Nonlinear Science

Stochastic Port-Hamiltonian Systems

Francesco Cordoni[1] · Luca Di Persio[2] · Riccardo Muradore[2]

Abstract

In the present work we formally extend the theory of port-Hamiltonian systems to include random perturbations. In particular, suitably choosing the space of flow and effort variables we will show how several elements coming from possibly different physical domains can be interconnected in order to describe a dynamic system perturbed by general continuous semimartingale. Relevant enough, the noise does not enter into the system solely as an external random perturbation, since each port is itself intrinsically stochastic. Coherently to the classical deterministic setting, we will show how such an approach extends existing literature of stochastic Hamiltonian systems on pseudo-Poisson and pre-symplectic manifolds. Moreover, we will prove that a power-preserving interconnection of stochastic port-Hamiltonian systems is a stochastic port-Hamiltonian system as well.

Contents

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Random Perturbations Of Hamiltonian Systems

N. Sri Namachchivaya,Y.K. Lin

Random Perturbations Of Hamiltonian Systems:

   Random Perturbations of Hamiltonian Systems Mark Iosifovich Freĭdlin,Alexander D. Wentzell,1994 Random perturbations of Hamiltonian systems in Euclidean spaces lead to stochastic processes on graphs and these graphs are defined by the Hamiltonian In the case of white noise type perturbations the limiting process will be a diffusion process on the graph Its characteristics are expressed through the Hamiltonian and the characteristics of the noise Freidlin and Wentzell calculate the process on the graph under certain conditions and develop a technique which allows consideration of a number of asymptotic problems The Dirichlet problem for corresponding elliptic equations with a small parameter are connected with boundary problems on the graph   **Random Perturbations of Hamiltonian Systems** Mark Iosifovich Freĭdlin,2014-08-31 Random perturbations of Hamiltonian systems in Euclidean spaces lead to stochastic processes on graphs and these graphs are defined by the Hamiltonian In the case of white noise type perturbations the limiting process will be a diffusion process on the graph Its characteristics are expressed through the Hamiltonian and the characteristics of the noise Freidlin and Wentzell calculate the process on the graph under certain conditions and develop a technique which allows consideration of a number of asymptotic problems The Dirichlet problem for corresponding elliptic equations with a small parameter are connected with boundary problems on the graph   <u>Random Perturbations of Dynamical Systems</u> Mark Iosifovich Freĭdlin,Alexander D. Wentzell,1998 The authors main tools are the large deviation theory the centred limit theorem for stochastic processes and the averaging principle all presented in great detail The results allow for explicit calculations of the asymptotics of many interesting characteristics of the perturbed system   <u>On Random Perturbations of Hamiltonian Systems with Many Degrees of Freedom</u> Mark I. Frejdlin,Matthias Weber,2000   *Lyapunov Exponents for Small Random Perturbations of Nilpotent and Hamiltonian Systems* Levon Goukasian,2001   *Topics in Stochastic Analysis and Nonparametric Estimation* Pao-Liu Chow,Boris S. Mordukhovich,G. George Yin,2010-07-19 This IMA Volume in Mathematics and its Applications TOPICS IN STOCHASTIC ANALYSIS AND NONPARAMETRIC ESTIMATION contains papers that were presented at the IMA Participating Institution conference on Asymptotic Analysis in Stochastic Processes Nonparamet ric Estimation and Related Problems held on September 15 17 2006 at Wayne State University The conference which was one of approximately ten selected each year for partial support by the IMA through its affiliates program was dedicated to Professor Rafail Z Khasminskii on the occasion th of his 75 birthday in recognition of his profound contributions to the field of stochastic processes and nonparametric estimation theory We are grateful to the participants and especially to the conference organizers for making the event so successful Pao Liu Chow Boris Mor dukhovich and George Yin of the Department of Mathematics at Wayne State University did a superb job organizing this first rate event and in editing these proceedings We take this opportunity to thank the Nation al Science Foundation for its support of the IMA   *Qualitative and Asymptotic Analysis of Differential Equations with Random Perturbations* Anatoliy M. Samoilenko,Oleksandr

