Series on Advances in Mathematics for Applied Sciences - Vol. 56

# HIGH-DIMENSIONAL NONLINEAR DIFFUSION STOCHASTIC PROCESSES

**Modelling for Engineering Applications** 

Yevgeny Mamontov Magnus Willander

World Scientific

# <u>Highdimensional Nonlinear Diffusion Stochastic</u> <u>Procebes Modelling For Engineering Applications</u>

Yevgeny Mamontov, M. Willander

## **Highdimensional Nonlinear Diffusion Stochastic Procebes Modelling For Engineering Applications:**

High-dimensional Nonlinear Diffusion Stochastic Processes Yevgeny Mamontov, Magnus Willander, 2001-01-19 This book is the first one devoted to high dimensional or large scale diffusion stochastic processes DSPs with nonlinear coefficients These processes are closely associated with nonlinear Ito's stochastic ordinary differential equations ISODEs and with the space discretized versions of nonlinear Ito's stochastic partial integro differential equations The latter models include Ito's stochastic partial differential equations ISPDEs. The book presents the new analytical treatment which can serve as the basis of a combined analytical numerical approach to greater computational efficiency in engineering problems A few examples discussed in the book include the high dimensional DSPs described with the ISODE systems for semiconductor circuits the nonrandom model for stochastic resonance and other noise induced phenomena in high dimensional DSPs the modification of the well known stochastic adaptive interpolation method by means of bases of function spaces ISPDEs as the tool to consistently model non Markov phenomena the ISPDE system for semiconductor devices the corresponding classification of charge transport in macroscale mesoscale and microscale semiconductor regions based on the wave diffusion equation the fully time domain nonlinear friction aware analytical model for the velocity covariance of particle of uniform fluid simple or dispersed the specific time domain analytics for the long non exponential tails of the velocity in case of the hard sphere fluid These examples demonstrate not only the capabilities of the developed techniques but also emphasize the usefulness of the complex system related approaches to solve some problems which have not been solved with the traditional statistical physics methods yet From this veiwpoint the book can be regarded as a kind of complement to such books as Introduction to the Physics of Complex Systems The Mesoscopic Approach to Fluctuations Nonlinearity and Self Organization by Serra Andretta Compiani and Zanarini Stochastic Dynamical Systems Concepts Numerical Methods Data Analysis and Statistical Physics An Advanced Approach with Applications by Honerkamp which deal with physics of complex systems some of the corresponding analysis methods and an innovative stochastics based vision of theoretical physics To facilitate the reading by nonmathematicians the introductory chapter outlines the basic notions and results of theory of Markov and diffusion stochastic processes without involving the measure theoretical approach This presentation is based on probability densities commonly used in engineering and applied sciences **High-dimensional Nonlinear Diffusion** Stochastic Processes Yevgeny Mamontov, M. Willander, 2001 Annotation This book is one of the first few devoted to high dimensional diffusion stochastic processes with nonlinear coefficients These processes are closely associated with large systems of Ito's stochastic differential equations and with discretized in the parameter versions of Ito's stochastic differential equations that are nonlocally dependent on the parameter The latter models include Ito's stochastic integro differential partial differential and partial integro differential equations The book presents the new analytical treatment which can serve as the basis of a combined analytical numerical approach to greater computational efficiency Some examples of the

modelling of noise in semiconductor devices are provided Mathematical Methods for the Natural and Engineering **Sciences** Ronald E. Mickens, 2004 This book provides a variety of methods required for the analysis and solution of equations which arise in the modeling of phenomena from the natural and engineering sciences It can be used productively by both undergraduate and graduate students as well as others who need to learn and understand these techniques A detailed discussion is also presented for several topics that are usually not included in standard textbooks at this level qualitative methods for differential equations dimensionalization and scaling elements of asymptotics difference equations and various perturbation methods Each chapter contains a large number of worked examples and provides references to the appropriate Clusters And Nano-assemblies: Physical And Biological Systems Purusottam Jena, Shiv Narain literature Khanna, Bijan K Rao, 2005-05-09 While the field of clusters and nano structures in the physical sciences has been actively pursued only over the past two decades nature has known the benefits of the nanoscale for a very long time. The focus of the International Symposium on Clusters and Nano Assemblies Physical and Biological Systems was to explore ways in which an understanding of the unique properties of nano scale biological systems such as proteins enzyme reactions RNA and DNA can help us design novel materials composed of inorganic nano scale systems and how techniques developed in the physical sciences can lead to a fundamental understanding of biological systems Bringing together the expert contributions from the conference this book deals with the fundamental science and technology of atomic clusters nano structures and their assemblies in physical and biological systems It explores in fascinating detail the manner in which finite size low dimensionality and reduced symmetry affect the properties of nano assemblies Stability And Time-optimal Control Of Hereditary Systems: With Application To The Economic Dynamics Of The Us (2nd Edition) Ethelbert Nwakuche Chukwu, 2001-12-28 Stability and Time Optimal Control of Hereditary Systems is the mathematical foundation and theory required for studying in depth the stability and optimal control of systems whose history is taken into account In this edition the economic application is enlarged and explored in some depth The application holds out the hope that full employment and high income growth will be compatible with low prices and low inflation provided that the control matrix has full rank i e the existing controls are fully effectively used The book concludes with a new appendix containing complete programs data graphs and quantitative results for the US economy Generalized Kinetic Models In Applied Sciences: Lecture Notes On Mathematical Problems Luisa Arlotti, Nicola Bellomo, Elena De Angelis, Miroslaw Lachowicz, 2003-08-12 This book deals with analytic problems related to some developments and generalizations of the Boltzmann equation toward the modeling and qualitative analysis of large systems that are of interest in applied sciences These generalizations are documented in the various surveys edited by Bellomo and Pulvirenti with reference to models of granular media traffic flow mathematical biology communication networks and coagulation models. The above literature motivates applied mathematicians to study the Cauchy problem and to develop an asymptotic analysis for models regarded as developments of the Boltzmann equation This

