuristics

Numerical Modeling of Space Plasma Flows Astronomical Society of the Pacific,2008 This volume is based on talks given at ASTRONUM 2007 This conference is the second in a series of international conferences organized by the Institute of Geophysics and Planetary Physics of the University of California at Riverside and the Laboratory for Research of the Fundamental Laws of the Universe of the French Commissariat of Atomic Energy The conference subjects include turbulence and cosmic ray transport astrophysical flows space plasma flows kinetic and hybrid simulations numerical

methods algorithms and frameworks and data handling and visualization All of these are of great importance for scientists investigating solar structure the heliosphere the Sun Earth connection and various astrophysical phenomena The problems discussed at the conference involved significantly different scales regions or particle populations for which several sets of defining equations or concepts are necessary to understand the physical system in its entirety This book will be of interest to specialists in applied mathematics astrophysics space physics and computer science who apply novel numerical algorithms to the contemporary problems in these fields Graduate students will find it a useful reference of the fundamental approaches to solving the fluid dynamics and Boltzmann equations governing space plasma flows publisher s website [Modelling and Numerics of Kinetic Dissipative Systems](#) Lorenzo Pareschi,Giovanni Russo,2006 The book is divided into three parts which contain respectively recent results in the kinetic theory of granular gases kinetic theory of chemically reacting gases and numerical methods for kinetic systems Part I is devoted to theoretical aspects of granular gases Part II presents recent results on modelling of kinetic systems in which molecules can undergo binary collisions in presence of chemical reactions and or in presence of quantum effects Part III contains several contributions related to the construction of suitable numerical methods and simulations for granular gases [Differential Equations on Measures and Functional Spaces](#) Vassili Kolokoltsov,2019-06-20 This advanced book focuses on ordinary differential equations ODEs in Banach and more general locally convex spaces most notably the ODEs on measures and various function spaces It briefly discusses the fundamentals before moving on to the cutting edge research in linear and nonlinear partial and pseudo differential equations general kinetic equations and fractional evolutions The level of generality chosen is suitable for the study of the most important nonlinear equations of mathematical physics such as Boltzmann Smoluchovskii Vlasov Landau Fokker Planck Cahn Hilliard Hamilton Jacobi Bellman nonlinear Schroedinger McKean Vlasov diffusions and their nonlocal extensions mass action law kinetics from chemistry It also covers nonlinear evolutions arising in evolutionary biology and mean field games optimization theory epidemics and system biology in general models of interacting particles or agents describing splitting and merging collisions and breakage mutations and the preferential attachment growth on networks The book is intended mainly for upper undergraduate and graduate students but is also of use to researchers in differential equations and their applications It particularly highlights the interconnections between various topics revealing where and how a particular result is used in other chapters or may be used in other contexts and also clarifies the links between the languages of pseudo differential operators generalized functions operator theory abstract linear spaces fractional calculus and path integrals [Hyperbolic Problems: Theory, Numerics, Applications](#) Thomas Y. Hou,Eitan Tadmor,2012-12-06 The International Conference on Hyperbolic Problems Theory Numerics and Applications was held in CalTech on March 25 30 2002 The conference was the ninth meeting in the bi annual international series which became one of the highest quality and most successful conference series in Applied mathematics This volume contains more than 90 contributions presented in this conference including

plenary presentations by A Bressan P Degond R LeVeque T P Liu B Perthame C W Shu B Sj green and S Ukai Reflecting the objective of series the contributions in this volume keep the traditional blend of theory numerics and applications The Hyp2002 meeting placed a particular emphasize on fundamental theory and numerical analysis on multi scale analysis modeling and simulations and on geophysical applications and free boundary problems arising from materials science and multi component fluid dynamics The volume should appeal to researchers students and practitioners with general interest in time dependent problems governed by hyperbolic equations

Trails in Kinetic Theory Giacomo Albi, Sara Merino-Aceituno, Alessia Nota, Mattia Zanella, 2021-07-15 In recent decades kinetic theory originally developed as a field of mathematical physics has emerged as one of the most prominent fields of modern mathematics In recent years there has been an explosion of applications of kinetic theory to other areas of research such as biology and social sciences This book collects lecture notes and recent advances in the field of kinetic theory of lecturers and speakers of the School Trails in Kinetic Theory Foundational Aspects and Numerical Methods hosted at Hausdorff Institute for Mathematics HIM of Bonn Germany 2019 during the Junior Trimester Program Kinetic Theory Focusing on fundamental questions in both theoretical and numerical aspects it also presents a broad view of related problems in socioeconomic sciences pedestrian dynamics and traffic flow management

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