国家天元数学西北中心前沿论坛

Conference on Nonlinear Analysis and Reaction-Diffusion Equations

Academic Program

August 18-20, 2021

国家天元数学西北中心
TIANYUAN MATHEMATICAL CENTER IN NORTHWEST CHINA

School of Mathematics and Statistics Xidian University

国家天元数学西北中心前沿论坛

Conference on Nonlinear Analysis and Reaction-Diffusion Equations

Xidian University·Xi'an·Shaanxi·China·
August 18-20, 2021

Introduction

The conference on nonlinear analysis and reaction-diffusion equations will be held online from August 18-20, 2021 and hosted by Tianyuan Mathematical Center in Northwest China. The aim of this workshop is to bring together experts working on nonlinear analysis and reaction-diffusion equations with applications to present their latest research findings, share innovative ideas, identify challenges, and to promote international collaborations in nonlinear analysis, differential equations and its applications. **All the talks will be held online using Tencent Meeting platform with Tencent ID: 681 2989 1303 .**

Organizing Committee:

Ruyun Ma	Xidian University
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Yongkui Chang	Xidian University
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Feng Wang	Xidian University

Hosted by Tianyuan Mathematical Center in Northwest China

Organized by School of Mathematics and Statistics, Xidian University

Contact Information:

Shiliang Wu Tel: 18392190403 E-mail: slwu@xidian.edu.cn

Ruyun Ma Tel: 13038744011 E-mail: mary@nwnu.edu.cn

Tianyuan Mathematical Center in Northwest China
School of Mathematics and Statistics, Xidian University
August 2021

Plenary Speakers:

1. Xueli Bai	Northwestern Polytechnical University
2. Xiongxiong Bao	Chang'an University
3. Yihong Du	University of New England
4. Jian Fang	Harbin Institute of Technology
5. Yuxia Guo	Tsinghua University
6. Fang Li	Sun Yat-sen University
7. Wantong Li	Lanzhou University
8. Xing Liang	University of Science and Technology of China
9. Zhigui Lin	Yangzhou University
10. Bin Liu	Huazhong University of Science and Technology
11. Bendong Lou	Shanghai Normal University
12. Manjun Ma	Zhejiang Sci-Tech University
13. Tian Ma	Sichuan University
14. Ming Mei	McGill University & Champlain College
15. Hua Nie	Shaanxi Normal University
16. Xingbin Pan	The Chinese University of Hong Kong (Shen Zhen)
17. Rui Peng	Jiangsu Normal University
18. Shigui Ruan	University of Miami
19. Wenxian Shen	Auburn University
20. Weijie Sheng	Harbin Institute of Technology
21. Junping Shi	College of William & Mary

22. Hongying Shu	Shaanxi Normal University
23. Yongli Song	Hangzhou Normal University
24. Chunlei Tang	Southwest University
25. Youshan Tao	Shanghai Jiao Tong University
26. Mingxin Wang	Harbin Institute of Technology
27. Rongnian Wang	Shanghai Normal University
28. Zhicheng Wang	Lanzhou University
29. Dongmei Xiao	Shanghai Jiao Tong University
30. Yanni Xiao	Xi'an Jiaotong University
31. Liang Zhang	Lanzhou University
32. Xiaoqiang Zhao	Memorial University of Newfoundland
33. Maolin Zhou	Nankai University
34. Huaiping Zhu	York University
35. Xingfu Zou	University of Western Ontario

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Time	Opening Ceremony
8:30-8:50	
Chair： Yuan Lou	
Time	**Speaker**	**Title**
8:50-9:25	**Yihong Du**	Classification of the spreading profiles for a two species diffusive competition model with free boundaries
9:25-10:00	**Wenxian Shen**	Principal spectral theory of nonlocal dispersal operators with almost periodic dependence and its applications
Break（10:00-10:10）	
Chair： Ruyun Ma	
Time	**Speaker**	**Title**
10:10-10:45	**Mingxin Wang**	Upper and lower solutions method of boundary value problems with nonlinear boundary conditions
10:45-11:20	**Tian Ma**	Theory for high-temperature superconductivity
11:20-11:55	**Wantong Li**	Acceleration propagation for nonlocal dispersal equations
Chair：Guo Lin	
Time	**Speaker**	**Title**
14:00-14:35	**Dongmei Xiao**	On uniqueness of traveling waves for a reaction diffusion equation with spatio-temporal delay
14:35-15:10	**Rongnian Wang**	Theory of invariant manifolds for infinite-dimensional nonautonomous dynamical systems and applications
Break（15:10-15:20）	
Chair：Rongnian Wang	
Time	**Speaker**	**Title**
15:20-15:55	**Xingbin Pan**	Liquid crystals in a magnetic field
15:55-16:30	**Chunlei Tang**	Ground state solutions of Schrodinger equations with Hardy potential
Break（16:30-16:40）	
Chair：Jianwen Sun	
Time	**Speaker**	**Title**
16:40-17:15	**Hongying Shu**	Threshold dynamics of a nonlocal and delayed cholera model in a spatially heterogeneous environment
17:15-17:50	**Weijie Sheng**	On the mean speed of bistable transition fronts in unbounded domains

