天元数学国际交流中心

Tianyuan Mathematics Research Center

分数布朗运动与粗糙动力系统
前沿研讨会

Worshop on Fractional Brownian Motion and Rough Dynamical systems

Organizers： 高洪俊（Gao Hongjun）
黄建华（Huang Jianhua）
曹琪勇（Cao Qiyong）

会议手册
Programme

Yunnan· Kunming

Aug.03-09,2005

Schedule

8:55 am-9:10 am	OPENING and GROUP PHOTO	
9:10 am-10:00 am	Speaker: 裴斌（Pei Bin）	Chair: 黄建华（Huang Jianhua）
10:00 am-10:30 am	TEA BREAK	
10:30 am-11:20 am	Speake 李晓月(Li Xiaoyue)	Chair: 崔建波(Cui Jianbo)
11:20 am-14:00 pm	LUNCH BREAK	
14:00 pm-14:50 pm	Speaker: 崔建波(Cui Jianbo)	Chair: 李晓月(Li Xiaoyue)
14:50 pm-15:20 pm	TEA BREAK	
15:20 pm-16:10 pm	Speaker: 陈楚楚(Chen Chuchu)	Chair: 曹婉容(Cao Wanrong)
16:10 pm-17:00 pm	Speaker: 曹婉容(Cao Wanrong)	Chair: 陈楚楚(Chen Chuchu)
17:00 pm	DINNER BREAK	

August 5,Tuesday

8:00 am-8:50 am	Speaker: 申广君(Shen Guangjun)	Chair: 吴付科(Wu Fuke)
8:50 am-9:40 am	Speaker: 吴付科(Wu Fuke)	Chair: 申广君(Shen Guangjun)
9:40 am-10:10 am	TEA BREAK	
10:10 am-11:00 am	Speaker: 徐杰(Xu Jie)	Chair: 乔会杰(Qiao Huijie)
11:00 am-14:00 pm	LUNCH BREAK	
14:00 pm-14:50 pm	Speaker: 乔会杰(Qiao Huijie)	Chair: 徐杰(Xu Jie)
14:50 pm-15:20 pm	TEA BREAK	
15:20 pm-16:10 pm	Speaker: 杨美华(Yang Meihua)	Chair: 刘志明(Liu Zhiming)
16:10 pm-17:00 pm	Speaker: 刘志明(Liu Zhiming)	Chair: 杨美华(Yang Meihua)
17:00 pm	DINNER BREAK	

August,6 Wednesday

8:00 am-8:50 am	Speaker: 杨洪福(Yang Hongfu)	Chair: 王伟(Wang Wei)
8:50 am-9:40 am	Speaker: 王伟(Wang Wei)	Chair: 杨洪福(Yang Hongfu)
9:40 am-10:10 am	TEA BREAK	
10:10 am-11:00 am	Speaker: 王业娟(Wang Yejuan)	Chair: 陈勇(Chen Yong)

11:00 am-11:50 am	Speaker: 陈勇(Chen Yong)	Chair: 王业娟(Wang Yejuan)
11:50 am-14:00 pm	LUNCH BREAK	
14:00 pm-17:00 pm	FREE DISSCUSSION	
17:00 pm	DINNER BREAK	

Aug 7,Thursday

8:00 am-8:50 am	Speaker: 曾才斌(Zeng Caibin)	Chair: 曲世铎(Qu Shiduo)
8:50 am-9:40 am	Speaker: 曲世铎(Qu Shiduo)	Chair: 曾才斌(Zeng Caibin)
9:40 am-10:10 am	TEA BREAK	
10:10 am-11:00 am	Speaker: 陈鹏玉(Chen Pengyu)	Chair: 陈章(Chen Zhang)
11:00 am-14:00 pm	LUNCH BREAK	
14:00 pm-14:50 pm	Speaker: 陈章(Chen Zhang)	Chair: 陈鹏玉(Chen Pengyu)
14:50 pm-15:20 pm	TEA BREAK	
15:20 pm-16:10 pm	Speaker: 石琳(Shi Lin)	Chair: 申俊(Shen Jun)
16:10 pm-17:00 pm	Speaker: 申俊(Shen Jun)	Chair: 石琳(Shi Lin)
17:00 pm	DINNER BREAK	