book aims to initiate the research plan by the analyzing afore mentioned analysis problems The first generalization dealt with refers to the averaged Boltzmann equation which is obtained by suitable averaging of the distribution function of the field particles into the action domain of the test particle. This model is further developed to describe equations with dissipative collisions and a class of models that are of interest in mathematical biology In this latter case the state of the particles is defined not only by a mechanical variable but also by a biological microscopic state. The book is essentially devoted to analytic aspects and deals with the analysis of the Cauchy problem and with the development of an asymptotic theory to Motor Vehicle Dynamics: Modelling And Simulation obtain the macroscopic description from the mesoscopic one Giancarlo Genta, 1997-04-19 The book starts with an historical overview of road vehicles. The first part deals with the forces exchanged between the vehicle and the road and the vehicle and the air with the aim of supplying the physical facts and the relevant mathematical models about the forces which dominate the dynamics of the vehicle The second part deals with the dynamic behaviour of the vehicle in normal driving conditions with some extensions towards conditions encountered in high speed racing driving Computational Methods For Pde In Mechanics (With Cd-rom) Berardino D'acunto, 2004-10-12 This book provides a good introduction to modern computational methods for Partial Differential Equations in Mechanics Finite difference methods for parabolic hyperbolic as well as elliptic partial differential equations are discussed A gradual and inductive approach to the numerical concepts has been used such that the presentation of the theory is easily accessible to upper level undergraduate and graduate students Special attention has been given to the applications with many examples and exercises provided along with solutions For each type of equation physical models are carefully derived and presented in full details Windows programs developed in C language have been included in the accompanying CD ROM These programs can be easily modified to solve different problems and the reader is encouraged to take full advantage of the innovative features of this powerful development tool Numerical Methods for Viscosity Solutions and Applications Maurizio Falcone, Charalampos Makridakis, 2001 Geometrical optics and viscosity solutions A P Blanc G T Kossioris and G N Makrakis Computation of vorticity evolution for a cylindrical Type II superconductor subject to parallel and transverse applied magnetic fields A Briggs et al A characterization of the value function for a class of degenerate control problems F Camilli Some microstructures in three dimensions M Chipot and V Lecuyer Convergence of numerical schemes for the approximation of level set solutions to mean curvature flow K Deckelnick and G Dziuk Optimal discretization steps in semi lagrangian approximation of first order PDEs M Falcone R Ferretti and T Manfroni Convergence past singularities to the forced mean curvature flow for a modified reaction diffusion approach F Fierro The viscosity duality solutions approach to geometric pptics for the Helmholtz equation L Gosse and F James Adaptive grid generation for evolutive Hamilton Jacobi Bellman equations L Grune Solution and application of anisotropic curvature driven evolution of curves and surfaces K Mikula An adaptive scheme on unstructured grids for the shape from shading problem M Sagona and A Seghini On a posteriori error