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Chair：Shigui Ruan		
Time	**Speaker**	**Title**
8:10-8:45	**Xiaoqiang Zhao**	Basic reproduction numbers for periodic reaction-diffusion population models
8:45-9:20	**Xingfu Zou**	Role of white-tailed deer in geographic spread of the black-legged tick Ixodes scapularis: analysis of a spatially nonlocal model
Break（9:20-9:30）		
Chair：Bendong Lou		
Time	**Speaker**	**Title**
9:30-10:05	**Shigui Ruan**	Modeling the growth, invasion and competition of Aedes mosquitoes
10:05-10:40	**Zhigui Lin**	气候变暖和空间异质性对西尼罗河病毒扩散的影响
Break（10:40-10:50）		
Chair：Zhigui Lin		
10:50-11:25	**Bendong Lou**	Zero number argument: some extension and applications
11:25-12:00	**Maolin Zhou**	The boundary regularity of rotating vortex patch
Chair：Taishan Yi		
Time	**Speaker**	**Title**
14:00-14:35	**Youshan Tao**	Thin-film-type approximation to a doubly cross-diffusive system
14:35-15:10	**Xing Liang**	Direction and symmetry of propagation of reaction-diffusion equations
Break（15:10-15:20）		
Chair：Binguo Wang		
Time	**Speaker**	**Title**
15:20-15:55	**Hua Nie**	The effect of diffusion on the dynamics of a predator-prey chemostat model
15:55-16:30	**Yongli Song**	Memory driven spatially inhomogeneous Hopf bifurcation and double Hopf bifurcation in the memory-based diffusion system
Break（16:30-16:40）		
Chair：Zhenguo Bai		
16:40-17:15	**Jian Fang**	Non-monotonicity of traveling waves for an iterative system
17:15-17:50	**Liang Zhang**	Propagation dynamics of a reaction-diffusion SI epidemic model with seasonality

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Chair：Junping Shi		
Time	**Speaker**	**Title**
8:10-8:45	**Huaiping Zhu**	Spatial movement of mosquitos and emerging mosquito-borne diseases considering climate change
8:45-9:20	**Ming Mei**	Sharp traveling waves for time-delayed reaction-diffusion equations
Break（9:20-9:30）		
Chair：Shiliang Wu		
Time	**Speaker**	**Title**
9:30-10:05	**Junping Shi**	A model of algal growth depending on nutrients and inorganic carbon in a poorly mixed water column
10:05-10:40	**Manjun Ma**	Traveling waves of reaction-diffusion equations with nonlinear advection
Break（10:40-10:50）		
Chair：Yongkui Chang		
10:50-11:25	**Yuxia Guo**	Non-degeneracy of bubbling solution for fractional prescribed curvature equation
11:25-12:00	**Zhicheng Wang**	Curved fronts of bistable reaction-diffusion equations in spatially periodic media
Chair：Shanbing Li		
Time	**Speaker**	**Title**
14:00-14:35	**Rui Peng**	Concentration behavior of endemic equilibrium for a reaction-diffusion-advection SIS epidemic model with mass action infection mechanism
14:35-15:10	**Fang Li**	Effects of dispersal strategies and heterogeneous environment on total population
Break（15:10-15:20）		
Chair：Yan Li		
Time	**Speaker**	**Title**
15:20-15:55	**Yanni Xiao**	Multi-scale mathematical models of the COVID-19 pandemic
15:55-16:30	**Xueli Bai**	Blow-up profiles and blow-up rate for the parabolic-elliptic Keller-Segel-Patlak system
16:30-17:05	**Xiongxiong Bao**	Propagation phenomena for reaction-diffusion cooperative systems

Titles and abstracts

(in alphabetical order)

Blow-up profiles and blow-up rate for the parabolic-elliptic Keller-Segel-Patlak system

Xueli Bai Northwestern Polytechnical University

We mainly consider the parabolic-elliptic Keller-Segel-Patlak system. For N=2, we show that each blowup is typeII in radial case. For the case N≥3, we solve an open problem proposed by P. Souplet and M. Winkler [2019, CMP]in the whole space case under suitable conditions. The main idea of our proof is to use some backward self-simlar solutions and apply zero number theory to the problem.

Propagation phenomena for reaction-diffusion cooperative systems

Xiongxiong Bao Chang'an University

In this talk, we will introduce our works on spatial spreading speeds and traveling wave solution of cooperative systems in periodic habitats with nonlocal dispersal, generalized transition waves of time-dependent reaction-diffusion cooperative systems and propagation dynamics for some three-species competitive-cooperative systems with delay and\or nonlocal dispersal.

Classification of the spreading profiles for a two species diffusive competition model with free boundaries

Yihong Du University of New England

In this talk I will report some recent advances on the research of a two species competition model with free boundaries. We are interested in a complete understanding of the spreading profiles of the system in the weak-strong competition case. We show that there are exactly five different types of long-time dynamical behavior for this system. This talk is based on theoretical work with Chang-Hong Wu, and numerical work with K. Khan, Shuang Liu and T. Schaerf.

