

2016年11月18日-21日,中国武汉主办单位:华中科技大学数学中心

本次青年论坛主旨是进一步加强非线性动力系统现代理论及其应用的理解,其主题着重于近年来围绕与动力系统相关的若干交叉学科问题的研究,并为国内外研究者(特别是广大青年研究者)提供一个分享研究成果,促进数学,物理,生物等各个学科之间交流合作的一个平台。此次研讨会将主要涵盖以下几个具体内容:

- (1) 动力系统理论与随机相关理论的交叉;
- (2) 非平衡态系统中的统计力学,热力学问题;
- (3) 动力系统中的分析,组合优化方法;
- (4) 动力系统在生物中的应用及图像处理问题。

一. 欢迎致辞

尊敬的来宾,

欢迎您参加由我们数学中心举办的"动力系统青年论坛"! 这次论坛旨在对动力系统及相关交叉学科中的研究热点进行探讨, 期望借助这个平台进一步广泛深入地促进数学, 物理, 生物等不同分支之间的交流合作。内容将突出随机动力系统, 非平衡态统热力学问题, 及其在生物中的应用。动力系统是我们数学中心的一个重要研究领域。我们数学中心的宗旨是:

- (1) 积极倡导数学不同分支之间的交叉研究;激发新的合作探索,催生新的研究领域和研究群体:
- (2) 努力推动数学与科学,工程,医学之间的交叉研究;建立数学家和科学家之间的广泛联系,从而达到合作共赢;
- (3) 聚集一流人才,培养优秀学生,做出一流研究,引领学科发展,服务国家和社会。

无论您来自哪里,数学是我们的共同语言,数学中心为我们提供共同探讨数学的家园。我们希望您度过一个愉快丰收的会议历程!

敬礼!

华中科大数学中心主任: 段金桥 2016.11.15

二. 会议时间及地点安排

11月18日: 注册 (地点):

注册地点: 宏嘉酒店一楼大厅(华中科技大学国际学术交流中心(校内喻园小区附近),武汉洪山区,喻家湖路 78 号)

11 月 19 日上午-21 日上午: 论坛报告

11月21日下午:游览马鞍山国家森林公园、离会

会议报告地点: 华中科技大学数学中心启明学院二楼学术报告厅



三. 会议组织

学术委员会: 段金桥、Peter Kloeden、Jurgen Kurths、傅新楚会议组委会: 李骥、张一威、林聪萍、殷钶、刘勤波、王金涛

会议助理: 徐婧悦

四. 差旅及住宿

本次会议不收取注册费,参会学者差旅费用自理,会议期间食宿由主办单位统一安排。

五. 联系人

徐婧悦 18771045768

mathcenter@hust.edu.cn

六. 华中科技大学地图以及公交线路指引(见下页)





公交地铁线路指引

终点:华中科技大学东校区(公交站名:珞喻东路佳园路)

起点1:武汉(火车)站,

- (a) 可乘坐 地铁 4 号线 <u>武汉火车站</u> 至 <u>洪山广场站</u> 转 2 号线 至 <u>光谷广场</u> (地理位置同"鲁巷"),之后可乘坐 公交车:518,703 等 至 <u>珞喻东路佳园路</u>
- (b) 可乘坐 公交 513 至 珞喻东路佳园路

起点 2: <u>武昌(火车)站(宏基长途客运站)</u>, 无地铁, 可乘坐 公交车: **518** <u>武昌火车站</u> 至 珞喻东路佳园路

起点 3: 傅家坡(长途)客运站,可乘坐公交车: 518,703 至珞喻东路佳园路

起点 4:汉口(火车)站

- (b) 可乘坐 公交 703 至 珞喻东路佳园路

起点 5: 天河机场站 可乘坐 地铁 2号线 至 光谷广场, 后同上。

附:

公交 518 运行时间:5:00-22:30 (末班车); 公交 703 运行时间 6:00-21:00 (末班车)

