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

召集人：高洪俊、黄建华、曹琪勇

会议手册

云南 · 昆明

2025年8月3日 - 9日

天元数学国际中心简介

天元数学国际研究交流中心(以下简称〝中心〞)成立于2023年7月，是由国家基金委员会天元基金和国家发展改革委员会基金项目共同组织建设的数学与交叉科学交流机构，依托单位是中国科学院数学与系统科学研究院。

中心位于云南省昆明市宜良县柴石滩水库库区内国家一级公益林中；三面环山，一面向水，环境优美，风景秀丽、气候宜人；海拔为1700米，距离昆明长水国际机场约90公里，乘车时间约1.5小时。距离石林风景区30公里，距离九乡风景区20公里；总用地面积约2.7万M2,绿化面积约1.9万M2，总建筑面积约6000M2。中心三栋二层主体建筑，为科研楼、专家楼和后勤保障楼。专家楼有50间宿舍，其中：41 间1.5米单床宿舍，9间为1.2米双床标准间宿舍；宿舍内均设卫生间及淋浴设备。设有4步楼梯及2部电梯，内庭院设有冥想亭。建筑内还设有公共卫生间、布草间、洗衣房等附属用房。二楼公共休息区设有自助咖啡机，二楼西南角一间配有洗衣烘干一体机的自助洗衣房。

科研楼有相对独立的大报告厅配备高清 LED 屏和上下推拉黑板，可容纳100人；中型会议室1间(80M2),配备高清 LED 屏；小型会议室4间(35M2)，室内配有微距高清投影仪和黑板；研讨/工作室21 间 (20M2)；1间图书阅览室；1间咖啡厅； 保障楼一层有一间活动室(职工之家健身房),约50M2；7间宿舍(中心管理服务人员使用)，每间约20M2； 二层餐厅(约200M2) 为中心为来访人员提供餐饮，可供60人同时用餐。

中心四周有围墙维护，还配有值班室、消防水池及水泵房、中水处理站及安防监控等。

天元数学国际交流中心

温馨提示：

1.中心免费提供参会人员食宿，并提供昆明机场或火车站至中心的往返交通，其他旅费自理。参会人员需要最晚在会议开始前3天，在中心网站提交详细参会信息。

2.中心WIFI全区域覆盖，WIFI密码：88888888

3. 限量供应荞麦枕、决明子枕，如有需要联系前台人员更换。

4.专家楼宿舍二楼西南角配有洗衣烘干一体机自助洗衣房。

5.专家楼和研究中心有多功能一体复印机，可打印，扫描文件。

6. 会议中心比较偏僻，请务必注意安全。中心前台备用部分应急药品。

会 议 日 程

2025年8月3日星期日	注册和报到
2025年8月9日星期六	离会

2025年8月4日星期一

8:55 am-9:10 am	OPENING and GROUP PHOTO	
9:10 am-10:00 am	Speaker: 裴斌	Chair: 黄建华
10:00 am-10:30 am	TEA BREAK	
10:30 am-11:20 am	Speaker: 李晓月	Chair: 崔建波
11:20 am-14:00 pm	LUNCH BREAK	
14:00 pm-14:50 pm	Speaker: 崔建波	Chair: 李晓月
14:50 pm-15:20 pm	TEA BREAK	
15:20 pm-16:10 pm	Speaker: 陈楚楚	Chair: 曹婉容
16:10 pm-17:00 pm	Speaker: 曹婉容	Chair: 陈楚楚
17:00 pm	DINNER BREAK	

2025年8月5日星期二

8:00 am-8:50 am	Speaker: 申广君	Chair: 吴付科
8:50 am-9:40 am	Speaker: 吴付科	Chair: 申广君
9:40 am-10:10 am	TEA BREAK	
10:10 am-11:00 am	Speaker: 徐杰	Chair: 乔会杰
11:00 am-14:00 pm	LUNCH BREAK	
14:00 pm-14:50 pm	Speaker: 乔会杰	Chair: 徐杰
14:50 pm-15:20 pm	TEA BREAK	

15:20 pm-16:10 pm	Speaker: 杨美华	Chair: 刘志明
16:10 pm-17:00 pm	Speaker: 刘志明	Chair: 杨美华
17:00 pm	DINNER BREAK	

2025年8月6日星期三

8:00 am-8:50 am	Speaker: 杨洪福	Chair: 王伟
8:50 am-9:40 am	Speaker: 王伟	Chair: 杨洪福
9:40 am-10:10 am	TEA BREAK	
10:10 am-11:00 am	Speaker: 王业娟	Chair: 陈勇
11:00 am-11:50 am	Speaker: 陈勇	Chair: 王业娟
11:50 am-14:00 pm	LUNCH BREAK	
14:00 pm-17:00 pm	FREE DISSCUSSION	
17:00 pm	DINNER BREAK	

2025年8月7日星期四

8:00 am-8:50 am	Speaker: 曾才斌	Chair: 曲世铎
8:50 am-9:40 am	Speaker: 曲世铎	Chair: 曾才斌
9:40 am-10:10 am	TEA BREAK	
10:10 am-11:00 pm	Speaker: 陈鹏玉	Chair: 陈章
11:00 am-14:00 am	LUNCH BREAK	
14:00 pm-14:50 pm	Speaker: 陈章	Chair: 陈鹏玉
14:50 pm-15:20 pm	TEA BREAK	
15:20 pm-16:10 pm	Speaker: 石琳	Chair: 申俊
16:10 pm-17:00 pm	Speaker: 申俊	Chair: 石琳
17:00 pm	DINNER BREAK	

2025年8月8日星期五

8:00 am-8:50 am	Speaker: 赵才地	Chair: 高洪俊
8:50 am-9:40 am	Speaker: 黎定仕	Chair: 赵才地
9:40 am-10:10 am	TEA BREAK	
10:10 am-11:00 am	Speaker: 曹琪勇	Chair: 黎定仕
11:00 am-14:00 pm	LUNCH BREAK	
14:00 am-14:50 am	Speaker: 陈涌	Chair: 周国立
14:50 pm-15:20 pm	TEA BREAK	
15:20 pm-16:10 pm	Speaker: 周国立	Chair: 陈涌
16:10 pm-17:00 pm	FREE DISSCUSSION	
17:00 pm	DINNER BREAK	

2025年8月9日星期六

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

报 告 信 息

曹琪勇，西南交通大学，中国

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，东南大学，中国

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，中国科学院数学与系统科学研究院，中国

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，西北师范大学，中国

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，浙江理工大学，中国

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，江西师范大学，中国

Title: Parameter Estimation for Complex α-Fractional Brownian Bridge

Abstract: We study the statistical inference problem for a complex α-fractional Brownian bridge process 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，山东大学，中国

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，香港理工大学，中国

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，西南交通大学，中国

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，天津工业大学，中国

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 刀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，国防科技大学，中国

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，西北工业大学，中国

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，东南大学，中国

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，东南大学，中国

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，安徽师范大学，中国

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，四川大学，中国

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，电子科技大学，中国

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，南京大学，中国

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，兰州大学，中国

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，华中科技大学，中国

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，河南师范大学，中国

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，华中科技大学，中国

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，广西师范大学，中国

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).