天元数学国际交流中心
"遍历论与随机微分方程的动力学"
研讨会
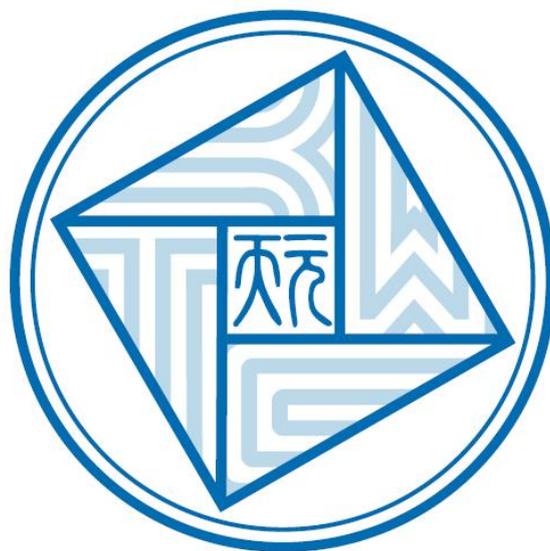
2026 年 3 月 22 日- 3 月 28 日

会务组：黄　文（中国科学技术大学）

张希承（北京理工大学）

柳振鑫（大连理工大学）

会议报告安排表

	3 月 23 日 （周一）	3 月 24 日 （周二）	3 月 25 日 （周三）	3 月 26 日 （周四）	3 月 27 日 （周五）
9:00 - 9:40	黄文	蒋继发	吴付科	王楷植	王健
9:45-10:25	吕翔	李国鹏	黄乔	苏耀峰	廖华夫
10:30-11:00	茶歇				
11:00-11:40	许惟钧	张文萌	李健	牟宸辰	罗德军
11:45-14:30	午餐、午休				
14:30-15:10	王玉昭	张国华	自由讨论	张登	自由讨论
15:15-15:55	许雷叶	黄远飞		韦屏远	
16:00-16:30	茶歇			茶歇	
16:30-17:10	周喆	马啸		顾陈琳	
17:15-17:55	王哲			蒲哲	

会议日程

时间	内容	主持人
	3 月 22 日（周日）全天，会议报到	
	3 月 23 日（周一）	
8:50-9:00	开幕式	
9:00-9:40	报告人：黄文（中国科学技术大学） 报告题目：Typical periodic optimization for dynamical systems: Symbolic dynamics	张希承
9:45-10:25	报告人：吕翔（上海师范大学） 报告题目：Stability analysis for nonlinear stochastic functional differential equations with additive white noise	
10:30-11:00	茶歇	
11:00-11:40	报告人：许惟钧（西湖大学） 报告题目：Periodic homogenisation for singular stochastic PDEs	陈锋
11:45-14:30	午餐、午休	
14:30-15:10	报告人：王玉昭（大连理工大学） 报告题目：Non-triviality of the radial Φ^4_d-model for $d \ge 4$	邵松
15:15-15:55	报告人：许雷叶（中国科学技术大学） 报告题目：动力系统中的独立性与平均敏感性	
16:00-16:30	茶歇	
16:30-17:10	报告人：周喆（中国科学院数学与系统科学研究院） 报告题目：从氢原子到薛定谔算子，再到斯图姆-刘维尔算子	窦斗
17:15-17:55	报告人：王哲（大连理工大学） 报告题目：Quenched invariance principle with rate for random dynamical systems	邱家豪
18:00-20:00	晚餐	

3 月 24 日（周二）		
时间	内容	主持人
9:00-9:40	报告人：蒋继发（河南师范大学） 报告题目: On Exponential Ergodicity and LDP of Stochastic Damping Hamiltonian	陈二才
9:45-10:25	报告人：李国鹏（北京理工大学） 报告题目: Probabilistic well-posedness of dispersive PDEs beyond variance blowup	
10:30-11:00	茶歇	
11:00-11:40	报告人：张文萌（重庆师范大学） 报告题目: Belitskii's C1 linearization revisited and smooth invariant bundles for Anosov diffeomorphisms on tori	黄建华
11:45-14:30	午餐、午休	
14:30-15:10	报告人：张国华（复旦大学） 报告题目: Weak Expansiveness in Topological Dynamics: From $\mathbb{Z}$-Actions to Amenable Groups	李晓月
15:15-15:55	报告人：黄远飞（Asia Pacific Center for Theoretical Physics） 报告题目：非高斯随机动力系统的熵产生：理论与算法	
16:00-16:30	茶歇	
16:30-17:10	报告人：马啸（中国科学技术大学） 报告题目: Periodic structure, horseshoes and extremal measures in hyperbolic dynamical systems	历智明
17:15-19:00	晚餐	