公交 513 运行时间: 6;00-20;00 (末班车) 地铁 2,4号线运行时间: 6;00-22:30 (末班车)

地铁线路图





会议日程

地点:8楼813室

11月19日,2016							
	时间 报告人 单位 报告题目						
	9:00-9:20	会议开幕		W.G. = 1.			
	9:20-10:00	杨晓松	华中科大	生态学的若干前沿问题及其动力系 统理论研究机遇			
	10:00-10:30	茶歇					
上	主持人:						
	10:30-11:10	邹秀芬	武汉大学	Controllability of dynamical			
				systems and application in			
午				identifying drug targets in			
				complex diseases			
	11:10-11:50	葛颢	北京大学	Nonequilibrium thermodynamics			
				of chemical reaction kinetics			
中午	12:00-13:00	午餐					
	主持人:						
	14:00-14:40	傅新楚	上海大学	Epidemic spreading on			
				adaptively weighted scale-free			
下				networks			
	14:40-15:20	许新建	上海大学	Contagion on complex networks			
				with persuasion			
午	15:20-15:50		学 歇				
	15:50-16:30	李科赞	桂林电子 科技大学	一类埃博拉传染病模型的动力学分 析			
	16:30-17:10	林聪萍	华中科大	Structure and Dynamics of ER:			
				Minimal Networks and			
				Biophysical Constraints.			
晚上	17:10-18:00	晚餐					
	11月20日,2016						
	时间	报告人	单位	报告题目			
	主持人:						
上	9:00-9:40	张云新	复旦大学	Relationship between promoter			
				sequence and its strength in			
				gene expression			
午	9:40-10:20	张兴安	华中师大	The mutation mechanisms of human			
				breast cancer			
	10:20-10:50	茶歇					



	10:50-11:30	王瑞琦	上海大学	基于组合摄动的组合药物在疾病治	
上				疗中的应用	
午	11:30-12:10	雷锦誌	清华大学	数学与癌症——从分子调控到组织	
				行为	
中午	12:10-13:00	午餐			
	主持人:				
	14:00-14:40	张景军	嘉兴大学	Global stability results on the	
				Euler-Poisson system arising	
下				from plasma physics	
	14:40-15:20	魏金龙	中南财经	Kinetic solutions for nonlocal	
			政法大学	scalar conservation laws	
午	15:20-15:50	茶歇			
	15:50-16:30	王玮明	淮阴师范	A stochastic SIRS epidemic model	
			大学	with infectious force under	
				intervention strategies	
	16:30-17:10	林伟	复旦大学		
晚上	17:10-18:00	晚餐			
	11月21日,2016				
75			月 21 日	, 2016	
	主持人:		月 21 日,	, 2016	
	主持人: 9:00-9:40		月 21 日	A New Variational Method for	
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		11		A New Variational Method for	
L		11		A New Variational Method for Bias Correction and its	
		11		A New Variational Method for Bias Correction and its Applications to Rodent Brain	
Ł	9:00-9:40 9:40-10:20	段玉萍 史作强	天津大学	A New Variational Method for Bias Correction and its Applications to Rodent Brain Extraction	
	9:00-9:40	11 段玉萍 史作强 茶歇	天津大学	A New Variational Method for Bias Correction and its Applications to Rodent Brain Extraction Low dimensional manifold model	
Ł	9:00-9:40 9:40-10:20	段玉萍 史作强	天津大学	A New Variational Method for Bias Correction and its Applications to Rodent Brain Extraction Low dimensional manifold model	
Ł	9:00-9:40 9:40-10:20 10:20-10:50	11 段玉萍 史作强 茶歇	天津大学	A New Variational Method for Bias Correction and its Applications to Rodent Brain Extraction Low dimensional manifold model for image processing	
Ł	9:00-9:40 9:40-10:20 10:20-10:50	11 段玉萍 史作强 茶歇	天津大学 清华大学 河南大学 中国地质	A New Variational Method for Bias Correction and its Applications to Rodent Brain Extraction Low dimensional manifold model for image processing BMO Estimate for SPDEs with Levy noise Computation of local ISS	
Ł	9:00-9:40 9:40-10:20 10:20-10:50 10:50-11:30	段玉萍 史作强 茶歇 吕广营	天津大学 清华大学 河南大学	A New Variational Method for Bias Correction and its Applications to Rodent Brain Extraction Low dimensional manifold model for image processing BMO Estimate for SPDEs with Levy noise Computation of local ISS Lyapunov functions for	
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上午	9:00-9:40 9:40-10:20 10:20-10:50 10:50-11:30	段玉萍 史作强 茶歇 吕广营	天津大学 清华大学 河南大学 中国地质	A New Variational Method for Bias Correction and its Applications to Rodent Brain Extraction Low dimensional manifold model for image processing BMO Estimate for SPDEs with Levy noise Computation of local ISS Lyapunov functions for	
Ł	9:00-9:40 9:40-10:20 10:20-10:50 10:50-11:30	段玉萍 史作强 茶歇 吕广营	天津大学 清华大学 河南大学 中国地质	A New Variational Method for Bias Correction and its Applications to Rodent Brain Extraction Low dimensional manifold model for image processing BMO Estimate for SPDEs with Levy noise Computation of local ISS Lyapunov functions for discrete-time systems via	