Non-monotonicity of traveling waves for an iterative system

Jian Fang Harbin Institute of Technology

In this talk, we are interested in the shape of traveling waves for a locally monotone iterative system. Based on some nonlocal Harnack type inequalities, we obtain a sufficient condition for the non-monotonicity of wave profiles. This talk is based on a joint work with Dr. Yingli Pan.

Non-degeneracy of bubbling solution for fractional prescribed curvature equation

Yuxia Guo Tsinghua University

We consider the following fractional prescribed scalar curvature problem

$$\begin{cases} (-\Delta)^s u = K(y)u^{2_s^*-1}, & in \ \ R^N, \\ u>0, \qquad u \in \dot{H}^s\left(R^N\right), \end{cases}$$

where $N > 2s+2$, $\frac{1}{2} < s < 1$, $2_s^* = \frac{2N}{N-2s}$ is the critical Sobolev exponent, $\dot{H}^s\left(R^N\right)$ is the completion of $C_0^\infty\left(R^N\right)$ under the semi-norm $[u]_{H^s\left(R^N\right)} := \left(\int_{R^N} \left| (-\Delta)^{\frac{s}{2}} u \right|^2 dx \right)^{\frac{1}{2}}$, and K(y) is a positive radial function. We first prove a non-degeneracy result for the positive bubbling solutions of the equation via the local Pohozaev identities. Then we apply the non-degeneracy result to construct new bubbling solutions by Lyapunv-Schmidt reduction arguments. It should be mentioned that due to the non-localness of the fractional operator, we can not establish the local Pohozaev identities for the solution of u directly. Instead, we consider its corresponding harmonic extension, and this difference not only makes the sharp estimates for several integrals in the local Pohozaev identities but also force us to use the Pohozaev identities in quite a different way.

Effects of dispersal strategies and heterogeneous environment on total population

Fang Li Sun Yat-sen University

In this talk, we consider a single species model with nonlocal dispersal strategy and investigate how the dispersal rate of the species and the distribution of resources affect the total population. First, we show that the upper bound for the ratio between total population and total resource is $C\sqrt{d}$. Moreover, examples are constructed to indicate

that this upper bound is optimal. Secondly, for a type of simplified nonlocal diffusion operator, we prove that under certain condition, the total population as a function of dispersal rate admits exactly one local maximum point. These results reveal essential discrepancies between local and nonlocal dispersal strategies. This is joint work with Xueli Bai.

Acceleration propagation for nonlocal dispersal equations

Wantong Li Lanzhou University

In this talk, we focus on the influences of nonlocal dispersal kernels on the spatial propagation in nonlocal dispersal cooperative systems with initial values having nonempty compact supports. It is well-known that the solution of a monostable nonlocal dispersal scalar equation spreads at a finite speed when the kernel is thintailed and propagates by accelerating when the kernel has a heavy tail (the fat-tailed). However, in such systems, we find that one species can propagate by accelerating although its dispersal kernel is thin-tailed, which is a new and interesting phenomenon. This gives us a new understanding of the cooperation relation in the spatial propagation of nonlocal dispersal cooperative systems. Further, we determine the spreading speed of an epidemic model with nonlocal diffusion and free boundary and show that when spreading is successful, the asymptotic spreading speed is finite or infinite depending on whether a threshold condition is satisfied by the kernel function governing the spatial dispersal of the agents. This suggests that accelerated spreading is a rather common phenomenon for free boundary problems with nonlocal diffusion. In contrast, for the corresponding models with random diffusion, the spreading can only proceed with finite speed.

Direction and symmetry of propagation of reaction-diffusion equations

Xing Liang University of Science and Technology of China

In this talk, I will introduce some works about the direction and symmetry of propagation of some kinds of reaction-diffusion equations. For KPP reaction-diffusion-advection equations in periodic and almost periodic media, based on the discussion about principal eigenvalues, we provide sufficient and necessary conditions for the symmetry of spreading speeds. For bistable L-V systems, develop the method in the work for the scale bistable equation (W. Ding and T. Gilleti, Adv. Math.

2021), we show some examples that the invasion of the new species can succeed in one direction but fail in another direction even in the case where there is no advection.
This talk based on the recent works with Weiwei Ding and Tao Zhou.

气候变暖和空间异质性对西尼罗河病毒扩散的影响

Zhigui Lin　Yangzhou University

我们用反应扩散方程组描述西尼罗河病毒的空间扩散，用自由边界表示病毒扩散的边沿。为了检查空间特征对病毒扩散的影响，我们定义了四个基本再生数，分别对应于常微分方程组问题、具齐次 Neumann 问题，齐次 Dirichlet 问题和自由边界问题。结果表明，在高风险区域，如果感染区域范围大或者扩散慢，病毒将蔓延；在低风险区域，小的初始感染病例，小的感染范围和大的扩散速率有利于病毒的消退。当病毒蔓延时我们证明了其空间扩散速度接近于一个常数。另外我们重点考察了全球气候变暖和空间异质性对西尼罗河病毒扩散的影响。

Asymptotic stability in a quasilinear chemotaxis-haptotaxis model with general logistic source and nonlinear signal production

Bin Liu　Huazhong University of Science and Technology

In this talk, we consider the quasilinear chemotaxis-haptotaxis model of cancer invasion. Under specific parameters conditions, it is shown that for any appropriately regular initial data, the associated initial-boundary value problem admits a globally bounded classical solution. And the asymptotic stability of solutions is also investigated. These results improve or extend previously known ones, and partial results are new. This talk have been published on Journal of Differential Equations 269 (2020), 10839-10918.

