无穷维随机动力系统研讨会

召集人：刘培东、段金桥

2025.08.24-2025.08.30

云南　昆明

承办单位：天元数学国际交流中心

资助单位：国家自然科学基金委

会议手册

无穷维随机动力系统研讨会

会议日程

2025 年 8 月 25 日（星期一）　天元数学国际交流中心

08:20 am—08:30 am	OPENING Speaker: Duan Jinqiao	
08:30 am—09:15 am	Speaker: Jiang Jifa	Chair:　Duan Jinqiao
09:15 am—10:00 am	Speaker: Dong Zhao	
10:00 am—10:30 am	TEA BREAK　&　GROUP PHOTO	
10:30 am—11:15 am	Speaker: Chen Zhang	Chair: Huan Jianhua
11:15 am—14:00 pm	LUNCH BREAK	
14:00 pm—14:45 pm	Speaker: Li Xiaojun	Chair: Yang Qigui
14:45 pm—15:30 pm	Speaker: Cui Hongyong	
15:30 pm—16:00 pm	TEA BREAK	
16:00 pm—16:45 pm	Speaker: Huang Qiao	Chair: Chen Yong
16:45 pm—17:30 pm	Speaker: Wei Pingyuan	
17:30 pm—	DINNER BREAK	

2025 年 8 月 26 日（星期二）　天元数学国际交流中心

08:30 am—09:15 am	Speaker: Huang Wen	Chair: Cao Yongluo
09:15 am—10:00 am	Speaker: Shi Yi	
10:00 am—10:30 am	TEA BREAK	
10:30 am—11:15 am	Speaker: Liu Rongchang	Chair: Wang Yi
11:15 am—14:00 pm	LUNCH BREAK	
14:00 pm—14:45 pm	Speaker: Zhu Yujun	Chair: Lian Zeng
14:45 pm—15:30 pm	Speaker: Zhang Wenmeng	
15:30 pm—16:00 pm	TEA BREAK	
16:00 pm—16:45 pm	Speaker: Ma Xiao	Chair: Li Xiliang
16:45 pm—17:30 pm	Speaker: Wang Xinsheng	
17:30 pm—	DINNER BREAK	

2025 年 8 月 27 日（星期三）　天元数学国际交流中心

08:30 am—09:15 am	Speaker: Li Xiaoyue	Chair: Chen Pengyu
09:15 am—10:00 am	Speaker: Li Xinhua	
10:00 am—10:30 am	TEA BREAK	
10:30 am—11:15 am	Speaker: Chao Ying	Chair: Chen Xiaoli
11:15 am—14:00 pm	LUNCH BREAK	
14:00 pm—17:30 pm	FREE DISSCUSSION	
17:30 pm—	DINNER BREAK	

2025 年 8 月 28 日（星期四）　天元数学国际交流中心

08:30 am—09:15 am	Speaker: Pei Bin	Chair: Wang Yejuan
09:15 am—10:00 am	Speaker: Lü Xiang	
10:00 am—10:30 am	TEA BREAK	
10:30 am—11:15 am	Speaker: Chen Xiaopeng	Chair: Shu Ji
11:15 am—14:00 pm	LUNCH BREAK	
14:00 pm—14:45 pm	Speaker: Li dingshi	Chair: Wang Renhai
14:45 pm—15:30 pm	Speaker: Zeng Caibin	
15:30 pm—16:00 pm	TEA BREAK	
16:00 pm—16:45 pm	Speaker: Zhou Zhe	Chair: Shen Jun
16:45 pm—17:30 pm	Speaker: Zhang Qi	
17:30 pm—	DINNER BREAK	

2025 年 8 月 29 日（星期五）　天元数学国际交流中心

08:30 am—09:15 am	Speaker: Li Ji	Chair: Zheng Yan
09:15 am—10:00 am	Speaker: Zhang Ao	Chair: Wang Guangwa
10:00 am—10:30 am	TEA BREAK	
10:30 am—11:15 am	FREE DISSCUSSION	
11:15 am—14:00 pm	LUNCH BREAK	
14:00 pm—17:30 pm	FREE DISSCUSSION	
17:30 pm—	DINNER BREAK	

2025 年 8 月 30 日（星期六）　天元数学国际交流中心

9:00—11:00	FREE DISSCUSSION	
12:00—14:30	LUNCH BREAK	

学术报告信息

蒋继发 （河南师范大学）

Title: The New Criteria on Exponential Ergodicity of Hypoelliptic Hamiltonian Systems