3 月 25 日（周三）		
时间	内容	主持人
9:00-9:40	报告人：吴付科（华中科技大学） 报告题目: Systems of Coupled Forward-Backward Stochastic Differential Equations: Fast and Slow Motions, Associated Quasi-Linear Partial Differential Equations, and Applications	王毅
9:40-10:20	报告人：黄乔（东南大学） 报告题目: Stability analysis of a branching diffusion solver for semilinear heat equations	
10:20-10:50	茶歇	
10:50-11:30	报告人：李健（汕头大学） 报告题目: The complexity of finite partitions in a standard probability space	张一威
11:30-14:00	午餐、午休	
14:00-17:00	自由讨论	
17:00-19:00	晚餐	

3月 26 日（周四）		
时间	内容	主持人
9:00-9:40	报告人：王楷植（上海交通大学） 报告题目: New Dynamical Phenomena for the Hamilton-Jacobi Equation	柳振鑫
9:45-10:25	报告人：苏耀峰（南方科技大学） 报告题目: Polynomial escape rates	
10:30-11:00	茶歇	
11:00-11:40	报告人：牟宸辰（香港城市大学） 报告题目: On Well-posedness of Mean Field Game Master Equations: A Unified Approach	刘伟
11:45-14:30	午餐、午休	
14:30-15:10	报告人：张登（上海交通大学） 报告题目: Recent progress on stochastic dispersive and fluid equations	郭英佳
15:15-15:55	报告人：韦屏远（东南大学） 报告题目: Complete Solutions of Stochastic HJB Equations on LCS Manifolds	
16:00-16:30	茶歇	
16:30-17:10	报告人：顾陈琳（清华大学） 报告题目: Some recent progresses on non-gradient exclusion process	孙振尧
17:15-17:55	报告人：蒲哲（大湾区大学/中国科学技术大学） 报告题目: Limiting Behavior of Invariant Measures for Stochastic Highly Nonlinear Partial Differential Equations on Thin Domains	任洁
18:00-20:00	晚餐	

3 月 27 日（周五）		
时间	内容	主持人
9:00-9:40	报告人：王健（福建师范大学） 报告题目: Stochastic homogenization of diffusions in turbulence driven by non-local symmetric Levy operators	谢颖超
9:40-10:20	报告人：廖华夫（大连理工大学） 报告题目: Hamilton-Jacobi-Bellman equations and controlled particle systems for generalized mean field control	
10:20-10:50	茶歇	
10:50-11:30	报告人：罗德军（中科院数学与系统科学研究院） 报告题目: Weak uniqueness by transport noise for 2D fluid equations	郑言
11:30-14:00	午餐、午休	
14:00-17:00	自由讨论	
17:00-19:00	晚餐	

报告题目和摘要

（按姓氏拼音字母序排列）

Some recent progresses on non-gradient exclusion process
顾陈琳（清华大学）

Abstract: The simple symmetric exclusion process (SSEP) has many nice properties, and sometimes is considered as a solvable model. The non-gradient exclusion process, also called speed-change exclusion process, is thus proposed to understand the more universal behavior. This talk summarizes some recent progresses on this model, especially with a focus on the combination of the quantitative homogenization and the classical techniques. The talk is based on my joint work with Tadahisa Funaki, Arianna Giunti, Jean-Christophe Mourrat, Maximilian Nitzschner, Han Wang, and Linzhi Yang.