Zero number argument: some extension and applications

Bendong Lou　Shanghai Normal University

Zero number of a solution to a linear parabolic equation can be used as a kind of “discrete Lyapunov” function to study the asymptotic behavior for the solutions to one-dimensional parabolic equations. The theory is based on the “zero number diminishing property” and the method is called “zero number argument”. I will talk

about the typical theory and some recent extensions, as well as some applications, not only to the qualitative study but also to the a priori gradient estimates.

Traveling waves of reaction-diffusion equations with nonlinear advection

Manjun Ma Zhejiang Sci-Tech University

This work is concerned with traveling waves of reaction-diffusion equations with nonlinear advection. By constructing invariant regions, we establish several theorems on the existence of wave fronts. A necessary and sufficient condition for the nonlinear selection mechanism of the minimal wave speed is obtained by a geometrical argument coupled with a perturbation method. On this basis, explicit sufficient conditions for the linear or nonlinear selection are derived. As applications, we are successful in proving some important results, including Murray's claim, Sabelnikov and Lipatnikov's claim.

Theory for high-temperature superconductivity

Tian Ma Sichuan University

In this report, we introduce a new theory on superconductivity based on the new mathematical and physical theories established by Tian Ma and Shouhong Wang.

Sharp traveling waves for time-delayed reaction-diffusion equations

Ming Mei McGill University & Champlain College

In this talk, I will talk about sharp traveling waves for two types of fundamental equations in PDEs, the classic Fisher-KPP equation with degenerate diffusion for population dynamics, and the classic Burgers equations with degenerate diffusion for fluid dynamics. Affected by the degeneracy of diffusions, the traveling waves are degenerate to be sharp-type. I will show the criteria for the existence of these sharp waves and their regularities.

The effect of diffusion on the dynamics of a predator-prey chemostat model

Hua Nie Shaanxi Normal University

This paper deals with a diffusive predator-prey chemostat system which describes the growth of planktonic rotifers, Brachionus calyciflorus, feeding on unicellular green algae, Chlorella vulgaris. The dynamical behavior of this system is established in terms of the diffusion rate. The results show that there exist two critical diffusion rates which classify the dynamical behavior of this system into the following three scenarios: (i) for large diffusion rate, all species will be washed out; (ii) for an intermediate diffusion rate, the predator goes extinct and the prey survives; (iii) for small diffusion rate, all species coexist. Finally, our numerical results show that the solution of this system may undergo a steady-state bifurcation or Hopf bifurcation for suitably small diffusion rate, which supplements our theoretical results.

Liquid crystals in a magnetic field

Xingbin Pan The Chinese University of Hong Kong (Shen Zhen)

Effects of magnetic fields on liquid crystals are interesting but not well understood mathematically. In this talk we examine long time behavior and dynamical instabilities of smectic liquid crystals in an applied magnetic field. Under a planar ansatz of the de Gennes model, we first establish existence of global weak solutions and prove convergence to an equilibrium as t tends to infinity. Then we discuss field-induced dynamical instability of the pure smectic states and of the pure nematic states. This talk is based on the joint work with Dr. Soojung Kim of Soongsil University.

Concentration behavior of endemic equilibrium for a reaction-diffusion-advection SIS epidemic model with mass action infection mechanism

Rui Peng Jiangsu Normal University

In this talk, I shall report our joint work on a reaction-diffusion-advection SIS epidemic model with mass action infection mechanism in a one dimensional bounded domain. We first prove the existence of endemic equilibrium (EE) whenever the basic reproduction number is greater than unity. We then focus on the asymptotic behavior of EE in three cases: large advection; small diffusion of the susceptible population; small diffusion of the infected population. Our main results show that the asymptotic profiles of the

susceptible and infected populations obtained here are very different from that of the corresponding system without advection and that of the system with standard incidence infection mechanism. Thus, the effects of advection and different infection mechanisms are substantial on the spatial distribution of infectious disease; our findings bring novel insight into the disease control strategy. This talk is based on my joint work with Renhao Cui, Huicong Li and Maolin Zhou.

Modeling the growth, invasion and competition of Aedes mosquitoes

Shigui Ruan University of Miami

The Aedes mosquitoes, in particular Aedes aegypti and Aedes albopictus, are the primary vectors that transmit several arboviral diseases, including chikungunya fever, dengue fever, yellow fever, and Zika. Recently, the world has been experiencing a series of major outbreaks of these vector-borne diseases (for example, the 2014 dengue outbreak in Guangdong, the 2016 Zika outbreak in Florida, etc.). In order to study the transmission dynamics of these vector-borne diseases, it is very important and necessary to understand the population dynamics, current distributions and movements of Aedes mosquitoes for successful surveillance and control programs. In this talk, we will introduce some of our recent studies on modeling the population dynamics of Aedes mosquitoes, the invasion of Aedes albopictus mosquitoes, and the competition between Aedes aegypti and Aedes Albopictus mosquitoes in Florida, the United States. In particular, we propose a competition model with road-field diffusion in which the invasive population not only disperses in the interior of the spatial domain but also moves faster on the boundary of the domain. Both strong-weak and weak-weak competitions are discussed. It is shown that the asymptotic spreading speed of the wave fronts is increasing only if the road diffusion rate is greater than the field diffusion rate. Numerical simulations are presented to illustrate our analytical results and to explain the current estimated distributions of these two mosquito species in Florida.