Aug 8,Friday

8:00 am-8:50 am	Speaker: 赵才地(Zhao Caidi)	Chair: 高洪俊(Gao Hongjun)
8:50 am-9:40 am	Speaker: 黎定仕(Li Dingshi)	Chair: 赵才地(Zhao Caidi)
9:40 am-10:10 am	TEA BREAK	
10:10 am-11:00 am	Speaker: 曹琪勇(Cao Qiyong)	Chair: 黎定仕
11:00 am-11:50 am	Speaker: 陈涌(Chen Yong)	Chair: 曹琪勇(Cao Qiyong)
11:50 am-14:00 pm	LUNCH BREAK	
14:00 pm-17:00 pm	FREE DISSCUSSION	
17:00 pm	DINNER BREAK	

Aug 9,Saturday

8:00 am-11:00 am	FREE DISSCUSSION
11:00 am-14:00 pm	LUNCH BREAK

Title & Abstract

曹琪勇(Cao Qiyong)，Southwest Jiaotong University

Title: Sychronization of stochastic differential equations driven by fractional noises

Abstract: In this talk, we concern a class of dissipative stochastic differential equations driven by nonlinear multiplicative fractional Brownian noise with Hurst index $H \in \left(\frac{1}{3}, 1\right)$. We establish the well-posedness of the associated coupled stochastic differential equations and prove synchronization in the sense of trajectories. Our approach relies on the Doss-Sussmann transformation, which enables us to extend existing results for additive and linear noise to the case of nonlinear multiplicative fractional Brownian noise. The findings provide new insights into the synchronization of dissipative systems under fractional noise perturbations.

曹婉容(Cao Wanrong)，Southeast University

Title: Approximation of invariant measure for the stochastic Cahn–Hilliard equation

Abstract: The stochastic Cahn – Hilliard equation (SCHE) serves as a fundamental model for phase separation in binary alloys under thermal fluctuations. In this work, we analyze the SCHE driven by additive white noise and prove the existence and uniqueness of an ergodic invariant measure in H_α. Motivated by the need of the numerical methods for capturing long-time behavior, we propose a fully discrete scheme and obtain its uniformly strong convergence rate. On the basis, we prove that the numerical solution admits a unique invariant measure converging to the exact one.

陈楚楚(Chen Chuchu)，Academy of Mathematics and Systems Science,CAS

Title: Stochastic modified equations of symplectic methods for stochastic Hamiltonian systems

Abstract: Stochastic Hamiltonian systems play a central role in various disciplines. A defining characteristic of such systems is the preservation of the stochastic symplectic structure by the phase flow. When numerically approximating these systems, it is natural to seek methods that inherit this structure, which has driven the development of stochastic symplectic methods. These methods have shown clear advantages over non-symplectic schemes, particularly in long-time simulations, as confirmed by numerous numerical experiments. In this talk, we investigate stochastic modified equations to reveal the mathematical mechanisms behind the effectiveness of stochastic symplectic methods. In particular, for stochastic symplectic methods, the associated stochastic modified equations are proved to have Hamiltonian formulations. And the pathwise error between the numerical solution and the modified equation can be made exponentially small with respect to the time step size.

陈鹏玉(Chen Pengyu)，Northwest Normal University

Title: Random dynamics of 3D Benjamin-Bona-Mahony equations

Abstract: In this talk, I will introduce our recent work on the existence and upper semi-continuity of pullback random attractors for non-autonomous Benjamin-Bona-Mahony equations driven by nonlinear colored noise defined on 3D unbounded channels. We first prove the existence, uniqueness, and backward compactness of a special kind of pullback random attractor by the methods of spectral decomposition inside bounded domains as well as the uniform tail-estimates of solutions outside bounded domains over the infinite time interval in order to surmount the difficulties caused by lack of compact Sobolev embedding on unbounded domains and weak dissipative structure of the equation. The measurability of such an attractor is proven by showing that the defined two kinds of attractors with respect to two different universes are equal. Then, the asymptotically autonomous upper semi-continuity of the attractors is investigated by assuming that the time-dependent external forcing term converges to the time-independent external force as the time-parameter tends to negative infinity. At last, the upper semi-continuity of random attractors for non-autonomous Benjamin-Bona-Mahony equations with nonlinear colored noise and time-delay as time delay approaches zero is established.

陈涌(Chen Yong)，Zhejiang Sci-Tech University

Title: On the stochastic Korteweg-de Vries equation with pure jump noise

Abstract: We investigate the stochastic Korteweg--de Vries (KdV) equation driven by pure jump noise in Marcus canonical form. First, we establish the existence of local strong solutions in the Sobolev space H^s for $s > \frac{3}{4}$ by employing a truncated equation approach and leveraging the local smoothing properties of the associated semigroup. For small initial data, we further prove global existence with high probability. Additionally, we derive a blow-up criterion in H^s for $s > \frac{3}{2}$, which, combined with conservation laws, enables us to establish almost sure global existence in H^s for $s \geq 2$. Furthermore, we demonstrate the existence of martingale solutions in L^2 and obtain a global strong solution through pathwise uniqueness. Finally, we analyze the asymptotic behavior of solutions as the intensity of the jump noise tends to zero. For initial data given by a solitary wave solution of the deterministic KdV equation, we show that the solution decomposes into a randomly modulated solitary wave and a small remainder term. We derive the modulation equations governing the wave parameters and prove that, as the noise vanishes, the remainder converges to the solution of a linear stochastic equation.

