Modeling and
Computational Methods
for Kinetic Equations

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Editors

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Modeling And Computational Methods For Kinetic Equations:

Modeling and Computational Methods for Kinetic Equations Pierre Degond,Lorenzo Pareschi,Giovanni Russo,2004-04-07 In recent years kinetic theory has developed in many areas of the physical sciences and engineering and has extended the borders of its traditional fields of application New applications in traffic flow engineering granular media modeling and polymer and phase transition physics have resulted in new numerical algorithms which depart from traditional stochastic Monte Carlo methods This monograph is a self contained presentation of such recently developed aspects of kinetic theory as well as a comprehensive account of the fundamentals of the theory Emphasizing modeling techniques and numerical methods the book provides a unified treatment of kinetic equations not found in more focused theoretical or applied works The book is divided into two parts Part I is devoted to the most fundamental kinetic model the Boltzmann equation of rarefied gas dynamics Additionally widely used numerical methods for the discretization of the Boltzmann equation are reviewed the Monte Carlo method spectral methods and finite difference methods Part II considers specific applications plasma kinetic modeling using the Landau Fokker Planck equations traffic flow modeling granular media modeling quantum kinetic modeling and coagulation fragmentation problems Modeling and Computational Methods of Kinetic Equations will be accessible to readers working in different communities where kinetic theory is important graduate students researchers and practitioners in mathematical physics applied mathematics and various branches of engineering The work may be used for self study as a reference text or in graduate level courses in kinetic theory and its applications **Modeling and Computational Methods for Multi-scale Quantum Dynamics and Kinetic Equations** ,2013 This dissertation consists of two parts quantum transitions Part 1 and hydrodynamic limits of kinetic equations Part 2 In both parts we investigate the inner mathematical connections between equations for different physics at different scales and use these connections to design efficient computational methods for multi scale problems Despite its numerous applications in chemistry and physics the mathematics of quantum transition is not well understood Using the Wigner transformation we derive semi classical models in phase space for two problems the dynamics of electrons in crystals near band crossing points surface hopping of quantum molecules when the Born Oppenheimer approximation breaks down In both cases particles may jump between states with comparable energies Our models can capture the transition rates for such processes We provide analytic analysis of and numerical methods for our models demonstrated by explicit examples The second part is to construct numerical methods for kinetic equation that are efficient in the hydrodynamic regime Asymptotically the kinetic equations reduce to fluid dynamics described by the Euler or Navier Stokes equations in the fluid regime Numerically the Boltzmann equation is still hard to handle in the hydrodynamic regime due to the stiff collision term We review the theoretical work that links the two sets of equations and present our asymptotic preserving numerical solvers for the Boltzmann equation that naturally capture the asymptotic limits in the hydrodynamic regime We also extend our methods to the case of multi species systems

Modeling Approaches and Computational Methods for Particle-laden Turbulent Flows Shankar Subramaniam,S. Balachandar,2022-10-20 Modelling Approaches and Computational Methods for Particle laden Turbulent Flows introduces the principal phenomena observed in applications where turbulence in particle laden flow is encountered while also analyzing the main methods for analyzing numerically The book takes a practical approach providing advice on how to select and apply the correct model or tool by drawing on the latest research Sections provide scales of particle laden turbulence and the principal analytical frameworks and computational approaches used to simulate particles in turbulent flow Each chapter opens with a section on fundamental concepts and theory before describing the applications of the modelling approach or numerical method Featuring explanations of key concepts definitions and fundamental physics and equations as well as recent research advances and detailed simulation methods this book is the ideal starting point for students new to this subject as well as an essential reference for experienced researchers Provides a comprehensive introduction to the phenomena of particle laden turbulent flow Explains a wide range of numerical methods including Eulerian Eulerian Eulerian Lagrange and volume filtered computation Describes a wide range of innovative applications of these models