Stability analysis of a branching diffusion solver for semilinear heat equations

黄乔（东南大学）

Abstract: Stochastic branching algorithms provide a useful alternative to grid-based schemes for the numerical solution of partial differential equations, particularly in high-dimensional settings. However, they require a strict control of the integrability of random functionals of branching processes in order to ensure the non-explosion of solutions. In this paper, we study the stability of a functional branching representation of PDE solutions by deriving sufficient criteria for the integrability of the multiplicative weighted progeny of stochastic branching processes. We also prove the uniqueness of mild solutions under uniform integrability assumptions on random functionals. This talk is based on joint work with N. Privault.

Typical periodic optimization for dynamical systems: Symbolic dynamics

黄文（中国科学技术大学）

Abstract: 主要综述和介绍最近关于动力系统通有最优化：符号系统方面的进展。内容包括：针对具有弱双曲性但 Mañé 上同调引理不成立的动力系统，发展的最大化集的理论。该理论建立了一个结构定理，有效地分离出系统中可能阻碍通有周期最优化的部分，进而介绍符号动力系统的通有周期最优化与边界最优化二分定理。这是与 Oliver Jenkinson, 许雷叶和张一威合作的工作.

非高斯随机动力系统的熵产生：理论与算法
黄远飞（Asia Pacific Center for Theoretical Physics）

Abstract: 在活性物质（Active Matter）系统中，系统通常受到非高斯活跃涨落的驱动，如列维过程或复合泊松过程，这给传统的随机动力学分析和稳态熵产生的定义带来了挑战。

本报告提出一个处理由非高斯活性涨落驱动的活跃物质系统的通用数学框架。基于概率流等价技术（Probability-flow equivalence technique），我们严格推导了熵产生的分解公式，并证明了总熵产生满足一个统一的详细涨落定理（Detailed Fluctuation Theorem），积分涨落定理（Integral Fluctuation Theorem）以及广义第二定律（Generalized Second Law）。此外，针对非高斯系统中概率密度演化难以解析求解的问题，我们引入了基于神经网络的深度学习计算方法。通过典型物理模型的数值模拟，展示了该框架在捕捉非平衡稳态动力学特征方面的有效性。

On Exponential Ergodicity and LDP of Stochastic Damping Hamiltonian Systems
蒋继发（河南师范大学）

Abstract: This paper establishes that a stochastic damping Hamiltonian system with twice continuously differentiable coefficients possesses the irreducible and strong Feller properties, as well as exponential ergodicity under a Lyapunov condition. Through a delicate construction of a Lyapunov function with polynomial growth, we provide verifiable criteria for exponential ergodicity. Our criteria are applicable to systems where the damping matrix lacks a lower bound and is unbounded with respect to velocity, as well as to systems with unbounded noise coefficients-three cases not covered by existing results. The use of a polynomial growing Lyapunov function, which is milder than exponential growth, expands the space of admissible initial distribution and effectively prevents exponential explosion. The criteria for the Donsker-Varadhan large deviation principle are also presented.

This is a joint work with Prof. Zhai Jianliang.

Probabilistic well-posedness of dispersive PDEs beyond variance blowup

李国鹏（北京理工大学）

Abstract: In this talk, we apply the fourth moment theorem to investigate a possible extension of the probabilistic well-posedness theory for nonlinear dispersive PDEs with random initial data beyond variance blowup. As a model equation, we study the Benjamin-Bona-Mahony (BBM) equation with Gaussian random initial data. By introducing a suitable vanishing multiplicative renormalization constant for the initial data, we show that solutions to the BBM with renormalized Gaussian random initial data beyond variance blowup converge in law to a solution of the stochastic BBM forced by the derivative of a spatial white noise.

If time allows, I will also discuss the variance blowup phenomena for the nonlinear wave equation.

Joint work with: Jiawei Li & Tadahiro Oh (Edinburgh) and Nikolay Tzvetkov (ENS Lyon).

The complexity of finite partitions in a standard probability space
李健（汕头大学）

Abstract: In this talk, we discuss several types of complexity of finite partitions in a standard probability space. We show that a collection of finite partitions is precompactness in the Rokhlin

metric if and only if it has zero maximal pattern entropy if and only if the collection of the characteristic functions of atoms in the partitions is precompactness in L^2 if and only if it has bounded mean complexity with respect the Hamming distance. Then we apply this result to the complexity of a partition of countably infinite discrete amenable group actions. This talk is based on a joint work with Tao Yu and Xianliang Zhong.