陈勇(Chen Yong)，Jiangxi Normal University

Title: Parameter Estimation for Complex α-Fractional Brownian Bridge

Abstract: We study the statistical inference problem for a complex α-fractional Brownian bridge process $\mathbb{Z}$:

$$\mathrm{d}Z_t = -\alpha \frac{Z_t}{T-t}\mathrm{d}t + \mathrm{d}\zeta_t, \quad t \in [0,T); \quad Z_0 = 0,$$

where $\alpha = \lambda - \sqrt{-1}w, \lambda > 0, w \in \mathbb{R}$, and $\{\zeta_t, t \in [0,T)\}$ is a complex fractional Brownian motion. The strong consistency and the asymptotic distribution for the least squares estimator of the parameter α when $H \in \left(\frac{1}{2}, 1\right)$ are obtained. The proofs are based on stochastic analysis elements about complex multiple Wiener-It\^o integrals and the complex Malliavin calculus.

陈章(Chen Zhang)，Shandong Universitgy

Title: Invariant measures for neural field lattice models under noise perturbation

Abstract: Neural field models may be used to describe the average activity of neural populations. To emphasize the discrete characters of neural networks, neural field lattice models were considered in the literature, which extend the famous Hopfield neural networks with finite neurons. In this talk, we will mainly introduce convergence and numerical approximation of invariant measures for neural field lattice models in random environment.

崔建波(Cui Jianbo)，The Hong Kong Polytechnic University

Title: Wasserstein Hamiltonian Flow and Its Structure Preserving Numerical Scheme

Abstract: We study discretizations of Hamiltonian systems on the probability density manifold equipped with the L2-Wasserstein metric. For low dimensional problems, based on discrete optimal transport theory, several Wasserstein Hamiltonian flows(WHFs) on graph are derived. They can be viewed as spatial discretizations to the original systems. By regularizing the system using Fisher information, we propose a novel regularized symplectic scheme which could preserve several desirable longtime behaviors. Furthermore, we use the coupling idea and WHF to propose a supervised learning scheme for some high-dimensional problem. If time permits we will talk about more details on solving high-dimensional Hamilton-Jacobi equation via the density coupling and supervised learning.

黎定仕(Li Dingshi)，Southwest Jiaotong University

Title: Uniform Measure Attractors for Non-autonomous Stochastic Delayed Lattice Systems with High-order Nonlinear Noise

Abstract: This talk investigates uniform measure attractors for nonautonomous stochastic lattice systems with delay driven by high-order nonlinear noise. While previous studies have investigated attractors for stochastic lattice systems with delay, the existence of uniform measure attractors for systems with high-order

nonlinear drift and diffusion terms remains unresolved due to the inherent difficulty in obtaining uniform closed absorbing sets under high-order nonlinearities. To address this challenge, we establish an equivalent theoretical framework for uniform measure attractors via ω-limit compactness and uniform asymptotic tightness, which removes the reliance on uniform closed absorbing sets. Within this novel framework, we prove the existence and uniqueness of uniform measure attractors for non-autonomous stochastic delay lattice systems with almost-periodic forcing and high-order nonlinear terms.

李晓月(Li Xiaoyue)，Tiangong University

Title: Discretization of super-linear slow–fast stochastic differential equations

Abstract: This talk is dedicated to the discretization of super-linear slow–fast stochastic differential equations (SFSDEs). Borrowing the heterogeneous multiscale idea, we propose an explicit multiscale discrete equation suitable for SFSDEs with locally Lipschitz coefficients using an appropriate truncation technique. By the averaging principle, we establish the strong convergence of the numerical solutions to the exact solutions in the th moment. Additionally, under lenient conditions on the coefficients, we also furnish a strong error estimate. This work is accomplished in cooperation with Yuanping Cui and Xuerong Mao.