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 **Landau Equation, Boltzmann-type Equations, Discrete Models, and Numerical Methods** Alexander V. Bobylev,2024-09-23 This two volume monograph is a comprehensive and up to date presentation of the theory and applications of kinetic equations The second volume covers discrete velocity models of the Boltzmann equation results on the Landau equation and numerical deterministic and stochastic methods for the solution of kinetic equations **Analytic Methods for Coagulation-Fragmentation Models, Volume I** Jacek Banasiak,Wilson Lamb,Philippe Laurencot,2019-09-04 Analytic Methods for Coagulation Fragmentation Models is a two volume set that provides a comprehensive exposition of the mathematical analysis of coagulation fragmentation models Initially an in depth survey of coagulation fragmentation processes is presented together with an account of relevant early results obtained on the associated model equations These provide motivation for the subsequent detailed treatment of more up to date investigations which have led to significant theoretical developments on topics such as solvability and the long term behaviour of solutions To make the account as self contained as possible the mathematical tools that feature prominently in these modern treatments are introduced at appropriate places The main theme of Volume I is the analysis of linear fragmentation models with Volume II devoted to processes that involve the nonlinear contribution of

coagulation Features of Volume I The main models of the theory together with their derivations and early methods of solution A detailed presentation of the operator theoretical methods and semigroup theory that play an essential role in the theory of fragmentation processes A comprehensive theory of fragmentation processes including fragmentation with growth and decay in both the discrete and continuous particle size cases An analytical explanation of the pathologies of the fragmentation equation such as the shattering phase transition and non uniqueness of solutions An analysis of the long term dynamics of the discrete size fragmentation equation with growth   *Chemical Reactor Modeling* Hugo A. Jakobsen,2014-04-02 Chemical Reactor Modeling closes the gap between Chemical Reaction Engineering and Fluid Mechanics The second edition consists of two volumes Volume 1 Fundamentals Volume 2 Chemical Engineering Applications In volume 1 most of the fundamental theory is presented A few numerical model simulation application examples are given to elucidate the link between theory and applications In volume 2 the chemical reactor equipment to be modeled are described Several engineering models are introduced and discussed A survey of the frequently used numerical methods algorithms and schemes is provided A few practical engineering applications of the modeling tools are presented and discussed The working principles of several experimental techniques employed in order to get data for model validation are outlined The monograph is based on lectures regularly taught in the fourth and fifth years graduate courses in transport phenomena and chemical reactor modeling and in a post graduate course in modern reactor modeling at the Norwegian University of Science and Technology Department of Chemical Engineering Trondheim Norway The objective of the book is to present the fundamentals of the single fluid and multi fluid models for the analysis of single and multiphase reactive flows in chemical reactors with a chemical reactor engineering rather than mathematical bias Organized into 13 chapters it combines theoretical aspects and practical applications and covers some of the recent research in several areas of chemical reactor engineering This book contains a survey of the modern literature in the field of chemical reactor modeling   *Systems, Control, Modeling and Optimization* F. Ceragioli,A. Dontchev,H. Furuta,L. Pandolfi,2006-10-31 We publish in this volume a selection of the papers presented at the 22nd Conference on System Modeling and Optimization held at the Politecnico di Torino in July 2005 The conference has been organized by the Mathematical Department of the Politecnico di Torino The papers presented in this volume mostly concern stochastic and distributed systems their control optimization and inverse problems IFIP is a multinational federation of professional and technical organiza tions concerned with information processes It was established in 1959 under the auspices of UNESCO IFIP still mantains friendly connections with spe cialized agencies of the UN systems It consists of Technical Committees The Seventh Technical Committee established in 1972 was created in 1968 by A V Balakrishnan J L Lions and G I Marchuk with a joint conference held in Sanremo and Novosibirsk The present edition of the conference is dedicated to Camillo Possio killed by a bomb during the last air raid overTorino in the sixtieth anniversary of his death The special session On the Possio equation and its special role in aeroelasticity was devoted to his achievements The special