Hamilton-Jacobi-Bellman equations and controlled particle systems for generalized mean field control
廖华夫（大连理工大学）

Abstract: In this talk I will present some of our recent works on HJB equations for generalized mean field control (MFC) and related controlled N-particle systems. Such kind of HJB equations are nonlinearly coupled with the distribution induced by the Wasserstein derivatives of solutions. A local in time classical solution for the HJB equation is generated via a probabilistic approach based on the mean field maximum principle. Given an extension of the displacement convexity condition, we obtain the uniform estimates on the HJB equation for the N-particle system. Thanks to the local well-posedness and the uniform estimates, we prove the global well-posedness of HJB equations for generalized MFC, which is also true for the degenerated case. I will also talk about related topics including Lipschitz approximators to optimal feedback functions for generalized MFC and examples in neural SDE.

Weak uniqueness by transport noise for 2D fluid equations
罗德军（中科院数学与系统科学研究院）

Abstract: In recent years, there are lots of results on the nonuniqueness of weak solutions to nonlinear fluid equations, both in deterministic and stochastic setting. The purpose of this talk is to present several positive results by showing that suitable transport noise restores uniqueness of weak solutions for some 2D fluid models, including Euler equations, mSQG equations and Boussinesq system. The talk is based on joint works with Lucio Galeati and Shuaijie Jiao.

Stability analysis for nonlinear stochastic functional differential equations with additive white noise
吕翔（上海师范大学）

Abstract: This paper is devoted to the existence and global stability of nontrivial stationary solutions for nonlinear stochastic functional differential equations with additive white noise, focusing on three distinct cases. For systems with discrete delays or bounded functionals, we establish a concise criterion that guarantees stability regardless of the size of the delays. For systems with unbounded functionals, we demonstrate the global stability provided that the time delay is sufficiently small. The main feature of this paper is that we don't need to construct Lyapunov functionals and some sufficient conditions presented here are easy to verify and sharp. Some examples are given to illustrate our main results.

Periodic structure, horseshoes and extremal measures in hyperbolic dynamical systems

马啸（中国科学技术大学）

Abstract: In this talk, we explore dynamical complexity from multiple perspectives, including volume growth, periodic structures, horseshoes, and extremal measures. The presentation is based on a series of joint works with Xinyu Bai, Wen Huang, Zeng Lian, Xue Liu, Leiye Xu, Jianhua Zhang, Yiwei Zhang, and Hang Zhao.

On Well-posedness of Mean Field Game Master Equations: A Unified Approach

牟宸辰（香港城市大学）

Abstract: It is well known that the global (in time) well-posedness of mean field game master equations relies on certain monotonicity conditions, and there have been several types of conditions proposed in the literature. In this talk we intend to provide a unified understanding on the role of monotonicity conditions in the theory. Inspired by Lyapunov functions for dynamical systems, we propose a general type of monotonicity condition, which covers all the existing ones as special cases and is essentially necessary for the existence of Lipschitz continuous classical solutions. Our approach works for very general mean field games, including extended mean field games and mean field games with volatility control. In particular, for the latter a new notion of second order monotonicity condition is required. The talk is based on some ongoing joint works with Jianfeng Zhang and Jianjun Zhou.

Limiting Behavior of Invariant Measures for Stochastic Highly Nonlinear Partial Differential Equations on Thin Domains

蒲哲（大湾区大学/中国科学技术大学）

Abstract: In this talk, we discuss the limiting behavior of invariant measures for a class of stochastic Highly Nonlinear Partial Differential Equations with nonlinear noise on thin domains. The existence and uniqueness of invariant measure on $(n + 1)$-dimensional thin domains are presented. The difficulty on estimates of the solutions for such problems in Sobolev space in the sense of thin domains is overcome by a novel proof techniques. Hence, the research results reveal that any limit of invariant measures of original equations on thin domains must be an invariant measure of the limiting equations when the $(n + 1)$-dimensional thin domains degenerates onto the n-dimensional space.

