随机偏微分方程与多尺度分析研讨会
SPDEs and multiscale analysisMultiscale analysis and SPDEs

Date

2024-04-12 ~ 2024-04-14

Location

Venue: Room A-121, TSIMF

ZOOM ID: 537 192 5549 ZOOM PW: BIMSA

Organizer

Wenjia Jing(荆文甲), Yau Mathematical Sciences Center, Tsinghua University
Ting Gao(高婷), Huazhong University of Science and Technology
Qi Zhang(张琦), Beijing Institute of Mathematical Sciences and Applications

Schedule

Time&Date	Thursday (April 11)	Friday (April 12)	Saturday (April 13）	Sunday (April 14)
7:30-8:30		*Breakfast (60 minutes)*		
Chair		段金桥	王伟	高洪俊
8:30-9:15		Funaki Tadahisa (舟木直久)	吴奖伦	邱彦奇
9:20-10:00		王伟	刘伟（线上）	荆文甲
10:00-10:30		*Coffee Break (within 30 minutes)*		
10:30-11:15		李向东	高洪俊	黄建华
11:20-12:00		洪柳	陈晓鹏	王健（线上）
12:00-14:00	*Check in*	*Lunch (120 minutes)*		
Chair		荆文甲	吴奖伦	
14:00-14:40		翟建梁	张登	Free Discussion 14:00-17:00
14:45-15:25		高婷	王中剑	
15:25-15:50		*Break (within 25 minutes)*		
15:50-16:30		魏巍	乔会杰	
16:35-17:15		王策	张燕杰	
17:20-18:00		朱湘禅（线上）	宋健（线上）	
18:00		*Dinner*	Banquet 18:00-20:00	

Titles and Abstracts

Chair: Duan Jinqiao(段金桥), Greater Bay Area University，Shenzhen

Interfacial curvature flow and its fluctuation in Glauber-Kawasaki dynamics

Prof. Funaki Tadahisa(舟木直久)
Beijing Institute of Mathematical Sciences and Applications(BIMSA)

We discuss derivation of interface motion from Glauber-Kawasaki dynamics, that is, interacting random walks with hard core exclusion and creation/annihilation of particles. Then its fluctuation is discussed in a simple situation and certain SPDEs are derived.

Homogenization for heat equation with nonlocal random singular potential

Prof. Wang Wei(王伟)
Nanjing University

In this talk we present a recent work on the homogenization for a heat equation with nonlocal random singular Gaussian potential. Represent the solution an infinite series by Duhamel formula and we then show the homogenized equation is an SPDEs with nonlocal spatial white noise.

On the Navier-Stokes equations and Bellman dynamic principle on group of volume preserving diffeomorphisms

Prof. Li Xiangdong(李向东)
Chinese Academy of Science(CAS)

In this talk, I will present my recent work on a new derivation of the incompressible Navier-Stokes equation via the Bellman dynamic programming principle on the group of volume preserving diffeomorphisms $G=SDiff(M)$ over a Riemannian manifold M. Joint work with G.-P. Liu (HUST, Wuhan).

Large Deviations Principle for the Fluctuating Boltzmann Equation

Dr. Hong Liu(洪柳)
Sun Yat-sen University

The Boltzmann equation plays a fundamental role in the fields of gas dynamics and non-equilibrium thermodynamics. In this study, by introducing a stochastic picture of the binary collision of particles, we reformulate the Boltzmann equation into a broader Markov-chain model. The corresponding Kolmogorov forward equations and Liouville equation in either discrete or continuous time and state space are constructed respectively, both of which offer stochastic generalizations of the classical Boltzmann equation. Then by using the WKB method, the large deviations principle for the fluctuating Boltzmann equation is constructed, which on one hand explains the probabilistic origin of the H-theorem, on the other hand provides time-reversible generalizations of the Boltzmann equation in a Hamiltonian structure. In a similar way, the diffusion limit is discussed too.

Chair: Jing Wenjia(荆文甲), Tsinghua University

Large deviations for stochastic generalized porous media equations driven by Lévy noise

Prof. Zhai Jianliang(翟建梁)
University of Science and Technology of China

We establish a large deviation principle for a class of stochastic porous media equations driven by L\'evy-type noise on a \sigma -finite measure space (E,\scrB (E),\mu), with the Laplacian replaced by a negative definite self-adjoint operator. One of the main contributions is that we do not assume the compactness of embeddings in the corresponding Gelfand triple.