摘 要

杨晓松(华中科技大学)

题目: 生态学的若干前沿问题及其动力系统理论研究机遇

摘要: 本报告简要回顾了生态学的基本问题和当前生态学理论研究的若干重要的前沿研究课题,并阐明了相关问题对数学特别是非线性动力系统理论带来的挑战,特别强调了从实际科学问题角度进行相关理论问题的研究重要性。最后探讨了当前生物数学研究者在这个领域遭遇的困境成因和解决途径。具体内容如下

- 1 生态学的若干前沿问题;
- 2 生态学研究的一些误区和不足;
- 3 达尔文灭绝和分叉理论;
- 4 生态系统混沌的是是非非;
- 5 生态数学研究的若干困境及其机遇;
- 6 对微分动力系统理论带来的若干挑战。

邹秀芬(武汉大学)

Title: Controllability of dynamical systems and application in identifying drug targets in complex diseases

Abstract: In this talk, I introduce a new concept of the domain control for nonlinear dynamical systems. Its theoretical proof is given and the effectiveness of our theory and approaches is proved by using several realistic disease-related networks: the epithelial-mesenchymal transition (EMT) core network, the T helper (Th) differentiation cellular network and the cancer network. These results not only offer a practical control scheme for nonlinear dynamical networks but also identify new drug targets for complex diseases.



葛颢(北京大学)

Title: Nonequilibrium thermodynamics of chemical reaction

kinetics

Abstract: Nonequilibrium thermodynamics and statistical physics in terms of stochastic models entered a stage of vigorous development since 1970s, which well fit the development of advanced experimental techniques in modern physical chemistry and biochemistry. I will discuss our recent stochastic approaches to investigate the nonequilibrium thermodynamics of chemical reaction systems. We show that the entropy production rate can be decomposed into the housekeeping heat and the decreasing rate of relative entropy, both of which are nonnegative, followed by a more stronger version of Clausius inequality. We further proved that in the macroscopic limit by merely allowing the molecular numbers to infinite, a generalized macroscopic free energy and its balance equation emerge. The balance equation is valid generally in isothermal driven systems. A general fluctuation dissipation theorem for stochastic reaction kinetics is also proved. Such an emergent "law" is independent of underlying kinetic details. The mathematical theory illustrates how a novel macroscopic dynamic law can emerge from the mesoscopic kinetics in a multi-scale system.