Stanzhytskyi,2011 1 Differential equations with random right hand sides and impulsive effects 1 1 An impulsive process as a solution of an impulsive system 1 2 Dissipativity 1 3 Stability and Lyapunov functions 1 4 Stability of systems with permanently acting random perturbations 1 5 Solutions periodic in the restricted sense 1 6 Periodic solutions of systems with small perturbations 1 7 Periodic solutions of linear impulsive systems 1 8 Weakly nonlinear systems 1 9 Comments and references 2 Invariant sets for systems with random perturbations 2 1 Invariant sets for systems with random right hand sides 2 2 Invariant sets for stochastic Ito systems 2 3 The behaviour of invariant sets under small perturbations 2 4 A study of stability of an equilibrium via the reduction principle for systems with regular random perturbations 2 5 Stability of an equilibrium and the reduction principle for Ito type systems 2 6 A study of stability of the invariant set via the reduction principle Regular perturbations 2 7 Stability of invariant sets and the reduction principle for Ito type systems 2 8 Comments and references 3 Linear and quasilinear stochastic Ito systems 3 1 Mean square exponential dichotomy 3 2 A study of dichotomy in terms of quadratic forms 3 3 Linear system solutions that are mean square bounded on the semiaxis 3 4 Quasilinear systems 3 5 Linear system solutions that are probability bounded on the axis A generalized notion of a solution 3 6 Asymptotic equivalence of linear systems 3 7 Conditions for asymptotic equivalence of nonlinear systems 3 8 Comments and references 4 Extensions of Ito systems on a torus 4 1 Stability of invariant tori 4 2 Random invariant tori for linear extensions 4 3 Smoothness of invariant tori 4 4 Random invariant tori for nonlinear extensions 4 5 An ergodic theorem for a class of stochastic systems having a toroidal manifold 4 6 Comments and references 5 The averaging method for equations with random perturbations 5 1 A substantiation of the averaging method for systems with impulsive effect 5 2 Asymptotics of normalized deviations of averaged solutions 5 3 Applications to the theory of nonlinear oscillations 5 4 Averaging for systems with impulsive effects at random times 5 5 The second theorem of M M Bogolyubov for systems with regular random perturbations 5 6 Averaging for stochastic Ito systems An asymptotically finite interval 5 7 Averaging on the semiaxis 5 8 The averaging method and two sided bounded solutions of Ito systems 5 9 Comments and references *Lyapunov Exponents* Arkady Pikovsky,Antonio Politi,2016-02-11 Lyapunov exponents lie at the heart of chaos theory and are widely used in studies of complex dynamics Utilising a pragmatic physical approach this self contained book provides a comprehensive description of the concept Beginning with the basic properties and numerical methods it then guides readers through to the most recent advances in applications to complex systems Practical algorithms are thoroughly reviewed and their performance is discussed while a broad set of examples illustrate the wide range of potential applications The description of various numerical and analytical techniques for the computation of Lyapunov exponents offers an extensive array of tools for the characterization of phenomena such as synchronization weak and global chaos in low and high dimensional set ups and localization This text equips readers with all the investigative expertise needed to fully explore the dynamical properties of complex systems making it ideal for both graduate students and experienced researchers **Stochastic Averaging** Wei-Qiu