Functional Tipping Indicators via Schrödinger Bridge

Prof. Gao Ting(高婷)
Huazhong University of Science and Technology

Action functionals between two meta-stable states in stochastic dynamical systems are good tools to study the critical transitions and tipping. We will present our recent findings on tipping indicators based on the Onsager-Machlup action functional and Schrödinger bridge. The latter also extends the transition paths to be pathway measures between two given invariant manifolds. To validate our framework, we apply our methodology to some neural models as well as real brain data, such as EEG and fMRI from epilepsy and Alzheimer's disease.

Bernoulli Functional Approach to Quantum Walks on Hypercubes

Dr. Wang Ce(王策)
Tsinghua University

In this talk, we firstly would like to introduce some backgrounds and recent developments about the quantum walk. Some interesting facts which are different from classical random walks are also mentioned. Then we would introduce our recent work for quantum walk on Hypercube.

Quantum Algorithms for Linear Stochastic Differential Equations:A Schrödingerization Approach

Dr. Wei Wei(魏巍)
Shanghai Jiao Tong University

Quantum computers are known for its potential to achieve exponential speedup compared to classical computers. In this talk, I will introduce numerical schemes for stochastic differential equations based on the Schrödingerisation method. Different from existing methods, our schemes are applicable to stochastic differential equations driven by stable processes. Our algorithms demonstrate a quantum advantage over the Euler-Maruyama scheme on classical computers in high dimensional scenarios. In the case under Gaussian noise, we show the convergence of strong sense with order 1/2 of the approximation equation under mean square norm. The algorithm is verified for the Ornstein–Uhlenbeck processes, geometric Brownian motions and one-dimensional Lévy flights.

GLOBAL WELL-POSEDNESS FOR 2D GENERALIZED PARABOLIC ANDERSON MODEL VIA PARACONTROLLED CALCULUS

Prof. Zhu Xiangchan(朱湘禅)
Chinese Academy of Science(CAS)

This article revisits the problem of global well-posedness for the generalized parabolic Anderson model on $\mathbb{R}^+\times \mathbb{T}^2$ within the framework of paracontrolled calculus \cite{GIP15}. The model is given by the equation:

\begin{equation*}
(\partial_t-\Delta) u=F(u)\eta
\end{equation*}

where $\eta\in C^{-1-\kappa}$ with $1/6>\kappa>0$, and $F\in C_b^2(\mathbb{R})$. Assume that $\eta\in C^{-1-\kappa}$ and can be lifted to enhanced noise, we derive new a priori bounds. The key idea follows from the recent work

\cite{CFW24} by A.Chandra, G.L. Feltes and H.Weber to represent the leading error term

as a transport type term, and our techniques encompass the paracontrolled calculus, the maximum principle, and the localization approach (i.e. high-low frequency argument).

Chair: Wang Wei(王伟), Nanjing University

Global well-posedness and ergodicity of 3D Burgers equation with a multiplicative noise force

Prof. Wu Jianglun(吴奖伦)
Beijing Normal University-Hong Kong Baptist University United International College

This talk is concerned with a 3D Burgers equation perturbed by a linear multiplicative noise. Utilising Doss-Sussman transformation, we link the 3D stochastic Burgers equation to a 3D random Burgers equation. Utilising certain techniques from nonlinear partial differential equations and stochastic analysis, we are able to establish the global well-posedness of 3D Burgers equation with constant diffusion coefficient. Moreover, by developing a solution which is orthogonal to the gradient of diffusion coefficient, we extend the global well-posedness result to a more general case to allow the diffusion coefficient to be a function of space and time variables. Our results and methodology pave a way to extend regularity results of 1D Burgers equations to 3D Burgers equations. Based on joint works with Zhao Dong (Chinese Academy of Sciences), Boling Guo (Beijing Institute of Applied Physics and Computational Mathematics) and Guoli Zhou (Chongqing University).

Long time behaviors of mean field interacting particle systems and McKean-Vlasov equations

Liu Wei(刘伟)
Wuhan University

In this talk, we will present our recent studies about the long time behaviors of mean-field interacting particle systems and the McKean-Vlasov equation, by using two different methods: coupling method and functional inequalities. This talk is based on the joint works with Arnaud Guillin, Liming Wu and Chaoen Zhang.

Rough Dynamical Systems

Prof. Gao Hongjun(高洪俊)
Southeastern University

We will report our recent advances for SDE(SPDEs) driven by rough path.