傅新楚(上海大学)

Title: Epidemic spreading on adaptively weighted scale-free networks

Abstract: In this talk, based on some more reasonable hypotheses, we propose three modified SIS models on scale-free networks that take into account variable population size, nonlinear infectivity, adaptive weights, behavior inertia and time delay, so as to better characterize the actual spread of epidemics. We develop new mathematical methods and techniques to study the dynamics of the models, including the basic reproduction number, and the global asymptotic stability of the disease-free and endemic equilibria. We find that Hopf bifurcation along the disease-free equilibrium will not happen. We further analyze the effects of local information of diseases and various immunization schemes on epidemic dynamics. We also perform some stochastic network simulations which yield quantitative agreement with the deterministic mean-field approach.



许新建(上海大学)

Title: Contagion on complex networks with persuasion

Abstract: The threshold model has been widely adopted as a classic model for studying contagion processes on social networks. We consider asymmetric individual interactions in social networks and introduce a persuasion mechanism into the threshold model. Specifically, we study a combination of adoption and persuasion in cascading processes on complex networks. It is found that with the introduction of the persuasion mechanism, the system may become more vulnerable to global cascades, and the effects of persuasion tend to be more significant in heterogeneous networks than those in homogeneous networks: a comparison between heterogeneous and homogeneous networks shows that under weak persuasion, heterogeneous networks tend to be more robust against random shocks than homogeneous networks; whereas under strong persuasion, homogeneous networks are more stable. Finally, we study the effects of adoption and persuasion heterogeneity on systemic stability. Though both heterogeneities give rise to global cascades, the adoption heterogeneity has an overwhelmingly stronger impact than the persuasion heterogeneity when the network connectivity is sufficiently dense.

李科赞(桂林电子科技大学)

题 目:一类埃博拉传染病模型的动力学分析

摘 要:考虑了人类和动物耦合传播的情况,提出了一类具有隔离仓室和动物仓室的埃博拉传染病模型。然后运用第二代生成矩阵的方法得到了基本再生数的表达式,利用稳定性和动力系统的相关理论证明了无病平衡点、边界平衡点、共存平衡点的存在性及全局稳定性,并对模型中的参数进行敏感性指数分析。最后通过数值模拟验证了这些结果的正确性。此项工作对于如何有效预防和控制埃博拉病毒的传播具有重要的指导意义。



林聪萍 (华中科技大学)

Title: Structure and Dynamics of ER: Minimal Networks and Biophysical Constraints.

Abstract: The endoplasmic reticulum (ER) in live cells is a highly mobile network whose structure dynamically changes on a number of timescales. The role of such drastic changes in any system is unclear, although there are correlations with ER function. A better understanding of the fundamental biophysical constraints on the system will allow biologists to determine the effects of molecular factors on ER dynamics. Previous studies have identified potential static elements that the ER may remodel around. Here, we use these structural elements to assess biophysical principles behind the network dynamics. By analyzing imaging data of tobacco leaf epidermal cells under two different conditions, i.e., native state (control) and latrunculin B (treated), we show that the geometric structure and dynamics of ER networks can be understood in terms of minimal networks. Our results show that the ER network is well modeled as a locally minimal-length network between the static elements that potentially anchor the ER to the cell cortex over longer timescales; this network is perturbed by a mixture of random and deterministic forces. The network need not have globally minimum length; we observe cases where the local topology may change dynamically between different Euclidean Steiner network topologies. The networks in the treated cells are easier to quantify, because they are less dynamic (the treatment suppresses actin dynamics), but the same general features are found in control cells. Using a Langevin approach, we model the dynamics of the nonpersistent nodes and use this to show that the images can be used to estimate both local viscoelastic behavior of the cytoplasm and filament tension in the ER network. This means we can explain several aspects of the ER geometry in terms of biophysical principles.