Zhu,Mao-Lin Deng,Guo-Qiang Cai,2025-06-19 The stochastic averaging methods are among the most effective and widely applied approximate methods for studying nonlinear stochastic dynamics Upon an overview of global research on the subject the book highlights a comprehensive summary of research results obtained by the group led by Professor Weiqiu Zhu at Zhejiang University in China and the group led by Professors Y K Lin and G Q Cai at Florida Atlantic University in the USA over the past three decades The books are structured to progress logically from foundational principles to simple problems and then to increasingly complex applications To facilitate understanding and mastery of the methods the books offer essential preliminary knowledge and a wealth of examples The book comprises two volumes Volume 1 introduces the basic principles of stochastic averaging methods and their applications to single degree of freedom systems under various random excitations It also covers stochastic averaging methods for quasi Hamiltonian systems subjected to different random excitations including Gaussian white noise combined Gaussian and Poisson white noises and fractional Gaussian noise Volume 2 explores stochastic averaging methods for quasi integrable Hamiltonian systems under colored noise excitation quasi integrable Hamiltonian systems with genetic effects under Gaussian white noise and colored noise excitations and quasi generalized Hamiltonian systems under Gaussian white noise excitation Additionally it covers applications of these methods in ecosystems and some other natural science and engineering scenarios These books serve as both introductory texts and valuable reference resources for readers in higher education and research institutions who are interested in or actively engaged in research involving nonlinear stochastic dynamics The fields covered include mechanics physics chemistry biology ecology astronautics and aeronautics oceanography civil engineering mechanical engineering and electrical engineering **IUTAM Symposium on Nonlinear Stochastic Dynamics** N. Sri Namachchivaya,Y.K. Lin,2012-12-06 Non linear stochastic systems are at the center of many engineering disciplines and progress in theoretical research had led to a better understanding of non linear phenomena This book provides information on new fundamental results and their applications which are beginning to appear across the entire spectrum of mechanics The outstanding points of these proceedings are Coherent compendium of the current state of modelling and analysis of non linear stochastic systems from engineering applied mathematics and physics point of view Subject areas include Multiscale phenomena stability and bifurcations control and estimation computational methods and modelling For the Engineering and Physics communities this book will provide first hand information on recent mathematical developments The applied mathematics community will benefit from the modelling and information on various possible applications On the Martingale Problem for Interactive Measure-Valued Branching Diffusions Edwin Arend Perkins,1995 This book develops stochastic integration with respect to Brownian trees and its associated stochastic calculus with the aim of proving pathwise existence and uniqueness in a stochastic equation driven by a historical Brownian motion Perkins uses these results and a Girsanov type theorem to prove that the martingale problem for the historical process associated with a wide class of interactive branching measure valued

diffusions superprocesses is well posed The resulting measure valued processes will arise as limits of the empirical measures of branching particle systems in which particles interact through their spatial motions or to a lesser extent through their branching rates **Symmetric Automorphisms of Free Products** Darryl McCullough,Andy Miller,1996 The authors construct a complex italic capital K italic capital G on which the automorphism group of italic capital G acts and use it to derive finiteness consequences for the group capital Greek Sigma italic Aut italic capital G They prove that each component of italic capital K italic capital G is contractible and describe the vertex stabilizers as elementary constructs involving the groups italic capital G subscript italic i and italic Aut italic capital G subscript italic i <u>Stochastic Climate Models</u> Peter Imkeller,Jin-Song von Storch,2012-12-06 The proceedings of the summer 1999 Chorin workshop on stochastic climate models captures well the spirit of enthusiasm of the workshop participants engaged in research in this exciting field It is amazing that nearly 25 years after the formal theory of natural climate variability generated by quasi white noise weather forcing was developed and almost 35 years after J M Mitchell first suggested this mechanism as the origin of sea surf ace temperature fluctuations and climate variability there have arisen so many fresh perspectives and new applications of the theory The workshop has succeeded admirably in high lighting these new aspects while clarifying the position of stochastic climate modelling within the general framework of climate research and mathematical modelling The organizers can be congratulated in bringing together leading researchers covering a wide range of scientific expertise from mathematicians concerned with the derivation of stochastic models from first principles to app lied climate modellers trying to understand the dynamics of the complex climate system Following the first burst of stochastic modelling papers in the decade from the mid seventies to the mid eighties in which the viability of the concept was demonstrated using relatively simple conceptual models there was a lull of work in this field One awaited the development of more sophisticated climate models with which one could carry out realistic quantitative analyses of the implications of stochastic forcing for the global climate system Now that these models have become widely available it is natural that one is witnessing a resurgence of stochastic modelling investigations **Markov Chains and Stochastic Stability** Sean Meyn,Richard L. Tweedie,2009-04-02 New up to date edition of this influential classic on Markov chains in general state spaces Proofs are rigorous and concise the range of applications is broad and knowledgeable and key ideas are accessible to practitioners with limited mathematical background New commentary by Sean Meyn including updated references reflects developments since 1996 *International Conference on Theory and Application in Nonlinear Dynamics (ICAND 2012)* Visarath In,Antonio Palacios,Patrick Longhini,2013-12-13 A collection of different lectures presented by experts in the field of nonlinear science provides the reader with contemporary cutting edge research works that bridge the gap between theory and device realizations of nonlinear phenomena Representative examples of topics covered include chaos gates social networks communication sensors lasers molecular motors biomedical anomalies stochastic resonance nano oscillators for generating microwave signals and related complex