Principal spectral theory of nonlocal dispersal operators with almost periodic dependence and its applications

Wenxian Shen Auburn University

Nonlocal and random dispersal evolution equations are widely used to model diffusive systems in applied sciences. These two types of equations share many properties, but

there are also some essential differences between them. In comparison to random dispersal evolution equations, many fundamental dynamical issues for nonlocal dispersal evolution equations are less well understood. This talk is concerned with principal spectral theory for linear nonlocal dispersal evolution equations with almost periodic dependence. We investigate the principal spectral theory of such operators from two aspects: top Lyapunov exponents and generalized principal eigenvalues. Among others, we provide various characterizations of the top Lyapunov exponents and generalized principal eigenvalues, establish the relations between them, and study the effect of time and space variations on them. We also discuss the application of the principal spectral theory to the asymptotic dynamics of nonlinear nonlocal dispersal equations with almost periodic dependence.

On the mean speed of bistable transition fronts in unbounded domains

Weijie Sheng Harbin Institute of Technology

In this talk, I will show the existence and further properties of propagation speeds of transition fronts for bistable reaction-diffusion equations in exterior domains and in some domains with multiple cylindrical branches. In exterior domains we show that all transition fronts propagate with the same global mean speed, which turns out to be equal to the uniquely defined planar speed. In domains with multiple cylindrical branches, we show that the solutions emanating from some branches and propagating completely are transition fronts propagating with the unique planar speed. We also give some geometrical conditions on the domain, either exterior or with multiple cylindrical branches, which guarantee that any transition front has a global mean speed.

A model of algal growth depending on nutrients and inorganic carbon in a poorly mixed water column

Junping Shi College of William & Mary, USA

A reaction-diffusion-advection model is proposed to describe the growth of algae depending on both nutrients and inorganic carbon in a poorly mixed water column. Nutrients from the water bottom and inorganic carbon from the water surface form an asymmetric resource supply mechanism for the algal growth. The existence and stability of semi-trivial steady state and positive steady state of the model are proved, and a threshold condition for the regime shift from extinction to survival of algae is

established. The influence of environmental parameters on the vertical distribution of algae is investigated in the water column. It is shown that the vertical distribution of algae can exhibit many different profiles under the combined limitation of nutrients and inorganic carbon. This is a joint work with Jimin Zhang (Heilongjiang University) and Xiaoyuan Chang (Harbin University of Science and Technology).

Threshold dynamics of a nonlocal and delayed cholera model in a spatially heterogeneous environment

Hongying Shu Shaanxi Normal University

A nonlocal and delayed cholera model with two transmission mechanisms in a spatially heterogeneous environment is derived. We introduce two basic reproduction numbers of environment and infection, respectively. If the basic reproduction number of environment is strictly less than one and the basic reproduction number of infection is no more than one, we prove globally asymptotically stability of the infection-free steady state. Otherwise, the infection will persist and there exists at least one endemic steady state. For the special homogeneous case, the endemic steady state is actually unique and globally asymptotically stable. Under some conditions, the basic reproduction number of infection is strictly decreasing with respect to the diffusion coefficients of susceptible and infectious hosts. When these conditions are violated, numerical simulation suggests that spatial diffusion may not only spread the infection from high-risk region to low-risk region, but also increase the infection level in high-risk region.

Memory driven spatially inhomogeneous Hopf bifurcation and double Hopf bifurcation in the memory-based diffusion system

Yongli Song Hangzhou Normal University

We first derive the algorithms for calculating the normal form of Hopf and double Hopf bifurcation for the memory-based diffusion system taking the memory delay as the perturbation parameter. Then, for the diffusive predator-prey system with memory-based diffusion and Holling type-II functional response, we employ this procedure to investigate the direction and stability of delay-induced mode-1 and mode-2 Hopf bifurcations and spatiotemporal dynamical classification near the double Hopf bifurcation.

Ground state solutions of Schrodinger equations with Hardy potential

Chunlei Tang Southwest University

In this talk, the aim is to present the state of the articles around the mathematical study of Schrodinger equation and its variants. Depending on an external potential, the results will be split into two main parts, namely constant potential and non-constant potential. We also report our recent works about the existence of ground state solutions to Schrodinger equations with Hardy potential.

Thin-film-type approximation to a doubly cross-diffusive system

Youshan Tao Shanghai Jiao Tong University

This talk reports a recent joint work with Michael Winkler (Paderborn) and it addresses a new progress in the study of so-called pursuit-evasion system which describes a fully cross-diffusive interaction mechanism between predators and preys. The system formally possesses two basic entropy-like structures, but the regularity thereby implied seems insufficient to ensure global solvability for large data. We design a suitable thin-film-type approximation which allows us to develop a theory not only of global weak solvability, but also of qualitative behavior.