张云新(复旦大学)

Title: Relationship between promoter sequence and its strength in gene expression

Abstract: Promoter strength, or activity, is important in genetic engineering and synthetic biology. A constitutive promoter with a certain strength for one given RNA can often be reused for other RNAs. Therefore, the strength of one promoter is mainly determined by its nucleotide sequence. One of the main difficulties in genetic engineering and synthetic biology is how to control the expression of a certain protein at a given level. One usually used way to achieve this goal is to choose one promoter with a suitable strength which can be employed to regulate the rate of transcription, which then leads to the required level of protein expression. For this purpose, so far, many promoter libraries have been established experimentally. However, theoretical methods to predict the strength of one promoter from its nucleotide sequence are desirable. Such methods are not only valuable in the design of promoter with specified strength, but also meaningful to understand the mechanism of promoter in gene transcription. In this study, through various tests, a theoretical model is presented to describe the relationship between promoter strength nucleotide sequence. Our analysis shows that promoter strength is greatly influenced by nucleotide groups with three adjacent nucleotides in their sequences. Meanwhile, nucleotides in different regions of promoter sequence have different effects on promoter strength. Based on experimental data for E. coli promoters, our calculations indicate that nucleotides in the -10 region, the -35 region, and the discriminator region of a promoter sequence are more important for determining promoter strength than those in the spacing region. With model parameter values obtained by fitting to experimental data, four promoter libraries are theoretically built for the corresponding experimental environments under which data for promoter strength in gene expression has been measured previously.



张兴安(华中师范大学)

Title: The mutation mechanisms of human breast cancer

Abstract: In this talk, we investigate the mutation mechanisms of human breast cancer by modeling of the data of the surveillance, epidemiology, and end results (SEER) registry and have found that there are 2-14 hits in the genome of the breast stem cells, in which one of them becomes a malignant cell leading to clinical detection. The data are age-specific incidence rates of breast cancer of females in USA. In order to estimate the age-specific incidence rates, we consider a stochastic multistage model, in which normal breast stem cells are deterministic in the carcinogenesis by solving several coupled ordinary differential equations derived from the kolmogorov backward equations. Our results suggest that the genetic network of human breast cancer should consist of at least two genes and at most fourteen genes.

王瑞琦 (上海大学)

题目:基于组合摄动的组合药物在疾病治疗中的应用

摘要: 组合药物在复杂疾病的治疗中发挥着重要的作用。该研究 把疾病治疗中的组合药物转化为动力学中的摄动问题。通过组合 摄动对疾病系统动力学影响的研究,可以为组合药物的筛选以及 优化的治疗策略提供理论支持。

雷锦誌 (清华大学)

题目: 数学与癌症——从分子调控到组织行为

摘要:癌症的发生发展是多步长期的动力学过程。尽管生物学家越来越清楚的了解影响癌症发展过程的细胞信号系统的细节,但是对这个复杂动态过程的认识仍然十分有限。早在二十年前,著名癌症研究专家罗伯特.温伯格就大胆预言"到下一个世纪的第二个10年结束时,细胞信号系统的细枝末节都将会大白于天下。到那时,擅长于分析复杂的多元系统的数学家将向生物学家解释细胞内部的实际运作情况,他们将告诉我们细胞的工作思路以及它在肿瘤演进途中叛变的过程。"本报告的内容是关于数学在癌症研究中的应用,主要介绍使用数学作为工具研究细胞凋亡调控、自噬与肿瘤发展、干细胞再生、炎症与癌症、化疗对血细胞动力学等不同层次的数学建模和动力学分析。



张景军 (嘉兴大学)

Title: Global stability results on the Euler-Poisson system arising from plasma physics

Abstract: Euler-Poisson system can be derived from two-fluid model by ignoring the effect of magnetic field and regarding the ions being immobile. In this talk, we will introduce the recent developments on the global stability results for this system in dimensions 1d-3d.

魏金龙(中南财经政法大学)

Title: Kinetic solutions for nonlocal scalar conservation laws

Abstract: We are concerned with the uniqueness and existence of kinetic solutions for a class of fractional scalar conservation laws:

 $\partial_t \rho(t, x) + di v F(\rho) + v(-\Delta)^{\frac{1}{2}} \rho = 0$

Our proof for uniqueness is based upon the analysis on a microscopic contraction functional and the existence is enabled by a parabolic approximation. As an illustration, we obtain the existence and uniqueness of kinetic solutions for the generalized fractional Burgers-Fisher type equations. Moreover, we demonstrate the kinetic solutions' Lipschitz continuity in time, and continuous dependence on nonlinearities and Levy measures.