Dynamics of nonlocal Kuramoto-Sivashinshy equations with white noise

Prof. Chen Xiaopeng(陈晓鹏)
Shantou University

In this talk, we discuss the long time dynamic properties of nonlocal Kuramoto-Sivashinsky equation with white noise. First of all, we consider the dynamic properties of the original problems via the conjugation which the stochastic nonlocal Kuramoto-Sivashinsky equations are transformed into the associated conjugated random differential equation. Next, we prove the existence and uniqueness of solutions for the conjugated random differential equations in the the theory of random dynamical systems. So we can establish the existence and uniqueness of pullback random attractor for the stochastic Kuramoto-Sivashinsky equation.

Chair: Wu Jianglun(吴奖伦), Beijing Normal University-Hong Kong Baptist University United International College

Multi-bubble blow-ups and multi-solitons to stochastic nonlinear Schrödinger equations

Prof. Zhang Deng(张登)
Shanghai Jiaotong University

This talk focuses on the long time behavior of solutions to focusing stochastic nonlinear Schrödinger equations. We will mainly show the construction and conditional uniqueness of multi-bubble Bourgain-Wang type blow-up solutions and non-pure multi-solitons, which provide new examples for the mass quantization conjecture and the soliton resolution conjecture. In the low asymptotic regime, the refined uniqueness is also derived in the deterministic case. Moreover, we show the construction of stochastic multi-solitons in the mass critical and subcritical cases, for which the classical pseudo-conformal symmetry is absent.

Asymmetric Transport computations in Dirac Models of Topological insulators

Prof. Wang Zhongjian(王中剑)
Nanyang Technological University

In this talk we will present a fast and accurate algorithm for computing transport properties of two-dimensional Dirac operators with linear domain walls, which model the macroscopic behavior of the robust and asymmetric transport observed at an interface separating two two-dimensional topological insulators. Our method is based on reformulating the partial differential equation as a corresponding volume integral equation, which we solve via a spectral discretization scheme.

We demonstrate the accuracy of our method by confirming the quantization of an appropriate interface conductivity modeling transport asymmetry along the interface, and moreover, confirm that this quantity is immune to local perturbations. We also compute the far-field scattering matrix generated by such perturbations and verify that while asymmetric transport is topologically protected the absence of back-scattering is not.

Large deviations of multiscale multivalued McKean-Vlasov stochastic systems

Prof. Qiao Huijie(乔会杰)
Southeast University

This work concerns about multiscale multivalued McKean-Vlasov stochastic systems. First of all, we use a contractive mapping principle to establish the well-posedness for fully coupled multivalued McKean-Vlasov stochastic systems under non-Lipschitz conditions. Then for multiscale multivalued McKean-Vlasov stochastic systems with small noises, we prove a large deviation principle by a weak convergence approach. As a by-product, two average principles are obtained.

Analysis for a class of stochastic fractional nonlinear Schr\"odinger equations with L\'evy noise

Prof. Zhang Yanjie(张燕杰)
Zhengzhou University

In this paper, we first establish the stochastic Strichartz estimate for the fractional Schr\"odinger equation with α-stable noise. With the help of the deterministic Strichartz estimates, we prove the existence and uniqueness of a global solution to the stochastic fractional nonlinear Schr\"odinger equation in $L^2(\mathbb{R}^n)$. We then show that the stochastic fractional nonlinear Schr\"odinger equation in the Stratonovich sense forms an infinite-dimensional stochastic Hamiltonian system, with its phase flow preserving symplecticity. Finally, we develop a structure-preserving algorithm for the stochastic fractional nonlinear Schr\"odinger equation from the perspective of symplectic geometry. An numerical example is conducted to validate the efficiency of the theory.

Stochastic partial differential equations associated with Feller processes

Prof. Song jian(宋健)
Shandong University

For a class of linear SPDEs associated with Feller processes, we obtain Feynman-Kac type of

representations for the Stratonovich and Skorohod solutions as well as for their moments. The regularity of the law and the Hölder continuity of the solutions are also studied.

Chair: Gao Hongjun(高洪俊), Southeast University

Mandelbrot Cascades: critical moments, Rajchman measures and Sobolov smoothness

Prof. Qiu Yanqi(邱彦奇)
Hangzhou Institute for Advanced Study, UCAS

We introduce a method for estimating weighted sum of random variables on trees. This method on the one hand will allow us to deal with the asymptotic order of moments of Mandelbrot Cascades at critical exponents, and on the other hand will allow us to establish Rajchman property of the random measure arising from the Mandelbrot Cascades, as well as the Sobolev smoothness of the self-convolution of the random measure. The talk is based on joint work with Xinxin Chen, Yong Han and Zipeng Wang.