systems A common theme among these and many other related lectures is to model study understand and exploit the rich behavior exhibited by nonlinear systems to design and fabricate novel technologies with superior characteristics Consider for instance the fact that a shark s sensitivity to electric fields is 400 times more powerful than the most sophisticated electric field sensor In spite of significant advances in material properties in many cases it remains a daunting task to duplicate the superior signal processing capabilities of most animals Since nonlinear systems tend to be highly sensitive to perturbations when they occur near the onset of a bifurcation there are also lectures on the general topic of bifurcation theory and on how to exploit such bifurcations for signal enhancements purposes This manuscript will appeal to researchers interested in both theory and implementations of nonlinear systems   Discretization of Homoclinic Orbits, Rapid Forcing and ``Invisible'' Chaos Bernold Fiedler,Jürgen Scheurle,1996 Numerically speaking continuous time dynamical systems do not exist Rather a discretized version is studied and interpreted in analogy to the continuous time dynamical system Over fixed finite time intervals this analogy is quite close and well understood in terms of discretization errors and sophisticated discretization schemes Over large or infinite time intervals this analogy is not so clear because discretization errors tend to accumulate exponentially with time In this paper we specifically investigate the correspondence between continuous and discrete time dynamical systems for homoclinic orbits By definition these are orbits which tend to the same stationary point for both large positive and large negative times   Automorphisms of the Lattice of Recursively Enumerable Sets Peter Cholak,1995 A version of Harrington s capital Greek Delta3 automorphism technique for the lattice of recursively enumerable sets is introduced and developed by reproving Soare s Extension Theorem Then this automorphism technique is used to show two technical theorems the High Extension Theorem I and the High Extension Theorem II This is a degree theoretic technique for constructing both automorphisms of the lattice of r e sets and isomorphisms between various substructures of the lattice

Second-Order Sturm-Liouville Difference Equations and Orthogonal Polynomials Alouf Jirari,1995 This memoir presents machinery for analyzing many discrete physical situations and should be of interest to physicists engineers and mathematicians We develop a theory for regular and singular Sturm Liouville boundary value problems for difference equations generalizing many of the known results for differential equations We discuss the self adjointness of these problems as well as their abstract spectral resolution in the appropriate italic capital L2 setting and give necessary and sufficient conditions for a second order difference operator to be self adjoint and have orthogonal polynomials as eigenfunctions

The 2-Dimensional Attractor of $x'(t)=-{\mu } x(t) + f(x(t-1))$ Hans-Otto Walther,1995 See attachment

Tilting in Abelian Categories and Quasitilted Algebras Dieter Happel,Idun Reiten,Sverre O. Smalø,1996 We generalize tilting with respect to a tilting module of projective dimension at most one for an Artin algebra to tilting with respect to a torsion pair in an Abelian category Our construction is motivated by the connection between tilting and derived categories We develop a general theory for such tilting and are led to a generalization of tilting algebras which we call quasitilted

algebras This class also contains the canonical algebras and we show that the quasitilted algebras are characterized by having global dimension at most two and each indecomposable module having projective dimension at most one or injective dimension at most one We also give other characterizations of quasitilted algebras and give methods for constructing such algebras

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Table of Contents Random Perturbations Of Hamiltonian Systems

1. Understanding the eBook Random Perturbations Of Hamiltonian Systems
    - The Rise of Digital Reading Random Perturbations Of Hamiltonian Systems
    - Advantages of eBooks Over Traditional Books
2. Identifying Random Perturbations Of Hamiltonian Systems
    - Exploring Different Genres
    - Considering Fiction vs. Non-Fiction
    - Determining Your Reading Goals
3. Choosing the Right eBook Platform
    - Popular eBook Platforms
    - Features to Look for in an Random Perturbations Of Hamiltonian Systems
    - User-Friendly Interface
4. Exploring eBook Recommendations from Random Perturbations Of Hamiltonian Systems
    - Personalized Recommendations
    - Random Perturbations Of Hamiltonian Systems User Reviews and Ratings
    - Random Perturbations Of Hamiltonian Systems and Bestseller Lists
5. Accessing Random Perturbations Of Hamiltonian Systems Free and Paid eBooks
    - Random Perturbations Of Hamiltonian Systems Public Domain eBooks
    - Random Perturbations Of Hamiltonian Systems eBook Subscription Services

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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