Abstract: Wu (2001) established exponential ergodicity for hypoelliptic Hamiltonian systems under assumptions that the damping matrix is uniformly positive-definite at infinity, the potential force diverges at infinity, and the noise is bounded. We prove that such systems are strong Feller and irreducible when coefficients are C^2, implying exponential ergodicity under an additional Lyapunov condition. Wu's ergodicity theorem extends to C2 coefficients and suitable unbounded noise by combining our result with Wu's Lyapunov function. We further propose an exponential ergodicity criterion for Hessian-driven hypoelliptic Hamiltonian systems via a polynomial-type Lyapunov function combining mixed energy, potential, and damping terms. This criterion applies to systems like the stochastic Moser equation where damping lacks uniform positivity at infinity and others with no lower bound damping. Polynomial Lyapunov functions can offer superior probabilistic properties: their slower growth reduces the possibility of exponential explosion and broadens the admissible class of initial distributions. This is a joint work with Prof. Zhai Jianliang.

董昭（中国科学院数学与系统科学研究院）

Title: Ergodic and mixing properties of the 2D Navier-Stokes equations with a degenerate multiplicative Gaussian noise

Abstract: We establish the ergodic and mixing properties of stochastic 2D Navier-Stokes equations driven by a highly degenerate multiplicative Gaussian noise. The noise can appear in as few as four directions, and its intensity depends on the solution. The case of additive Gaussian noise was previously treated by Hairer and Mattingly [Ann. of Math., 164(3):993–1032, 2006]. To derive the ergodic and mixing properties in the present setting, we employ Malliavin calculus to establish the asymptotically strong Feller property. The primary challenge lies in proving the "invertibility" of the Malliavin matrix, which differs fundamentally from the additive case.

陈章（山东大学）

Title: Stochastic supercritical wave equations on unbounded domains

Abstract: The stochastic wave equation is one of important hyperbolic PDEs with the random fluctuation. In this talk, we will introduce well-posedness of stochastic wave equations with supercritical drift term on unbounded domains, and discuss long-time dynamics of the associated infinite dimensional random dynamical system.

李晓军（河海大学）

Title: Large deviation principles of invariant measures of stochastic discrete wave equations with nonlinear noise and nonlinear damping

Abstract: In this talk, we show the large deviation principle of invariant measures of a class of

discrete wave equations with nonlinear noise and nonlinear damping. We first establish the existence of invariant measures for the stochastic system and analyze the limiting behavior of these measures as the noise intensity approaches zero. Next, we establish the Freidlin-Wentzell uniform large deviations and the Dembo-Zeitouni uniform large deviations of the solutions of the stochastic system. Lastly, we get the large deviations of invariant measures by combining exponential probability estimates and arguments based on weighted spaces.

崔洪勇（华中科技大学）

Title: Some notes on bi-spatial random attractors

Abstract: In this talk I shall first introduce the bi-spatial random attractor theory with particular focus on several continuity conditions used in the literature, and then introduce a well-known but not much used approach, called a smoothing approach, in proving the asymptotic compactness of the system. By this approach I shall show that with the external forces f in H the Navier-Stokes equations on 2D torus with additive white noise can have a tempered (H, H^2)-random attractor of finite fractal dimension, indicating that the smooth solutions can fully determine the asymptotic behavior of the system.

黄乔（东南大学）

Title: A study of path measures based on second-order Hamilton--Jacobi equations and their applications in stochastic thermodynamics

Abstract: This talk systematically investigates the mathematical structure of path measures, both from a measure-theoretical perspective and through stochastic differential equations. The realization of path measures as Langevin systems hinges on the pivotal role of second-order Hamilton--Jacobi--Bellman equations, which form the foundation of stochastic geometric mechanics and applications in stochastic thermodynamics. We explore the emergence of the Onsager--Machlup functional in large deviation theory, the rates of entropy production in irreversible thermodynamic processes, entropy minimization problems encoded in stochastic geometric mechanics, and the identification of Langevin systems from most probable paths. This talk is based on joint work with Dr. Jianyu Hu and Dr. Yuanfei Huang.

