2022 年微分方程定性理论学术研讨会

会议手册

2022 年 5 月 7-8 日

数学科学中心 & 数学与物理学院

中国地质大学

湖北 武汉

2022 年微分方程定性理论学术研讨会

为了探讨微分方程定性理论及相关领域的最新研究成果和学术发展动态，促进学术交流与合作，中国地质大学（武汉）于 2022 年 5 月 7-8 日通过腾讯会议平台举行"微分方程定性理论"网络在线学术会议。会议以加强微分方程定性理论及相关领域的学术交流为主旨，展示和介绍理论及应用方面的最新研究成果和进展。

会议方式：腾讯会议链接 https://meeting.tencent.com/dm/khePwSN3uIcX

特邀专家名单（以姓氏拼音为序）：

序号	名称	单位	序号	名称	单位
1	陈海波	中南大学	15	倪明康	华东师范大学
2	陈珊珊	哈尔滨工业大学	16	马满军	浙江理工大学
3	陈兴武	四川大学	17	马世旺	南开大学
4	储继峰	上海师范大学	18	綦建刚	山东大学
5	戴斌祥	中南大学	19	唐先华	中南大学
6	杜增吉	江苏师范大学	20	王宾国	兰州大学
7	郭志明	广州大学	21	王锦荣	贵州大学
8	黄继才	华中师范大学	22	王其如	中山大学
9	贾保国	中山大学	23	王荣年	上海师范大学
10	蒋卫华	哈尔滨工业大学	24	王智诚	兰州大学
11	李德生	天津大学	25	徐君祥	东南大学
12	李万同	兰州大学	26	周 展	广州大学
13	林 国	兰州大学	27	朱长荣	重庆大学
14	刘 斌	华中科技大学			

组委会：

郭上江、 刘志苏、 魏周超、 黄 刚、 王 毅、 李尚芝、
王佳兵、 张 玲、 郭艳凤、 廖勇凯、 郭万里、 刘汉兵、
王 明、 张腾飞、 万 灵、 李慧娟、 陈停停、 谷龙江

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中国地质大学（武汉）数学与物理学院
2022 年 05 月

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2022 年微分方程定性理论学术研讨会日程安排

5 月 7 日（上午） 腾讯会议 ID：440-4531-9630

时间	开幕式
8:15-8:30	

主持人：刘斌		
时间	报告人	报告题目
8:30-9:10	李万同	Dynamics of nonlocal dispersal SIS epidemic models
9:10-9:50	徐君祥	Persistence of lower dimensional degenerate invariant tori with prescribed frequencies in Hamiltonian systems with small parameter

休息（9:50-10:00）		
主持人：戴斌祥		
时间	报告人	报告题目
10:00-10:40	王智诚	Propagation dynamics of a nonlocal time-space periodic reaction-diffusion model with delay
10:40-11:20	朱长荣	Bifurcations of degenerate homoclinic orbits
11:20-12:00	王荣年	Invariant manifolds for infinite-dimensional non-autonomous dynamical systems

5 月 7 日（下午） 腾讯会议 ID：440-4531-9630

主持人：黄继才		
时间	报告人	报告题目
14:30-15:10	杜增吉	Dynamics of traveling waves for a Keller-Segel system with small cell diffusion
15:10-15:50	储继峰	Minimization of lowest positive periodic eigenvalue for Camassa-Holm equation with indefinite potentials

休息（15:50-16:00）		
主持人：陈海波		
时间	报告人	报告题目
16:00-16:40	綦建刚	利用第一特征值恢复势函数的新方法
16:40-17:20	王锦荣	旋转球坐标下海洋环流方程解的存在性
17:20-18:00	蒋卫华	Bogdanov-Takens bifurcation and spatiotemporal dynamics in diffusive Rosenzweig-MacArthur model involving

		nonlocal prey competition

5 月 8 日（上午） 腾讯会议 ID：440-4531-9630

主持人：唐先华		
时间	报告人	报告题目
8:30-9:10	倪明康	对 Leslie-Gower 反应扩散数学模型的研究
9:10-9:50	李德生	Global existence, regularity, and dissipativity of retarded reaction-diffusion equations with supercritical nonliearities
休息（9:50-10:00）		
主持人：周展		
时间	报告人	报告题目
10:00-10:40	马世旺	Asymptotic properties of groundstates for Choquard equations with combined nonlinearities
10:40-11:20	王其如	Global dynamics of a Holling-II amensalism system with nonlinear growth rate and Allee effect on the first species
11:20-12:00	马满军	Spreading speeds and monostable waves in a reaction-diffusion model with nonlinear competition