Polynomial escape rates

苏耀峰（南方科技大学）

Abstract: In this talk, I will tall about escape rates for various slowly mixing systems. Different from Markov chains and some uniformly expanding systems, the systems we consider here only exhibit polynomial escape rates, and such rates can tell the locations that the orbits prefer to visit.

Stochastic homogenization of diffusions in turbulence driven by non-local symmetric Levy operators
王健（福建师范大学）

Abstract: We investigate the stochastic homogenization of a class of turbulent diffusions generated by non-local symmetric Levy operators with divergence-free drift fields in ergodic random environments, where neither the drift fields nor their associated stream functions are assumed to be bounded. A pivotal step in our proof is the establishment of $W_{loc}^{1,q}$ estimates with $q\in (1,2)$ for the corresponding correctors, under mild prior regularity conditions imposed on the Levy measure and the stream function.

New Dynamical Phenomena for the Hamilton-Jacobi Equation
王楷植（上海交通大学）

Abstract: The weak KAM theorem tells us that the dynamical behavior of the semiflow generated by the Hamilton-Jacobi equation, which originates from classical mechanics, is simple. However, the dynamical behavior of the semiflow generated by the contact Hamilton-Jacobi equation, which has profound backgrounds in fields such as thermodynamics, is completely different. This talk will cover topics related to the (in)stability, the existence and multiplicity of periodic and quasi-periodic solutions, as well as chaotic phenomena, concerning the contact Hamilton-Jacobi equation.

Non-triviality of the radial Φ^4_d-model for $d \ge 4$
王玉昭（大连理工大学）

Abstract: The Φ^4_d-measure is the central object in constructive quantum field theory. Its construction for $d = 2, 3$ is one of the early achievements in the field in 1970s. For $d \ge 4$, the Φ^4_d-measure is known to be trivial with a recent breakthrough work for the 4-d case by Aizenman and Duminil-Copin (2021).

In this talk, by imposing the radial assumption, I will present the construction of the Φ^4_d-measure for $d \ge 4$ on the unit ball by considering the limit of the Φ^4_d-measures on punctured balls. In order to control the singularity at the origin, we exploit the Markov property of the Gaussian free field over disjoint sets and sharp Green's function estimates on a punctured ball. We also show that the resulting Φ^4_d-measure has a sub-Gaussian tail and that it is singular with respect to the base Gaussian free field.

This is based on a joint work with Tadahiro Oh (the University of Edinburg), Leonardo Tolomeo (the University of Edinburgh), and Nikolay Tzvetkov (ENS Lyon).

Quenched invariance principle with rate for random dynamical systems
王哲（大连理工大学）

Abstract: In this talk, we will discuss the quenched invariance principle and Wassertein convergence rate for random Young towers. We will also discuss a new martingale-coboundary decomposition for the random tower map, which provides a good control over sums of squares of the approximating martingale. We apply our results to independent and identically distributed

(i.i.d.) translations of LSV maps.

Stochastic contact Hamilton–Jacobi–Bellman equations with applications in optimal control
韦屏远（东南大学）

Abstract: In recent decades, the Hamilton‑Jacobi theorem has been reinterpreted in modern geometric terms and extended to contact systems, LCS systems, and various other settings. Meanwhile, stochastic versions of the Hamilton‑Jacobi equation — commonly known as stochastic Hamilton‑Jacobi‑Bellman (HJB) equations—have attracted growing interest. These equations describe the evolution of optimally controlled systems under random dynamics, and also serve as powerful tools in the study of stochastic models across probability theory and mathematical physics. In this talk, we introduce two types of stochastic contact Hamilton‑Jacobi‑Bellman equations and explore their potential applications in optimal control. Part of this talk is based on joint work with Jinqiao Duan (GBU) and Qiao Huang (SEU).

Systems of Coupled Forward-Backward Stochastic Differential Equations: Fast and Slow Motions, Associated Quasi-Linear Partial Differential Equations, and Applications
吴付科（华中科技大学）

Abstract: This work analyzes systems of coupled forward-backward stochastic differential equations with fast and slow motions. First, well-posedness and a number of estimates of the systems are established. Then the paper is focused on obtaining averaging principles in the sense of mean-square convergence uniform in finite time interval for solutions of both forward and backward stochastic differential equations.