韦屏远 （东南大学）

Title: Freidlin–Wentzell Large Deviation Principle and Onsager–Machlup Functional Theory in Contact Geometric Framework

Abstract: Stochastic contact Hamiltonian systems naturally arise in the modeling of dynamical systems subject to both dissipative forces and random perturbations, serving as the odd-dimensional counterparts to classical symplectic Hamiltonian systems. In this work, we investigate the Freidlin–Wentzell (FW) large deviation principle and the Onsager–Machlup (OM) functional within the context of contact geometry. Notably, for stochastic dissipative Hamiltonian systems defined on the standard (q,p)-phase space,

both FW and OM action functionals correspond to integrals of an associated Lagrangian. Extending this perspective to the contact setting, namely the extended (q,p,S)-phase space, the S-equation encapsulates the accumulated damped action functional along system trajectories. Incorporating these functionals in the contact geometric framework allows the intrinsic geometric structure of the system to be taken into account, thereby offering a refined characterization of phenomena such as metastable transitions. As a demonstrative example, we analyze a Langevin system under both stochastic dissipative and stochastic contact formulations.

黄文（中国科学技术大学）

Title: Multiple Recurrence without commutativity

Abstract: Furstenberg's multiply recurrent theorem states that any dynamical system has multiply recurrent points. In this talk, we discuss multiple recurrence without commutativity. This based on joint works with Prof. Song Shao and Xiangdong Ye.

史逸（四川大学）

Title: Lyapunov spectrum rigidity and simultaneous linearization of random Anosov diffeomorphisms

Abstract: Let A be an Anosov automorphism on T2 and $\{f_1,...,f_k\}$ be a family of C^r-random perturbations of A with r>2. We show that $\{f_1,...,f_k\}$ is Lyapunov spectrum rigid, i.e. any stationary SRB measure has the same Lyapunov exponents to A, if and only if there exists a smooth conjugacy simultaneously linearize $\{f_1,...,f_k\}$ to affine actions. As an application, we show that a random action of positive matrices in SL(2,Z) has positive Lyapunov spectrum rigidity if and only if the action can be simultaneous linearized. This is a joint work with A. Brown.

刘荣昌（四川大学）

Title: Large deviations for 2D stochastic Navier-Stokes Equations driven by a periodic force and a degenerate noise

Abstract: We consider the incompressible 2D Navier-Stokes equations on the torus, driven by a deterministic time periodic force and a noise that is white in time and degenerate in Fourier space. We first establish a Ruelle-Perron-Frobenius type theorem for the time inhomogeneous Feynman-Kac evolution operators that characterizes asymptotic behaviors of the operators in terms of the periodic family of principal eigenvalues and corresponding unique eigenvectors. The proof involves a time inhomogeneous version of Ruelle's lower bound technique. Utilizing this Ruelle-Perron-Frobenius type theorem and a Kifer's criterion, we then establish a Donsker-Varadhan type large deviation principle with a nontrivial good rate function for the occupation measures of the time inhomogeneous solution processes. This is based on joint work with Kening Lu.

朱玉峻（厦门大学）

Title: On the entropies and invariant measures for certain correspondences

Abstract: ecently, the entropies and invariant measures are investigated for correspondences, which are also known as upper semi-continuous set-valued maps. In this talk, the entropy and the invariant measure are explicitly expressed for certain correspondences generated by finite differentiable maps via the equilibrium state of the pressure for certain particular potential.

张文萌（重庆师范大学）

Title: On differentiable Anosov splitting and invariant foliation

Abstract: As pointed out by Pugh, Shub and Wilkinson, one of the major technical barriers to the understanding of Anosov diffeomorphisms is the fact that the splittings (and the invariant foliations) are not in general differentiable. In this talk, we review the known results of differentiable Anosov splittings and invariant foliations, where one encounters the so-called bunching conditions. We will discuss the possibility of removing those bunching conditions, which may require some new ideas.

马啸（中国科学技术大学）

Title: Typical periodic optimization conjecture and more

Abstract: In this talk, we study the ergodic optimization problem for a class of typical systems, including Axiom A attractors for both discrete and continuous time case, Anosov diffeomorphisms, subshifts of finite type and uniformly expanding maps. In view of the Typical Periodic optimization conjecture proposed by Yuan and Hunt in 1999, we prove that when the space of observables is $\mc C^{0,\alpha}$ with $\alpha\in(0,1]$ or $\mathcal C^{1,0}$, the optimal (minimizing or maximizing) orbits are generically periodic, thus confirm the conjecture. This is a joint work with Wen Huang, Zeng Lian, Leiye Xu, and Yiwei Zhang.