Quantitative homogenization of elliptic problems in periodic high contrast environments

Prof. Jing Wenjia (荆文甲)
Tsinghua University

We consider elliptic equations with periodic high contrast coefficients and study the asymptotic analysis when the periodicity is sent to zero and/or the contrast parameters are sent to extreme values. Those coefficients model small inclusions that have very different physical properties compared to the surrounding environment. Homogenization captures the macroscopic effects of those inclusions. We report some quantitative results such as the convergence rates of the homogenization (with proper correctors) and uniform regularity for the solutions of the heterogeneous equations. The talk is based on joint works with Mr. Xin Fu.

Convergence rates and CLT for 3-D stochastic fractional Boussinesq equations with transport noise

Prof. Huang Jianhua(黄建华)
National University of Defense Technology

This talk is devoted to the 3-D stochastic fractional Boussinesq equations on the torus driven by

transport noise. Firstly, the existence of weak solutions is established by using the Galerkin approximation and the compactness method. Next, under a suitable scaling of the noise, we prove that the weak solution of stochastic fractional Boussinesq equations converges to the unique solution of the deterministic fractional Boussinesq equations in certain suitable negative Sobolev norm. This means that transport noise regularizes the fractional Boussinesq equations so that it enjoys approximate weak uniqueness. Finally, the central limit theorem with an explicit convergence rate are obtained to interpret the aforementioned limit result as a law of large numbers.

Quantitative periodic homogenization for fractional Laplacian-like operators

Prof. Wang Jian(王健)
Fujian Normal University

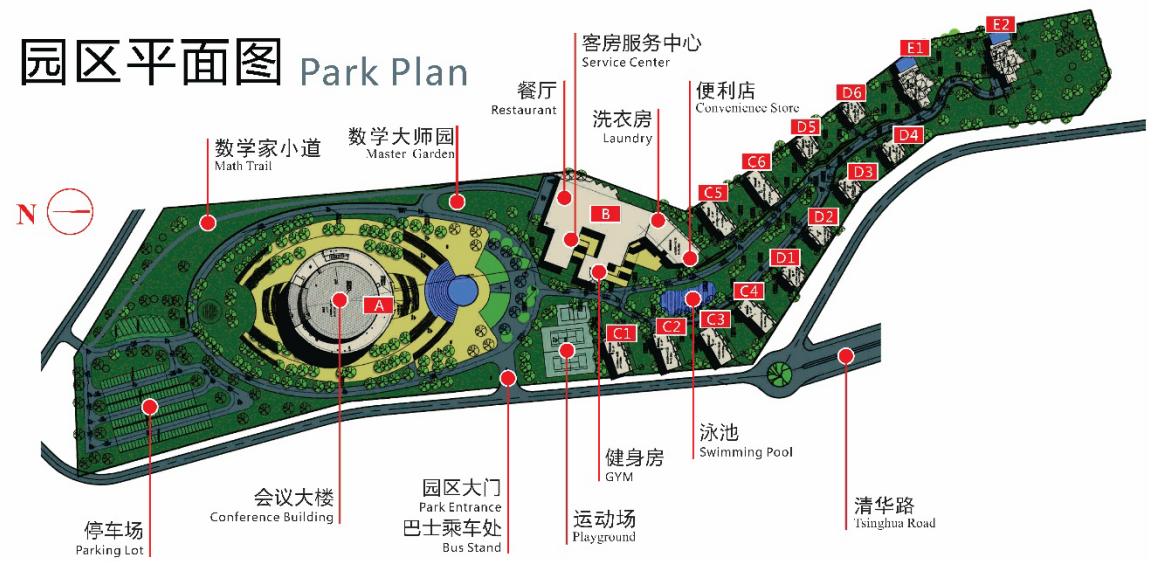
The homogenization for non-local operators in periodic environments has been studied intensively recently, and all known works are mainly devoted to the qualitative results, that is, to determine the explicit form of the limiting operator. To the best of our knowledge, there is no result concerning the convergence rates of the homogenization for non-local operators in periodic environments. In this talk, we establish a quantitative version of homogenization for fractional Laplacian-like operators with periodic coefficients.

Welcome to TSIMF

The facilities of TSIMF are built on a 23-acre land surrounded by pristine environment at Phoenix Hill of Phoenix Township. The total square footage of all the facilities is over 29,000 square meter that includes state-of-the-art conference facilities (over 10,000 square meter) to hold many international workshops simultaneously, two reading rooms of library, a guest house (over 10,000 square meter) and the associated catering facilities, a large swimming pool, gym and sports court and other recreational facilities.