5 月 8 日（下午） 腾讯会议 ID：440-4531-9630

主持人：贾保国		
时间	报告人	报告题目
14:30-15:10	陈兴武	Dynamics of some switching systems
15:10-15:50	林 国	Spatial propagation in a within-host viral infection model
休息（15:50-16:00）		
主持人：郭志明		
时间	报告人	报告题目
16:00-16:40	王宾国	A mathematical model reveals the influence of NPIs and vaccination on SARS-CoV-2 Omicron Variant
16:40-17:20	陈珊珊	Global dynamics of a Lotka-Volterra competition patch model

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Global dynamics of a Lotka-Volterra competition patch model

陈珊珊，哈尔滨工业大学（威海）

The global dynamics of the two-species Lotka–Volterra competition patch model with asymmetric dispersal is classified under the assumptions that the competition is weak and the weighted digraph of the connection matrix is strongly connected and cycle-balanced. We show that in the long time, either the competition exclusion holds that one species becomes extinct, or the two species reach a coexistence equilibrium, and the outcome of the competition is determined by the strength of the inter-specific competition and the dispersal rates. Our main techniques in the proofs follow the theory of monotone dynamical systems and a graph-theoretic approach based on the tree-cycle identity. This is a joint work with Profs. Junping Shi, Zhisheng Shuai and Yixiang Wu.

Dynamics of some switching systems

陈兴武，四川大学

We talk about dynamics of switching systems including singular points, limit cycles, sliding closed loops, crossing closed loops and their bifurcations.

Minimization of lowest positive periodic eigenvalue for Camassa-Holm equation with indefinite potentials

储继峰，上海师范大学

We study the optimal lower bound of the lowest positive periodic eigenvalues periodic eigenvalues the Camassa-Holm equation by admitting the potential to change sign.

Dynamics of traveling waves for a Keller-Segel system with small cell diffusion

杜增吉，江苏师范大学

In this talk, we are concerned with the existence of traveling pulse solutions of one-dimensional generalized Keller-Segel system with nonlinear chemical gradients and small cell diffusion by using the dynamical systems approach. To show the existence of traveling pulse solutions, we first analyze the dynamics of the system by geometric singular perturbation theory. And then we seek an invariant region for the associated traveling wave equation. Finally, we apply Poincare-Bendixson theorem to analyze the flow on this invariant region to obtain the existence of traveling pulse solutions in this bounded invariant region. As applications, we present two examples to illustrate our main results.

Bogdanov-Takens bifurcation and spatiotemporal dynamics in diffusive Rosenzweig-MacArthur model involving nonlocal prey competition

蒋卫华，哈尔滨工业大学

In this talk, firstly, the explicit formula for the coefficients of normal form for Bogdanov-Takens bifurcation of general partial functional differential equations involving nonlocal interactions, are presented concisely. Secondly, for a diffusive Rosenzweig-MacArthur model involving nonlocal prey competition, the first bifurcation curve is precisely described, which shows that the coexistence equilibrium can lose its stability through not only codimension one Turing (Hopf) bifurcation, but also codimension two Bogdanov-Takens, Turing-Hopf and Hopf-Hopf bifurcations, even codimension three Bogdanov-Takens-Hopf bifurcation. Finally, complex spatio-temporal patterns are theoretically predicted near Bogdanov-Takens singularity, and also shown numerically, including tri-stable nonuniform patterns with the shape of $\cos(wt)\cos(x/l)$-like or $\cos(x/l)$-like. This talk is based on a joint work with Dr. Xun Cao and Dr. Xianyong Chen.

Global existence, regularity, and dissipativity of retarded reaction-diffusion equations with supercritical nonliearities

李德生，天津大学数学学院

In this talk I will show some recent results on the initial-boundary value problem of retarded reaction-diffusion equations in bounded domains with fast-growing

nonlinearities. We allow the nonlinear terms to be supercritical, in which case even if local well-posedness is less well understood. We are particularly interested in how dissipative structures of the non-retarded terms can successfully control the retarded ones and produce nice analytic properties and determines the global dynamics of the problem. Specifically, we establish global existence and regularity results for solutions of the problem and prove the existence of global attractors. Although we are working in the context of retarded differential equations, to the best of our knowledge, part of our results are new even for non-retarded equations.