王昕晟（汕头大学）

Title: Preimage Mean Dimension

Abstract: In this talk, the mean dimension theory via the preimage structure for noninvertible infinite dimensional dynamical systems with infinite topological entropy is considered. Several invariants, such as the topological preimage mean dimensions, the metric preimage mean dimensions and the rate distortion preimage mean dimensions involving two variables (metrics and measures) are introduced and the relations among these quantities are considered. Particularly, for a non-invertible system with the backward marker property, a double variational principle relating rate distortion preimage mean dimensions and topological preimage mean dimension is established. This is a joint work with Weisheng Wu and Yujun Zhu.

李晓月（天津工业大学）

Title: Dynamical behaviors of nonlinear McKean-Vlasov SDEs with common noise

Abstract: This talk reports some results on the dynamical behaviors of McKean-Vlasov stochastic differential equations (SDEs) with common noise whose coefficients depend on both the state and the measure. We give the existence and uniqueness of the invariant measure for McKean-Vlasov SDEs with common noise whose drift and diffusion coefficients grow polynomially. Then we investigate the uniform-in-time propagation of chaos and then the convergence between the measure of one particle of the mean-field particle systems and the invariant measure of the McKean-Vlasov SDE with common noise.

李新华（兰州大学）

Title: Inertial Manifolds Without Spectral Gap Conditions: Modified Navier-Stokes Equations

Abstract: Inertial manifold (IM for short) is a smooth finite-dimensional invariant manifold that contains the global attractor and that attracts all the orbits at an exponential rate, and it is also a graph of some Lipschitz continuous functions. If a PDE possesses an IM, then its dynamical can be completely determined by a system of ODEs. Classical theory of IM required a so-called spectral gap condition for constructing an IM. In this talk, we introduce a method which can construct IMs without spectral gap condition and consider the application for 2D modified NSEs. An original motivation for the theory of IMs was treating the NSEs. Unfortunately, this problem is still open now. This talk will review key results concerning IMs for modified NSEs and present our recent contributions to this field.

晁颖（西安交通大学）

Title: Transition Paths and Rates in Langevin Systems under Nongradient Perturbations

Abstract: In this talk, we investigate the exit problem from the domain of attraction of a stable state in kinetic Langevin systems with nongradient perturbations. In the small-noise regime, Freidlin-Wentzell large deviation theory provides a rigorous variational framework for characterizing the most probable escape paths. While the unperturbed system admits escape paths corresponding to time-reversed heteroclinic orbits, the problem becomes challenging for general systems. By reformulating the Euler-Lagrange equations in Hamiltonian form and applying Melnikov theory, we establish a condition under which the optimal escape path remains a heteroclinic orbit in the perturbed system. Furthermore, we explore how periodic perturbations influence the rate of metastable transitions in stochastic mechanical systems with weak noise, focusing on both the underdamped and overdamped Langevin systems. Our analysis reveals that parametric excitation at a resonant frequency can dramatically accelerate metastable transitions. This presentation is based on joint work with Molei Tao, Jinqiao Duan, and Pingyuan Wei.

裴斌 （西北工业大学）

Title: Probabilistic solutions of nonlinear dynamical systems driven by fractional Gaussian noise

Abstract: This talk aims to introduce non-Markovian dynamics of nonlinear dynamical systems subjected to fractional Gaussian noise (FGN) and Gaussian white noise. A memory-dependent Fokker-Planck-Kolmogorov (memFPK) equation is developed to characterize the probability structure in such non-Markovian systems. Finally, we investigate the probabilistic solutions of nonlinear SDOF oscillators under FGN excitation. This framework provides a practical tool for analyzing non-Markovian stochastic dynamics, with potential extensions to multidimensional and parametric FGN problems.

吕翔（上海师范大学）

Title: Generalized Ornstein-Uhlenbeck process for affine stochastic functional differential equations and its applications

Abstract: This paper studies the existence and global stability of generalized Ornstein-Uhlenbeck process for affine stochastic functional differential equations. Various very basic and important properties are established. In the applications, we present a standard and rigorous procedure for guaranteeing the existence and uniqueness of random equilibria for nonlinear stochastic functional differential equations, which attracts all pull-back trajectories in different types of convergence. Some examples are given to illustrate our main results. The results presented in this paper improve and simplify the conclusions of Jiang and Lv [{SIAM J. Control Optim.}, 54 (2016), pp. 2383-2402] and [{J. Differential Equations}, 367 (2023), pp. 890-921].