Upper and lower solutions method of boundary value problems with nonlinear boundary conditions

Mingxin Wang Harbin Institute of Technology

In this talk we intruduce the upper and lower solutions method of boundary value problems with nonlinear boundary conditions. It will be shown that, if a boundary value problem of an elliptic equation (system) with nonlinear boundary conditions has ordered upper and lower solutions, then it has at least one solution (coupled quasi-solutions) located between the upper and lower solutions. Especially, if the system is quasi-monotone increasing or decreasing, then such coupled quasi-solutions are the solutions of this problem. It is well known that there are two approaches to the upper and lower solutions method of linear boundary conditions: fixed point method and monotonic iteration. However, the upper and lower solutions method of nonlinear boundary conditions can only be treated by monotone iteration, not fixed point method.

Theory of invariant manifolds for infinite-dimensional nonautonomous dynamical systems and applications

Rongnian Wang Shanghai Normal University

We consider an abstract nonautonomous dynamical system defined on a general Banach space. We prove that under several conditions, there exists a finite-dimensional Lipschitz invariant manifold. The manifold has an exponential tracking property acting on a local range. We then apply this general framework to two types of nonautonomous evolution equations: Scalar reaction-diffusion equations and FitzHugh-Nagumo systems, on 2-D rectangular domains or a 3-D cubic domain. We prove the existence of an inertial manifold of nonautonomous type for the former while a finite-dimensional global manifold for the latter. It is significant that the spectrum of the Laplacian δ is not guaranteed to have arbitrarily large gaps on these spatial domains.

Curved fronts of bistable reaction-diffusion equations in spatially periodic media

Zhicheng Wang Lanzhou University

In this talk, we construct curved fronts for spatially periodic bistable reaction-diffusion equations under the a priori assumption that there exist pulsating fronts in every direction. Some sufficient and some necessary conditions of the existence of curved fronts are given. Furthermore, the curved front is proved to be unique and stable. Finally, a curved front with varying interfaces is also constructed. Despite the effect of the spatial heterogeneity, the result shows the existence of curved fronts for spatially periodic bistable reaction-diffusion equations which is known for the homogeneous case.

On uniqueness of traveling waves for a reaction diffusion equation with spatio-temporal delay

Dongmei Xiao Shanghai Jiao Tong University

In this talk, we fifirst introduce a general reaction-diffffusion equation with spatio-temporal delay, and prove that the traveling wave solutions with any given admissible speed (including the minimal wave speed) of this general equation are unique up to translation under certain assumptions. As the applications of results, we

solve some open problems on the uniqueness of traveling wave solutions of a few well-known models. This is a joint work with Zhaoquan Xu.

Multi-scale mathematical models of the COVID-19 pandemic

Yanni Xiao Xi'an Jiaotong University

The global outbreak of COVID-19 has caused worrying concern amongst the public and health authorities. Modeling of this novel coronavirus also presents us a great challenge. In this talk I initially introduce some hot research issues in epidemiology when facing the outbreak of infectious diseases, then introduce our recent work on COVID-19 infection, including a multi-scale models describing the multiple outbreaks and a stochastic individual based model on complex networks with four layers. We would like to investigate how behavior changes, vaccination and relaxation of non-NPIs affect the development of COVID-19 infections. Finally I shall give some considerations on modelling COVID-19 infections and concluding remarks.

Propagation dynamics of a reaction-diffusion SI epidemic model with seasonality

Liang Zhang Lanzhou University

In this talk, we the asymptotic speed of spread and traveling wave solutions for a time-periodic reaction-diffusion SI epidemic model which lacks the comparison principle. By using the basic reproduction number R_0 of the corresponding periodic ordinary differential system and the minimal wave speed c*, the spreading properties of the corresponding solution of the model are established. More precisely, if $R_0< 1$, then the solution of the system converges to the disease-free equilibrium as $t\to\infty$ and if $R_0 > 1$, the disease is persistent behind the front and extinct ahead the front. On the basis of it, we then analyze the full information about the existence and nonexistence of traveling wave solutions of the system involved with R_0 and c*. This talk is based on the joint work with Prof. Z.-C. Wang and L. Zhao.

Basic reproduction numbers for periodic reaction-diffusion population models

Xiaoqiang Zhao Memorial University of Newfoundland

The basic reproduction number (or ratio) R0 is an important concept in population biology. As a threshold quantity for population dynamics, it is unquestionably one of the most valuable mathematical ideas brought to theoretical ecology and epidemiology. In this talk, I first review the definition, stability equivalence, numerical computation and asymptotic behavior of R0 for periodic reaction-diffusion systems with compartmental structure. Then I introduce a spatial model of Zika virus transmission with seasonality and establish a threshold type result on the global stability in terms of R0. Finally, I present numerical simulations for the Zika transmission in Rio de Janeiro Municipality, Brazil and briefly discuss the effects of some model parameters on R0.