Management Center of Tsinghua Sanya International Forum is responsible for the construction, operation, management and service of TSIMF. The mission of TSIMF is to become a base for scientific innovations, and for nurturing of innovative human resource; through the interaction between leading mathematicians and core research groups in pure mathematics, applied mathematics, statistics, theoretical physics, applied physics, theoretical biology and other relating disciplines, TSIMF will provide a platform for exploring new directions, developing new methods, nurturing mathematical talents, and working to raise the level of mathematical research in China.

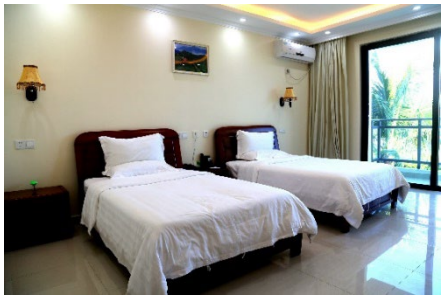
About Facilities



Registration

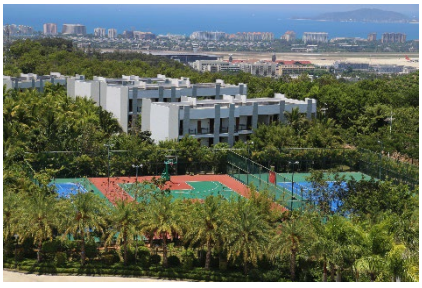
Conference booklets, room keys and name badges for all participants will be distributed at the front desk. Please take good care of your name badge. It is also your meal card and entrance ticket for all events.

Guest Room



All the rooms are equipped with: free Wi-Fi (Password:tsimf123), TV, air conditioning and other utilities.

Family rooms are also equipped with kitchen and refrigerator.



Library

Opening Hours: 09:00am-22:00pm

TSIMF library is available during the conference and can be accessed by using your room card. There is no need to sign out books but we ask that you kindly return any borrowed books to the book cart in library before your departure.

In order to give readers a better understanding of the contributions made by the Fields Medalists, the library of Tsinghua Sanya International Mathematics Forum (TSIMF) instituted the Special Collection of Fields Medalists as permanent collection of the library to serve the mathematical researchers and readers.
So far, there are 271 books from 49 authors in the Special Collection of Fields Medalists of TSIMF library. They are on display in room A220. The participants are welcome to visit.

Restaurant

All the meals are provided in the restaurant (Building B1) according to the time schedule.

Breakfast	07:30-08:30
Lunch	12:00-13:30
Dinner	17:30-19:00

Laundry

Opening Hours: 24 hours

The self-service laundry room is located in the Building(B1).

Gym

The gym is located in the Building 1 (B1), opposite to the reception hall. The gym provides various fitness equipment, as well as pool tables, tennis tables etc.

Playground

Playground is located on the east of the central gate. There you can play basketball, tennis and badminton. Meanwhile, you can borrow table tennis, basketball, tennis balls and badminton at the reception desk.

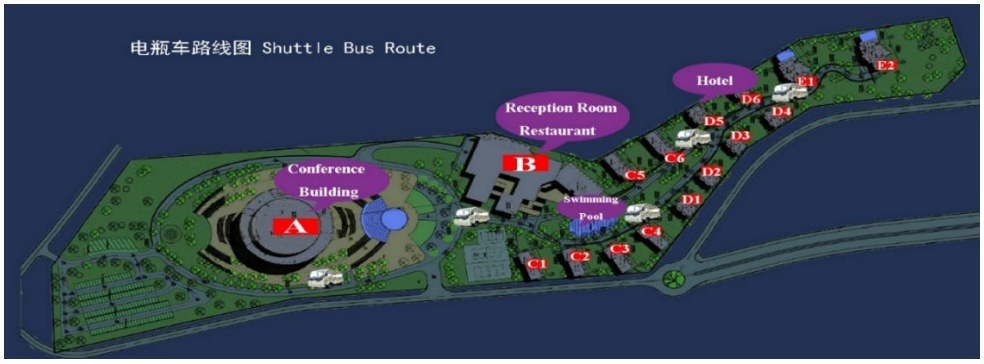
Swimming Pool

Please note that there are no lifeguards. We will not be responsible for any accidents or injuries. In case of any injury or any other emergency, please call the reception hall at +86-898-38882828.

Free Shuttle Bus Service at TSIMF

We provide free shuttle bus for participants and you are always welcome to take our shuttle bus, all you need to do is wave your hands to stop the bus.

Destinations: Conference Building, Reception Room, Restaurant, Swimming Pool, Hotel etc.



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*Room maintainer night duty hours: 23:00-7:00, if you need maintenance services, please call: 0086-38263909 (exterior line) 30162 (internal line)

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