陈晓鹏（汕头大学）

Title: Positivity-preserving Numerical Algorithms for Stochastic Differential Equations Driven by Fractional Brownian Motion

Abstract: In fields such as finance and ecology, stochastic differential equations (SDEs) must strictly preserve the positivity of solutions to align with practical significance. However, traditional numerical methods exhibit limitations in addressing such issues. This paper focuses on the construction of positivity-preserving numerical algorithms for SDEs driven by fractional Brownian motion (fBm) with non-Markovian systems. Specifically, the proposed algorithm is applied to the Cox-Ingersoll-Ross (CIR) model driven by fBm, and numerical simulations are conducted to analyze its first moment and second moment.

黎定仕（西南交通大学）

Title: Approximation of Invariant Measures of Dissipative Dynamical Systems on Thin Domains

Abstract: In this talk, an abstract method is presented to show that upper semicontinuity of

invariant measures of dissipative dynamical systems on thin domains. The abstract method presented can be used to many physical systems. As an example, we consider reaction-diffusion equations on thin domains. To this end, we first show the existence of invariant measures of the equations in a bounded domain in $\R^{n+1}$ which can be viewed as a perturbation of a bounded domain in $\R^n$. We then prove that any limit of invariant measures of the perturbed systems must be an invariant measure of the limiting system when the thin domains collapses.

曾才斌 （华南理工大学）

Title: Oseledets splitting on fields of Banach spaces: A volume growth and s-numbers approach

Abstract: In this talk, we present an Oseledets' filtration and splitting for quasi-compact cocycles over Banach space bundles, without assuming compactness or injectivity. Using s-numbers, we develop a functional-analytic framework for computing volumes and determinants on finite-dimensional Banach fibers. A key idea is to view Gelfand numbers as geometric invariants, which provides a direct link between Lyapunov exponents and volume growth for general non-injective cocycles, bypassing auxiliary dimension reduction.

周喆（中国科学院数学与系统科学研究院）

Title: 从氢原子到薛定谔算子

Abstract: 我们通过简要回顾氢原子的能级推导，引出薛定谔算子。在前人工作基础上，如：[Johnson-Moser, CMP, 1982]，汇报我们利用动力系统方法，特别是旋转数工具，在几乎周期薛定谔算子等的一点工作进展。

张琦 （北京雁栖湖应用数学研究院）

Title: Conservative Dynamic $P(\phi)_2$ Model on $\mathbb{R}^2$ and its Reversible Measures

Abstract: In this talk, we consider the conservative dynamic $P(\phi)_2$ model on the whole plane $\mathbb{R}^2$ and its reversible measures. We first establish the lattice approximation for both non-conservative and conservative dynamic $P(\phi)_2$ models on torus $M\mathbb{T}^2$. Then we show the tightness of $P(\phi)_2$ measures on torus $M\mathbb{T}^2$ by energy estimates. Based on lattice approximation and tightness result, we construct a family of reversible canonical $P(\phi)_2$ measures under the conservative law. Moreover, we prove the global-well posedness of the conservative dynamic $P(\phi)_2$ model on $\mathbb{R}^2$ when the initial value is sample from the stationary measure. This is a joint work with Tadahisa Funaki (BIMSA), Bin Xie (Shinshu), and Hang Zeng (BIMSA).

李骥 （华中科技大学）

Title: Orbital stability of breathers in the modified Camassa-Holm equation

Abstract: The modified Camassa-Holm equation (mCH) with a cubic nonlinearity is an integrabel and nonlocal mathematical model for the unidirectional propagation of shallow-water waves. This study establishes the existence of time-periodic, spatially localized smooth-wave solutions, known as breathers, within a specific range of the linear dispersive parameter. By employing three rarely used conserved quantities, expressed in terms of the momentum variable m, it is demonstrated that breathers, as solutions to the mCH equation, are orbitally stable under perturbations in the Sobolev space H^2.

张奥 （中南大学）

Title: Semiclassical Approximation and Wigner Measure Convergence for Stochastic Nonlinear Schrödinger Equations

Abstract: We analyze the semiclassical limit of stochastic nonlinear Schrödinger equations with multiplicative noise. Combining semiclassical WKB approximation techniques with the theory of Wigner transforms and stochastic measures, we rigorously derive the eikonal and transport equations and prove convergence of Wigner transforms to a measure-valued solution of a stochastic Liouville equation.