session Shape Analysis and optimization commemorates the 100th anniversary of Pompeiu thesis **Mathematics of Energy and Climate Change** Jean-Pierre Bourguignon,Rolf Jeltsch,Alberto Adrego Pinto,Marcelo Viana,2015-07-29 The focus of this volume is research carried out as part of the program Mathematics of Planet Earth which provides a platform to showcase the essential role of mathematics in addressing planetary problems and creating a context for mathematicians and applied scientists to foster mathematical and interdisciplinary developments that will be necessary to tackle a myriad of issues and meet future global challenges Earth is a planet with dynamic processes in its mantle oceans and atmosphere creating climate causing natural disasters and influencing fundamental aspects of life and life supporting systems In addition to these natural processes human activity has increased to the point where it influences the global climate impacts the ability of the planet to feed itself and threatens the stability of these systems Issues such as climate change sustainability man made disasters control of diseases and epidemics management of resources risk analysis and global integration have come to the fore Written by specialists in several fields of mathematics and applied sciences this book presents the proceedings of the International Conference and Advanced School Planet Earth Mathematics of Energy and Climate Change held in Lisbon Portugal in March 2013 which was organized by the International Center of Mathematics CIM as a partner institution of the international program Mathematics of Planet Earth 2013 The book presents the state of the art in advanced research and ultimate techniques in modeling natural economical and social phenomena It constitutes a tool and a framework for researchers and graduate students both in mathematics and applied sciences *Mathematical Modeling of Collective Behavior in Socio-Economic and Life Sciences* Giovanni Naldi,Lorenzo Pareschi,Giuseppe Toscani,2010-08-12 Mathematical modeling using dynamical systems and partial differential equations is now playing an increasing role in the understanding of complex multi scale phenomena Behavior in seemingly different areas such as sociology economics and the life sciences can be described by closely related models Using examples from financial markets and modern warfare to the flocking of birds and the swarming of bacteria the collected research in this volume demonstrates the common methodological approaches and tools for modeling and simulating collective behavior The topics presented point toward new and challenging frontiers of applied mathematics making the volume a useful reference text for applied mathematicians physicists biologists and economists involved in the modeling of socio economic systems **Profit Maximization Techniques for Operating Chemical Plants** Sandip K. Lahiri,2020-04-30 A systematic approach to profit optimization utilizing strategic solutions and methodologies for the chemical process industry In the ongoing battle to reduce the cost of production and increase profit margin within the chemical process industry leaders are searching for new ways to deploy profit optimization strategies Profit Maximization Techniques For Operating Chemical Plants defines strategic planning and implementation techniques for managers senior executives and technical service consultants to help increase profit margins The book provides in depth insight and practical tools to help readers find new and unique opportunities to implement profit optimization strategies

From identifying where the large profit improvement projects are to increasing plant capacity and pushing plant operations towards multiple constraints while maintaining continuous improvements there is a plethora of information to help keep plant operations on budget The book also includes information on Take away methods and techniques for identifying and exploiting potential areas to improve profit within the plant Focus on latest Artificial Intelligence based modeling knowledge discovery and optimization strategies to maximize profit in running plant Describes procedure to develop advance process monitoring and fault diagnosis in running plant Thoughts on engineering design best practices and monitoring to sustain profit improvements Step by step guides to identifying building and deploying improvement applications For leaders and technologists in the industry who want to maximize profit margins this text provides basic concepts guidelines and step by step guides specifically for the chemical plant sector *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 *Integrative Production Technology* Christian Brecher,Denis Özdemir,2017-01-09 This contributed volume contains the research results of the Cluster of Excellence Integrative Production Technology for High Wage Countries funded by the German Research Society DFG The approach to the topic is genuinely interdisciplinary covering insights from fields such as engineering material sciences economics and social sciences The book contains coherent deterministic models for integrative product creation chains as well as harmonized cybernetic models of production systems The content is structured into five sections Integrative Production Technology Individualized Production Virtual Production Systems Integrated Technologies Self Optimizing Production Systems and Collaboration Productivity The target audience primarily comprises research experts and practitioners in the field of production engineering but the book may also be beneficial for graduate students

Computational Methods in Multiphase Flow IV A.A. Mammoli,C.A. Brebbia,2007-05-11 Fluid Dynamics is one of the most important topics of applied mathematics and physics Together with complex flows and turbulence multiphase flows remains one of the most challenging areas of computational mechanics and even seemingly simple problems remain unsolved to date Multiphase flows are found in all areas of technology at all length scales and flow regimes The fluids involved can be compressible or incompressible linear or nonlinear Because of the complexity of the problem it is often essential to utilize advanced computational and experimental methods to solve the complex equations that describe them Challenges in these simulations include nonlinear fluids treating drop breakup and coalescence characterizing phase structures and many others This volume brings together work presented at the Fourth International Conference on Computational and Experimental