刘志明(Liu Zhiming)，National University of Defense Technology

Title: Weak mean random attractors for nonautonomous stochastic parabolic equation with variable exponents

Abstract: In this paper, we consider the asymptotic behavior of solutions for nonautonomous stochastic parabolic equation with nonstandard growth condition driven by nonlinear multiplicative noise for the first time. First, by making use of variational method, we prove the existence and uniqueness of solutions, and then the mean random dynamical systems generated by stochastic parabolic equations with variable exponents are obtained. Finally, due to the influence of variable indexes (dependent on space variable), we show the existence of weak mean random attractors under suitable assumptions on the variable exponents and the diffusion term.

裴斌(Pei Bin)，National University of Defense Technology

Title: Averaging principle for semilinear slow–fast rough partial differential equations

Abstract: In this talk, we investigate the averaging principle for a class of semilinear slow–fast partial differential equations driven by finite-dimensional rough multiplicative noise. Specifically, the slow component is driven by a general random γ-Hölder rough path for some $\gamma \in (1/3, 1/2)$, while the fast component is driven by an Itô-type Brownian rough path. Using controlled rough path theory and the classical Khasminskii's time discretization scheme, we demonstrate that the slow component converges strongly to the solution of the corresponding averaged equation under the Hölder topology.

乔会杰(Qiao Huijie)，Southeast University

Title: Path independence for the additive functionals of stochastic Volterra equations with singular kernels and Holder continuous coefficients

Abstract: In this paper, we are concerned with stochastic Volterra equations with singular kernels and Holder continuous coefficients. We first establish the well-posedness of these equations by utilizing the Yamada-Watanabe approach. Then, we aim to characterize the path-independence for additive functionals of these equations. The main challenge here is that the solutions of stochastic Volterra equations are not semimartingales nor Markov processes, thus the existing techniques for obtaining the path-independence of usual, semimartingale type stochastic differential equations are no longer applicable. To overcome this difficulty, we link the concerned stochastic Volterra equations to mild formulation of certain parabolic type stochastic partial differential equations, and further apply our previous results on the path-independence for stochastic evolution equations to get the desired result.

曲世铎(Qu Shiduo)，Southeast University

Title: Delay Rough Partial Differential Equations

Abstract: In this talk, we will introduce delay rough partial differential equations (DRPDEs) . Firstly, we review some concepts about rough path theory and stochastic delay differential equations. Secondly, we focus on the existence and stability of the solution of a class of delay rough partial differential equations. Moreover, we prove that the solution of DRPDEs can converge to that of RPDEs as the delay tends to zero. Furthermore, these results can be applied to study a class of delayed stochastic partial differential equations (SPDEs) driven by Brownian motion and fractional Brownian with Hurst parameter belonging to (1/3,1/2).

申广君(Shen Guangjun)，Anhui Normal University

Title: Some results on distribution dependent SDEs driven by fractional Brownian motions

Abstract: In this talk, we will introduce some recent progress on distribution dependent SDEs driven by fractional Brownian motions, including the averaging principle, large and moderate deviation principles.

申俊(Shen Jun)，Sichuan University

Title: Stochastic invariant manifolds for stochastic differential equations

Abstract: In this talk, we consider the long-term dynamic behavior of stochastic differential equations driven by a nonlinear multiplicative noise. Unlike the case driven by additive or linear multiplicative noise, the classical Ornstein-Ulenbeck transformation is no longer applicable. Here we do not consider the framework of mean-square random dynamical systems that has been established. We will generalize the martingale representation theorem and establish the theory of adapted solutions of backward stochastic differential equations for the negative time direction. As a result, we prove the existence of stochastic unstable manifolds and stable sets.

石琳(Shi Lin)，University of Electronic Science and Technology of China

Title: Limiting behaviors of invariant manifolds and foliations for SPDEs on thin domain

Abstract: In this talk, we study stochastic partial differential equations driven by multiplicative white noise in varying phase spaces. We establish the smooth convergence of invariant manifolds and foliations of these equations, respectively. In contrast to the convergence of pseudo-unstable manifolds, we introduce a novel technique to address challenges arising from the singularity of the stable term of hyperbolicity in the proof of convergence of stable manifolds and stable foliations as the space collapses.

王伟(Wang Wei)，Nanjing University

Title: Rough path in SK approximation

Abstract: I will talk about the higher order SK approximation which is related to the rough path theory.

王业娟(Wang Yejuan)，Lanzhou University

Title: Feynman-Kac formula for general diffusion equations driven by TFBM with Hurst index $H \in (0,1)$

Abstract: We consider the general diffusion equation driven by TFBM with Hurst index $H \in (0,1)$ and tempering parameter $\lambda > 0$. By using methods from stochastic analysis, we show that the Feynman-Kac representation is the unique mild solution to the deterministic general diffusion equation with nonautonomous external potential. Based on approximating TFBM with a family of Gaussian processes possessing absolutely continuous sample paths, a unified framework of the Feynman-Kac formula is established for the general stochastic diffusion equation driven by TFBM. By using the properties of TFBM and especially that of

the modified Bessel function of the second kind, we prove that the process defined by the Feynman-Kac formula is the mild and weak solutions of the general diffusion equation driven by TFBM.