王玮明(淮阴师范大学)

Title: A stochastic SIRS epidemic model with infectious force under intervention strategies

Abstract: In this talk, we extend a classical SIRS epidemic model with the infectious forces under intervention strategies from a deterministic framework to a stochastic differential equation (SDE) one through introducing random fluctuations. The value of our study lies in two aspects. Mathematically, by using the Markov semigroups theory, we prove that the reproduction number R_0^s can be used to govern the stochastic dynamics of SDE model. If R_0^s <1, under mild extra conditions, the SDE system has a disease-free absorbing set which means the extinction of disease with probability one. If R_0^s >1, under mild extra conditions, it has an endemic stationary distribution which leads to the stochastic persistence of the disease. Epidemiologically, we find that random fluctuations can suppress disease outbreak, which can provide us some useful control strategies to regulate disease dynamics.



林伟(复旦大学)

段玉萍 (天津大学)

Title: A New Variational Method for Bias Correction and its Applications to Rodent Brain Extraction

Abstract: Brain extraction is an important preprocessing step for further analysis of brain MR images. Serious intensity inhomogeneity can be observed in rodent brain images due to the high-field MRI technique. Unlike most existing brain extraction methods requiring to perform on the bias corrected MRI, we present a high-order and LO regularized variational model for bias correction and brain extraction. The model is composed of a data fitting term, a piecewise constant regularization and a smooth regularization, which is constructed on a 3-D formulation for medical images with anisotropic voxel sizes. We propose an efficient multi-resolution algorithm for fast computation. At each resolution layer, we solve an alternating direction scheme, all subproblems of which have the closed-form solutions. The method is tested on three T2 weighted acquisition configurations comprising a total of 50 rodent brain volumes, which are with the acquisition field strengths of 4.7 Tesla, 9.4 Tesla and 17.6 Tesla, respectively. On one hand, we compare the results of bias correction with N3 and N4 in terms of the coefficient of variations on 20 different tissues of rodent brain. On the other hand, the results of brain extraction are compared against manually

segmented gold standards, BET, BSE and 3-D PCNN based on a number of metrics. With the high accuracy and efficiency, our proposed method can facilitate automatic processing of large-scale brain studies.



史作强 (清华大学)

Title: Low dimensional manifold model for image processing

Abstract: In this talk, I will present a novel low dimensional manifold model for some image processing problem. This model is based on the observation that for many natural images, the patch manifold usually has low dimension structure. Then, we use the dimension of the patch manifold as a regularization to recover the original image. Using some formula in differential geometry, this problem is reduced to solve Laplace-Beltrami equation on manifold. The Laplace-Beltrami equation is solved by the point integral method. Numerical tests show that this method gives very good results in image inpainting, denoising and super-resolution problem.

吕广营 (河南大学)

Title: BMO Estimate for SPDEs with Levy noise

Abstract: In this talk, we first give the BMO estimate for singular integral operator, and then apply this result to SPDEs with Levy noise.

李慧娟(中国地质大学)

Title: Computation of local ISS Lyapunov functions for discrete-time systems via linear programming

Abstract: This paper presents a numerical algorithm for computing ISS Lyapunov functions for discrete-time systems which are input-to-state stable (ISS) on compact subsets of the state space. The algorithm relies on solving a linear optimisation problem and delivers a continuous and piecewise affine ISS Lyapunov function on a suitable triangulation covering the given compact set excluding a small neighbourhood of the origin. The objective of the linear optimisation problem is to minimise the ISS gain. It is shown that for every ISS system there exists a suitable triangulation such that the proposed algorithm terminates successfully.





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