estimation for constant obstacle problems A Veeser Mathematical Models and Methods for Smart Material Mauro Fabrizio, 2002 This book contains the papers presented at the conference on OC Mathematical Models and Methods for Smart MaterialsOCO held in Italy in 2001 The papers are divided into four parts OCOMethods in Materials ScienceOCO deals mainly with mathematical techniques for the investigation of physical systems such as liquid crystals materials with internal variables amorphous materials and thermoelastic materials Also techniques are exhibited for the analysis of stability and controllability of classical models of continuum mechanics and of dynamical systems OCOModelling of Smart MaterialsOCO is devoted to models of superfluids superconductors materials with memory nonlinear elastic solids and damaged materials In the elaboration of the models thermodynamic aspects play a central role in the characterization of the constitutive properties OCOWell Posedness in Materials with MemoryOCO deals with existence uniqueness and stability for the solution of problems most often expressed by integrodifferential equations which involve materials with fading memory Also attention is given to exponential decay in viscoelasticity inverse problems in heat conduction with memory and automatic control for parabolic equations OCOAnalytic Problems in Phase TransitionsOCO discusses nonlinear partial differential equations associated with phase transitions and hysteresis possibly involving fading memory effects Particular applications are developed for the phase field model with memory the Stefan problem with a Cattaneo type equation the hysteresis in thermo visco plasticity and the solid solid phase transition **Advanced Mathematical And Computational Tools In Metrology** Vi Patrizia Ciarlini, Maurice G Cox, Franco Pavese, Giovanni Battista Rossi, Dieter Richter, 2004-07-09 This volume collects refereed contributions based on the presentations made at the Sixth Workshop on Advanced Mathematical and Computational Tools in Metrology held at the Istituto di Metrologia G Colonnetti IMGC Torino Italy in September 2003 It provides a forum for metrologists mathematicians and software engineers that will encourage a more effective synthesis of skills capabilities and resources and promotes collaboration in the context of EU programmes EUROMET and EA projects and MRA requirements It contains articles by an important worldwide group of metrologists and mathematicians involved in measurement science and together with the five previous volumes in this series constitutes an authoritative source for the mathematical statistical and software tools necessary to modern metrology. The proceedings have been selected for coverage in Index to Scientific Technical Proceedings ISTP ISI Proceedings Index to Scientific Technical Proceedings ISTP CDROM version ISI Proceedings CC Proceedings Engineering Physical Sciences Wavelet and Wave Analysis as Applied to Materials with Micro Or Nanostructure Carlo Cattani, I?A?rema I?A?roslavovich Rushchit?s?ki?, 2007 This seminal book unites three different areas of modern science the micromechanics and nanomechanics of composite materials wavelet analysis as applied to physical problems and the propagation of a new type of solitary wave in composite materials nonlinear waves Each of the three areas is described in a simple and understandable form focusing on the many perspectives of the links among the three All of the techniques and procedures are described here in the clearest and most open form enabling

the reader to quickly learn and use them when faced with the new and more advanced problems that are proposed in this book By combining these new scientific concepts into a unitary model and enlightening readers on this pioneering field of research readers will hopefully be inspired to explore the more advanced aspects of this promising scientific direction. The application of wavelet analysis to nanomaterials and waves in nanocomposites can be very appealing to both specialists working on theoretical developments in wavelets as well as specialists applying these methods and experiments in the **Evolution Equations And Approximations** Kazufumi Ito,Franz Kappel,2002-05-24 This book presents an approximation theory for a general class of nonlinear evolution equations in Banach spaces and the semigroup theory including the linear Hille Yosida nonlinear Crandall Liggett and time dependent Crandall Pazy theorems The implicit finite difference method of Euler is shown to generate a sequence convergent to the unique integral solution of evolution equations of the maximal monotone type Moreover the Chernoff theory provides a sufficient condition for consistent and stable time integration of time dependent nonlinear equations The Trotter Kato theorem and the Lie Trotter type product formula give a mathematical framework for the convergence analysis of numerical approximations of solutions to a general class of partial differential equations This book contains examples demonstrating the applicability of the generation as well as the approximation theory In addition the Kobayashi Oharu approach of locally quasi dissipative operators is discussed for homogeneous as well as nonhomogeneous equations Applications to the delay differential equations Navier Stokes equation and scalar conservation equation are given **Multigroup Equations for the Description of the Particle Transport in Semiconductors** Martin Galler, 2005 Deterministic simulation of the particle transport in semiconductor devices is an interesting alternative to the common Monte Carlo approach In this book a state of the art technique called the multigroup approach is presented and applied to a variety of transport problems in bulk semiconductors and semiconductor devices High field effects as well as hot phonon phenomena in polar semiconductors are studied in detail The mathematical properties of the presented numerical method are studied and the method is applied to simulating the transport of a two dimensional electron gas formed at a semiconductor heterostructure Concerning semiconductor device simulation several diodes and transistors fabricated of silicon and gallium arsenide are investigated For all of these simulations the numerical techniques employed are discussed in detail This unique study of the application of direct methods for semiconductor device simulation provides the interested reader with an indispensable reference on this growing research area Dissipative Phase Transitions Pierluigi Colli, Nobuyuki Kenmochi, J. Sprekels, 2006 Phase transition phenomena arise in a variety of relevant real world situations such as melting and freezing in a solid liquid system evaporation solid solid phase transitions in shape memory alloys combustion crystal growth damage in elastic materials glass formation phase transitions in polymers and plasticity The practical interest of such phenomenology is evident and has deeply influenced the technological development of our society stimulating intense mathematical research in this area This book analyzes and approximates some models and