吴付科(Wu Fuke)，Huazhong University of Science and Technology

Title: Large deviations for regime-switching diffusions with infinite delay

Abstract: Focusing on a class of regime-switching functional diffusion processes with infinite delay, a Freidlin – Wentzell type large deviations principle (LDP) is established by using an extended contraction principle and an exponential approximation argument under a local one-side Lipschitz condition. The result is new even for functional diffusion processes with infinite delay without regime-switching. Several interesting examples are given to illustrate our results.

徐杰(Xu Jie)，Henan Norma University

Title: Diffusion approximation for full coupled SDEs and related problems

Abstract: In this talk, I will focus on the diffusion approximation for full coupled SDEs and related problems.

杨美华(Yang Meihua)，Huazhong University of Science and Technology

Title: Pointwise convergence of free Ostrovsky equation with random data

Abstract: This talk is about the pointwise convergence of free Ostrovsky equation with random data. Firstly, we show the pointwise convergence of free Ostrovsky equation in $L^2(\mathbb{R})$ with initial random data. Secondly, we show the pointwise convergence of free reduced Ostrovsky equation in $\widehat{L}^r(\mathbb{R})$, $r \geq 2$ with initial random data. The results show that the random data case requires lessregularity of the initial data than the rough data case. Joint work with Wei Yan, Jinqiao Duan, Qiaoqiao Zhang, Xiangqian Yan and Yajuan Zhao.

杨洪福(Yang Hongfu)，Guanxi Normal University

Title: Strong convergence and asymptotic stability of explicit numerical schemes for nonlinear stochastic differential equations

Abstract: This talk will introduce the development of several low-order explicit numerical methods for highly nonlinear stochastic differential equations, along with their strong convergence theory and asymptotic stability approximation theory. Additionally, we will introduce a novel explicit method specifically designed for the stochastic SIS epidemic model, which can preserve both the bounded positive domain and asymptotic properties of solutions. This talk is based on joint work with Prof. Jianhua Huang, Prof. Xiaoyue Li, and Prof. Xuerong Mao.

曾才斌，华南理工大学，中国

Title: Global well-posedness for rough PDEs of level 3

Abstract: This talk addresses nonlinear diffusion problems in the rapidly evolving field of rough partial differential equations (RPDEs). While existing results exclusively rely on level-2 rough paths, we develop a novel framework for level-3 controlled rough paths. Using this structure, we establish global well-posedness for a class of RPDEs via refined a priori estimates. Furthermore, we construct a tailored control function and an associated sequence of greedy times. The combinatorial properties of these key tools yield an integrable bound on solutions.

赵才地，温州大学，中国

Title: Statistical solutions and related properties for non-autonomous quasi-geostrophic equations with fractional dissipation

Abstract: This article investigates the statistical solutions and related properties for a non-autonomous quasi-geostrophic equation with sub-critical dissipation. The authors first prove the existence of a pullback attractor for the evolution process generated by the solution mappings and then establish that the process admits a family of invariant Borel probability measures. Then they prove that the obtained probability measures satisfies the Liouville theorem in Statistical Mechanics and is indeed a statistical solution for the addressed quasi-geostrophic equation. Afterwards, they show that the statistical solutions degenerates to a single bounded complete trajectory which possesses the Lusin type regularity provided that the Grashof number associated with the external force is small enough. Finally, the equivalence between invariant measures and regular statistical solutions is verified. This work is joint with Liang Tongtong and Yan Wei.

周国立，重庆大学，中国

Title: Stochastic 3D Burgers Equation

Abstract: In this talk, we give an introduction to our recent progress in stochastic 3D viscous/inviscid Burgers equation including:

(i) the global well-posedness of stochastic 3D viscous Burgers equation in H12(T3).

(ii) the ergodicity of stochastic 3D viscous Burgers equation in H12(T3).

(iii) the existence and uniqueness of weak solutions to stochastic 3D viscous Burgers equation in L2(T3).

(iv) the global well-posedness of stochastic 3D inviscid Burgers equation and its application to inviscid limit.

(v) the ergodicity of stochastic 3D inviscid Burgers equation.

(vi) the global well-posedness and large deviations of stochastic 3D viscous Burgers equation in H1(R3).