The boundary regularity of rotating vortex patch

Maolin Zhou Nankai University

In this talk, we will discuss the regularity of the singular points of some vortex patch. It is a joint work with Yuchen Wang and Guanghui Zhang.

Spatial movement of mosquitos and emerging mosquito-borne diseases considering climate change

Huaiping Zhu York University

Due to climate warming, invasive species of mosquitos keep moving north in North America. There have been spatial-temporal modelling studies for the movement of mosquitoes and spreading of emerging mosquito-borne diseases. One typical approach is to use reaction-diffusion equation models. In this talk, I will first present some general reflections about the modeling for the movement of mosquito species and spread of mosquito-borne diseases. Then, I will give a summary of our early studies using free boundary on the mosquito range movement driven by warming. I will then use our future climate projections data and data-driven dynamical models with delays and simulations to assess the risk of emerging of Aedes mosquitoes and predict the spatial risk of Chikungunya, an emerging mosquito-borne disease in Canada.

Role of white-tailed deer in geographic spread of the black-legged tick Ixodes scapularis: analysis of a spatially nonlocal model

Xingfu Zou University of Western Ontario

Lyme disease is transmitted via blacklegged ticks, the spatial spread of which is believed to be primarily via transport on white-tailed deer. In this paper, we develop a mathematical model to describe the spatial spread of blacklegged ticks due to deer dispersal. The model turns out to be a system of differential equations with a spatially non-local term accounting for the phenomenon that a questing female adult tick that attaches to a deer at one location may later drop to the ground, fully fed, at another location having been transported by the deer. We first justify the well-posedness of the model and analyze the stability of its steady states. We then explore the existence of traveling wave fronts connecting the extinction equilibrium with the positive equilibrium for the system. We derive an algebraic equation that determines a critical value c* which is then proved to be (i) the minimal speed of traveling wave fronts in the sense that for c > c*, there is a traveling wave front of speed c connecting the extinction steady state to the positive steady state; and for c<c*, there is no such traveling wave front; and (ii) the actually spread speed when initial distribution has compact support. We also carry out some numerical simulations for the original spatial model system and the results confirm the role of c* described above. We also numerically explore the dependence of c* on the dispersion rate of the white tailed deer, by which one may evaluate the role of the deer's dispersion in the geographical spread of the ticks.

国家天元数学西北中心简介

国家天元数学西北中心（以下简称“中心”）是国家自然科学基金委员会天元数学基金为推动中国数学率先赶上世界先进水平、推动中国数学区域、领域均衡发展而设立的数学研究机构（平台）。

中心的定位是：依托交大、立足西北、面向全国、放眼世界，建设数学工作者与其它学科领域学者深度交叉融合的学术交流中心和数学与数学技术研究中心。目标是：逐步将中心建设成为中国数学与其他学科交叉前沿研究基地、国家重大任务承接地、数学与数学技术研发基地与人才集聚地，新一代应用数学创新人才培养基地。

中心的主要任务包括：面向学科前沿开展学术交流，面向国家重大需求组织重大交叉问题研讨和重大课题研究；实施“天元学者/博士后”项目，促进数学研究与人才培养的地区平衡；策划并举办“全国应用数学暑期学校”及“全国大学数学教师暑期学校”，促进我国的应用数学发展及中西部地区大学数学教师队伍的培养。

中心依托西安交通大学，协同西北工业大学、兰州大学、西安电子科技大学、西北大学、陕西师范大学、新疆大学、西北师范大学、宁夏大学、青海师范大学等九所西部高校联合建设。中心支持各联建单位开展具有地域特色、符合各校情况的学术活动。

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西安电子科技大学数学与统计学院简介

西安电子科技大学数学与统计学院前身可追溯至建校初期的基础部，历经数学教研室、应用数学系、理学院数学系，不断发展壮大，于 2013 年 7 月成立。学院的应用数学学科 1996 年获得博士点，是西北地区第一个应用数学博士点、陕西省第二个数学博士点，入选陕西省优秀博士学位论文 4 篇。

学院现有数学一级学科博士点、统计学一级学科硕士点、应用统计硕士专业学位授权点，数学博士后科研流动站，以及 3 个本科专业，其中数学与应用数学为国家级一流本科专业建设点、统计学为陕西省一流本科专业建设点，并依托基础学科拔尖学生培养计划，招收旨在培养拔尖创新型复合人才的数学拔尖班。

学院现有教职工 130 人，其中专职教师 118 人，包括国家高层次人才特殊支持计划领军人才 1 人、国家百千万人才工程 1 人、国家级教学名师 1 人、教育部教指委委员 1 人、跨世纪优秀人才 1 人、新世纪优秀人才 2 人、享受国务院政府特殊津贴 2 人、陕西省人才计划 3 人、陕西省杰出青年基金获得者 1 人、陕西省高等学校“青年杰出人才支持计划”入选者 2 人。

学院现有国家级教学团队 1 个，国家精品资源课程 2 门，出版国家级规划教材 2 部，先后获得国家级教学成果奖 3 项。指导学生参加数模竞赛，共获国际及国家级奖励 300 余项，其中有国际大学生数模竞赛特等奖 3 项、全国大学生数模竞赛 Matlab 创新奖 1 项，获奖层次和数量在全国高校中位居前列。