The averaging principle enables us to further analyze certain associated quasi-linear PDEs. In addition, as an application, the convergence of a class of associated singularly perturbed stochastic control problems is established.

动力系统中的独立性与平均敏感性
许雷叶（中国科学技术大学）

摘要： 在本次报告中，我将介绍我们在局部熵理论方面的工作。对于极小拓扑动力系统，在不可压缩性或不变测度存在的假设下，系统的正则性被独立性或平均敏感性严格控制，且所有平均敏感性串均为 IT 串。对于保测系统，所有测度序列熵串均为独立性串；进一步，若不变测度是遍历测度并且作用群是可数无限顺从群，则测度序列熵串与测度平均敏感性串等价。

Periodic homogenisation for singular stochastic PDEs
许惟钧（西湖大学）

Abstract: We introduce renormalisation procedures in recent developments in singular

stochastic PDEs, as well as homogenisation problem for equations with oscillatory coefficients. Both renormalisation and homogenisation are singular limiting procedures, but with very different features. It is then natural to ask how these two limiting procedures interact with each other when they appear in the same problem. We will share some of our recent works and understandings in this direction. Part of the talk are based on joint works with Yilin Chen (PKU) and Ben Fehrman (LSU).

Recent progress on stochastic dispersive and fluid equations
张登（上海交通大学）

Abstract: In this talk we will review some recent progresses on stochastic dispersive and fluid equations. More precisely, it is shown the construction and conditional uniqueness of multi-bubble blow-ups and multi-solitons to (stochastic) nonlinear Schrödinger equations, related to the mass quantization conjecture and the uniqueness open problem posed by Martel (ICM 2018). Further well-posedness and scattering results are derived for the 4D energy-critical stochastic Zakharov system.

For stochastic fluid equations, we will present the construction of continuous energy solutions to the 3D stochastic Navier-Stokes equation. In the 2D case, we also show the Lagrangian chaos driven by degenerate bounded noise, related to the open problem posed by Bedrossian (ICM 2022).

Weak Expansiveness in Topological Dynamics: From \mathbb{Z}-Actions to Amenable Groups

张国华（复旦大学）

Abstract: Weak expansiveness, including h-expansiveness and asymptotic h-expansiveness introduced by Bowen and Misiurewicz for \mathbb{Z}-actions, plays a key role in the existence of maximal entropy measures. This talk extends the discussion to amenable group actions, which arise naturally in statistical mechanics and ergodic theory. I will survey weak expansiveness for amenable groups from four perspectives: topological conditional entropy, (quasi-)symbolic extensions, topological entropy of subsets, and dimensional entropy of subsets. Recent characterizations via stable sets will also be presented, along with some open questions for sofic group actions.

Belitskii's C1 linearization revisited and smooth invariant bundles for Anosov diffeomorphisms on tori
张文萌（重庆师范大学）

Abstract: Linearization of hyperbolic dynamical systems is a foundational problem in the study of differential equations and dynamical systems, supporting analysis of local stability, global bifurcation and chaotic dynamics. The widely applied Belitskii's C1 linearization theorem (1973) was shown to have gaps in its original proof, leaving a critical unsolved problem in the field. Our work addresses this gap by rigorously proving the theorem within the framework of random dynamical systems. We propose novel approaches to establish the C^1 smoothness of stable and

unstable bundles, which in turn implies the C^1 smoothness of stable and unstable foliations. This result enables us to prove C^1 linearization via the method of invariant foliation decoupling. Moreover, we extend our new idea to the framework of tori and study the smoothness of stable and unstable bundles for Anosov diffeomorphisms on tori.

从氢原子到薛定谔算子，再到斯图姆-刘维尔算子
周喆（中国科学院数学与系统科学研究院）

Abstract: 我们通过氢原子的能级推导，引出薛定谔算子。在前人工作基础上，汇报我们利用旋转数方法，在几乎周期薛定谔算子的一点工作进展。时间允许，再汇报在几乎周期斯图姆-刘维尔算子的一点工作进展。