Methods in Multiphase and Complex Flows Featured topics include Suspensions Bubble and Drop Dynamics Flow in Porous Media Interfaces Turbulent Flow Injectors and Nozzles Particle Image Velocimetry Macroscale Constitutive Models Large Eddy Simulation Finite Volumes Interface Tracking Methods Biological Flows Environmental Multiphase Flow Phase Changes and Stochastic Modelling   The Princeton Companion to Applied Mathematics Nicholas J. Higham,Mark R. Dennis,Paul Glendinning,Paul A. Martin,Fadil Santosa,Jared Tanner,2015-09-15 The must have compendium on applied mathematics This is the most authoritative and accessible single volume reference book on applied mathematics Featuring numerous entries by leading experts and organized thematically it introduces readers to applied mathematics and its uses explains key concepts describes important equations laws and functions looks at exciting areas of research covers modeling and simulation explores areas of application and more Modeled on the popular Princeton Companion to Mathematics this volume is an indispensable resource for undergraduate and graduate students researchers and practitioners in other disciplines seeking a user friendly reference book on applied mathematics Features nearly 200 entries organized thematically and written by an international team of distinguished contributors Presents the major ideas and branches of applied mathematics in a clear and accessible way Explains important mathematical concepts methods equations and applications Introduces the language of applied mathematics and the goals of applied mathematical research Gives a wide range of examples of mathematical modeling Covers continuum mechanics dynamical systems numerical analysis discrete and combinatorial mathematics mathematical physics and much more Explores the connections between applied mathematics and other disciplines Includes suggestions for further reading cross references and a comprehensive index   *Material Substructures in Complex Bodies* Gianfranco Capriz,Paolo Maria Mariano,2007-05-24 Stringent industrial requirements of sophisticated performances and of circumstantial control for micro devices or nanotechnology manufactures and other types of machinery at multiple scales can be satisfied often only by resort to or allowance for complex materials The adjective complex beckons to the fact that the substructure influences gross mechanical behaviour in a prominent way and interactions due to substructural changes are represented directly The description of the mechanical behaviour of complex bodies proposes a wide class of challenging problems from macroscopic to nano world The collection of chapters composing this book aims to explore some aspects of these problems proposing also new matter of discussion together with specific solutions Contributors are Carlo Cercignani Gianfranco Capriz Pierre Degond Antonio Fasano Harley T Johnson Sukky Jun Krishna Kannan Wing Kam Liu Alberto Mancini Paolo Maria Mariano Ingo M ller Kumbakonan R Rajagopal Jan Jerzy Slawianowski The book can be a useful tool for Scholars and PhD students addressing their research activity toward basic mathematical and physical problems accruing from the mechanics of materials   Energy and Environmental Engineering Yijin Wu,2015-02-04 The 2014 International Conference on Energy and Environmental Engineering ICEEE 2014 was held September 21 22 2014 in Hong Kong This proceedings volume assembles papers from various professionals leading researchers engineers scientists and students and presents

innovative ideas and research results focused on Energy and Environmental Engine **Walking and Pedestrians** ,2025-06-23 Walking and pedrestrians series highlights new advances in the field with this new volume presenting interesting chapters Each chapter is written by an international board of authors Provides the latest information on health research Offers outstanding and original reviews on a range of walking and pedrestrians research topics Serves as an indispensable reference for researchers and students alike **Foodborne Pathogens: Hygiene and Safety** Maria Schirone,Pierina Visciano,Rosanna Tofalo,Giovanna Suzzi,2019-11-26 <u>Immersed Boundary Method</u> Somnath Roy,Ashoke De,Elias Balaras,2020-05-15 This volume presents the emerging applications of immersed boundary IB methods in computational mechanics and complex CFD calculations It discusses formulations of different IB implementations and also demonstrates applications of these methods in a wide range of problems It will be of special value to researchers and engineers as well as graduate students working on immersed boundary methods specifically on recent developments and applications The book can also be used as a supplementary textbook in advanced courses in computational fluid dynamics

The Enigmatic Realm of **Modeling And Computational Methods For Kinetic Equations**: Unleashing the Language is Inner Magic

In a fast-paced digital era where connections and knowledge intertwine, the enigmatic realm of language reveals its inherent magic. Its capacity to stir emotions, ignite contemplation, and catalyze profound transformations is nothing short of extraordinary. Within the captivating pages of **Modeling And Computational Methods For Kinetic Equations** a literary masterpiece penned with a renowned author, readers embark on a transformative journey, unlocking the secrets and untapped potential embedded within each word. In this evaluation, we shall explore the book is core themes, assess its distinct writing style, and delve into its lasting effect on the hearts and minds of those that partake in its reading experience.

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