学院科研注重应用性和交叉性，在非线性分析与微分方程、半群代数、优化、控制、微分方程反问题、大数据、金融数学等方面发展势头良好。近五年获得省部级科研奖励 4 项，部分成果发表在相关领域的权威期刊如 Adv. Math.，Trans. Amer. Math. Soc.， SIAM J. Appl. Math.， Calc. Var. Partial Differential Equations， J. Differential Equations，Nonlinearity，J. Algebra，Inverse problem，SIAM J. Control. Optim.，SIAM J. Financ. Math.，IEEE Trans. Signal Process 等。

西安电子科技大学简介

西安电子科技大学是以信息与电子学科为主，工、理、管、文多学科协调发展的全国重点大学，直属教育部，是国家“优势学科创新平台”项目和“211 工程”项目重点建设高校之一、国家双创示范基地之一、首批 35 所示范性软件学院、首批 9 所示范性微电子学院、首批 9 所获批设立集成电路人才培养基地和首批一流网络安全学院建设示范项目的高校之一。2017 年学校信息与通信工程、计算机科学与技术入选国家“双一流”建设学科。

学校前身是 1931 年诞生于江西瑞金的中央军委无线电学校，是毛泽东等老一辈革命家亲手创建的第一所工程技术学校。1958 年学校迁址西安，1966 年转为地方建制，1988 年定为现名。建校 89 年来，学校始终得到了党和国家的高度重视，是我国“一五”重点建设的项目之一，也是 1959 年中央批准的全国 20 所重点大学之一。20 世纪 60 年代，学校就以“西军电”之称蜚声海内外。毛泽东同志曾先后两次为学校题词：“全心全意为人民服务”、“艰苦朴素”。

学校是国内最早建立信息论、信息系统工程、雷达、微波天线、电子机械、电子对抗等专业的高校之一，开辟了我国 IT 学科的先河，形成了鲜明的电子与信息学科特色与优势。“十三五”期间，学校获批 8 个国防特色学科。学校现有 2 个国家“双一流”重点建设学科群，2 个国家一级重点学科，1 个国家二级重点学科，34 个省部级重点学科，14 个博士学位授权一级学科，26 个硕士学位授权一级学科，具有工程博士专业学位授权，有 17 个硕士专业学位授权点，9 个博士后科研流动站，63 个本科专业。全国第四轮一级学科评估结果中，3 个学科获评 A 类：电子科学与技术学科评估结果为 A+档，并列全国第 1；信息与通信工程学科位于 A 档；计算机科学与技术学科评估结果为 A-档，学校电子信息类学科继续保持国内领先水平。根据 ESI 公布数据，学校工程学和计算机科学均位列全球排名前 1‰。

学校树立了以人为本、教师是大学核心竞争力的理念，锻造了一支结构合理、富有创新精神的教师队伍。现有专任教师 2200 余名，其中，博士生导师 520 余人。学校有院士 4 人，双聘院士 15 人，“万人计划”入选者 25 人，长江学者 33 人，国家自然科学基金创新研究群体 1 个，科技部重点创新团队 4 个，教育部创新团队 6

个，国家杰出青年基金获得者 15 人，优秀青年科学基金获得者 13 人，国家级教学名师 4 人，国家级教学团队 6 个，973 项目首席科学家 3 人，教育部新世纪优秀人才 52 人，中国青年科技奖获得者 4 人，“何梁何利”科学与技术奖获得者 5 人，国家“百千万人才工程”培养对象 13 人，陕西省杰出青年基金获得者 5 人，陕西省特支计划 7 人，陕西青年科技奖获得者 28 人，教育部教学指导委员会委员 19 人，享受政府特殊津贴 160 人。

多年来，学校致力于电子信息技术领域的系统研制、科技攻关、工程研发等，创造了我国电子与信息技术领域等多项第一，包括第一台气象雷达、第一套流星余迹通讯系统、第一台可编程雷达信号处理机、第一台毫米波通讯机，以及我军通信装备史上第一部“塞绳电报互换机”、第一台“塔型管空腔振荡器”、第一套“三坐标相控阵雷达”等，为我国信息化、国防现代化做出了重要的贡献。

建校 89 年来，学校先后为国家输送了 25 万余名电子信息领域的高级人才，产生了 120 多位解放军将领，成长起了 23 位两院院士（1977 年恢复高考以后院士校友 15 位，位列全国前茅），10 余位国家副部级以上领导，培养了联想创始人柳传志，国际 GSM 奖获得者李默芳，欧洲科学院院士、著名的纳米技术专家王中林，“天宫一号”目标飞行器总设计师杨宏等一大批 IT 行业领军人物和技术骨干、科研院所所长和大学校长等，为国家建设和社会进步做出了重要贡献。

在全面建设社会主义现代化国家新征程中，西安电子科技大学将继续坚持走内涵式发展道路，秉承“全心全意为人民服务”的办学宗旨，坚持“立足西部、育人育才、强军拓民、服务引领、团结实干”的发展思路，坚持立德树人根本任务，全面提升教育质量，为把学校建设成为电子信息特色鲜明的一流大学而不懈奋斗！