related partial differential equation problems that involve phase transitions in different contexts and include dissipation Advanced Mathematical & Computational Tools in Metrology VII P. Ciarlini, 2006 This volume collects the effects refereed contributions based on the presentations made at the Seventh Workshop on Advanced Mathematical and Computational Tools in Metrology a forum for metrologists mathematicians and software engineers that will encourage a more effective synthesis of skills capabilities and resources. The volume contains articles by world renowned metrologists and mathematicians involved in measurement science and together with the six previous volumes in this series constitutes an authoritative source of the mathematical statistical and software tools necessary in modern metrology Sample Chapter's Chapter 1 Modelling Measurement Processes in Complex Systems with Partial Differential Equations From Heat Conduction to the Heart 537 KB Contents Modeling Measurement Processes in Complex Systems with Partial Differential Equations From Heat Conduction to the Heart M Bnr et al Mereotopological Approach for Measurement Software E Benoit Data Evaluation of Key Comparisons Involving Several Artefacts M G Cox et al Box Cox Transformations and Robust Control Charts in SPC M I Gomes Multisensor Data Fusion and Its Application to Decision Making P S Giruo et al Generic System Design for Measurement Databases OCo Applied to Calibrations in Vacuum Metrology Bio Signals and a Template System H Gross et al Evaluation of Repeated Measurements from the Viewpoint of Conventional and Bayesian Statistics I Lira Detection of Outliers in Interlaboratory Testing C Perruchet On Appropriate Methods for the Validation of Metrological Software D Richter et al Data Analysis OCo A Dialogue with the Data D S Sivia Validation of Soft Sensors in Monitoring Ambient Parameters P Ciarlini et al Evaluation of Standard Uncertainties in Nested Structures E Filipe Measurement System Analysis and Statistical Process Control A B Forbes Monte Carlo Study on Logical and Statistical Correlation B Siebert et al Some Problems Concerning the Estimate of the Degree of Equivalence in MRA Key Comparisons and of Its Uncertainty F Pavese Preparing for a European Research Area Network in Metrology Where are We Now M Khne et al and other papers Readership Researchers graduate students academics and professionals in metrology Applied And Industrial Mathematics In Italy - Proceedings Of The 7th Conference Mario Primicerio, Renato Spigler, Vanda Valente, 2005-06-14 Industrial mathematics is evolving into an important branch of mathematics Mathematicians in Italy in particular are becoming increasingly aware of this new trend and are engaged in bridging the gap between highly specialized mathematical research and the emerging demand for innovation from industry In this respect the contributions in this volume provide both R D workers in industry with a general view of existing skills and academics with state of the art applications of mathematics to real world problems which may also be incorporated in advanced courses The proceedings have been selected for coverage in Index to Scientific Technical Proceedings ISTP ISI Proceedings Index to Scientific Technical Proceedings ISTP Applied and Industrial Mathematics in CDROM version ISI Proceedings CC Proceedings Engineering Physical Sciences <u>Italy II</u> Vincenzo Cutello, 2007 Industrial mathematics is evolving into an important branch of mathematics Mathematicians in

particular in Italy are becoming increasingly aware of this new trend and are engaged in bridging the gap between highly specialized mathematical research and the emerging demand for innovation from industry The contributions in this volume provide both R D workers in industry with a general view of existing skills and academics with state of the art applications of mathematics to real world problems which may also be incorporated in advanced courses **Lecture Notes on the Discretization of the Boltzmann Equation** N. Bellomo, Ren e Gatignol, 2003 This book presents contributions on the following topics discretization methods in the velocity and space analysis of the conservation properties asymptotic convergence to the continuous equation when the number of velocities tends to infinity and application of discrete models It consists of ten chapters Each chapter is written by applied mathematicians who have been active in the field and whose scientific contributions are well recognized by the scientific community Mechanical And Thermodynamical Modeling **Of Fluid Interfaces** Renee Gatignol, Roger Prud'homme, 2001-06-08 This book constitutes a comprehensive survey of the balance equations for mass momentum and energy for the interfaces in pure fluids and mixtures Constitutive laws are presented for many situations in engineering science and examples are provided including surface viscosity effects variable surface tension and vapor recoil In addition some extensions of existing theory are given stretch effect in premixed flames relaxation zones downstream two phase shock waves and effective surface tension for steep gradient zones

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