Dynamics of nonlocal dispersal SIS epidemic models

李万同，兰州大学

In this talk we consider a nonlocal dispersal susceptible-infected-susceptible (SIS) epidemic model, where the spatial movement of individuals is described by a nonlocal (convolution) diffusion operator, the transmission rate and recovery rate are spatially heterogeneous, and the total population number is constant. We first define the basic reproduction number R_0 and discuss the existence, uniqueness and stability of steady states of the nonlocal dispersal SIS epidemic model in terms of R_0. Then we consider the impacts of the large diffusion rates of the susceptible and infectious populations on the persistence and extinction of the disease. The obtained results indicate that the nonlocal movement of the susceptible or infectious individuals will enhance the persistence of the infectious disease. In particular, our analytical results suggest that the spatial heterogeneity tends to boost the spread of the infectious disease.

Spatial Propagation in a Within-Host Viral Infection Model

林国，兰州大学

We study the asymptotic spreading in a within-host viral infection model which describes the spatial expansion speeds of viruses and infected cells within an infected host. We first establish the boundedness of solutions to the Cauchy problem via local L^p-estimates and dual arguments. Then the spreading speed is estimated when the basic reproduction number of the corresponding kinetic system is larger than one. When the basic reproduction number of the corresponding kinetic system is less than one, the virus dies out uniformly. This talk is based on the work with Xinjian Wang (Lanzhou U.) and Shigui Ruan (U. Miami).

对 Leslie-Gower 反应扩散数学模型的研究

倪明康，华东师范大学

研究了具有弱扩散的 Leslie-Gower 反应扩散模型行波解和周期解的存在性．在假设捕食者和被捕食者的扩散速率都充分小，且被捕食者的自然增长率远大于捕食者的情况下，通过无量纲化转化成一个具有两个小参数的奇摄动问题。运用几何奇摄动理论，可得该快-慢系统异宿轨、鸭爆炸现象和松弛振荡环的存在性，从而证明反应扩散模型行波解和周期解的存在性．

Spreading speeds and monostable waves in a reaction-diffusion model with nonlinear competition

马满军，浙江理工大学

This work studies the propagation dynamics of a Lotka-Volterra type of model with cubic competition. The existence of traveling waves and the uniqueness of spreading speeds are established. It is also shown that the spreading speed is equal to the minimal speed for traveling waves. Furthermore, general conditions for the linear or nonlinear selection of the spreading speed are obtained by using the comparison principle and the decay characteristics for traveling waves. By constructing appropriate upper solutions, explicit conditions to determine the linear selection of the spreading speed are derived.

Asymptotic properties of groundstates for Choquard equations with combined nonlinearities

马世旺，南开大学数学学院

We study asymptotic behaviour of positive ground state solutions of the nonlinear Choquard equation

$$-\Delta u + \varepsilon u = (I_\alpha * |u|^p)|u|^{p-2}u + |u|^{q-2}u, \text{in} \mathbb{R}^N, (P_\varepsilon)$$

where $N \geq 3$ is an integer, $p \in [\frac{N+\alpha}{N}, \frac{N+\alpha}{N-2}]$, $q \in (2, \frac{2N}{N-2}]$, I_α is the Riesz potential and $\varepsilon > 0$ is a parameter. We show that as $\varepsilon \to 0 (resp. \varepsilon \to \infty)$, after a suitable rescaling the ground state solutions of (P_ε) converge in $H^1(\mathbb{R}^N)$ to a particular solution of some limit equations. We also establish a sharp asymptotic characterisation of such a rescaling, and the exact asymptotic behaviors of $u_\varepsilon(0)$, $\| \nabla u_\varepsilon \|_2^2$, $\| u_\varepsilon \|_2^2$, $\| u_\varepsilon \|_q^q$ and $\int_{\mathbb{R}^N}(I_\alpha * |u_\varepsilon|^p)|u_\varepsilon|^p$, which depend in a non-trivial way on the exponents p, q and the space dimension N. This is a joint work with V. Moroz.

利用第一特征值恢复势函数的新方法

綦建刚，山东大学（威海）

本报告将介绍利用一族第一特征值（类谱函数）唯一恢复谱问题中未知势函数的方法。这与经典的逆谱理论利用两族谱（或等价的谱数据）唯一恢复势函数的方法不同，其优点在于第一特征值是易于获取的谱数据。报告将介绍类谱函数的各种性质，研究类谱函数恢复未知势函数的存在性、唯一性、稳定性和重构四大问题，同时也提出相应的最优恢复问题。

A mathematical model reveals the influence of NPIs and vaccination on SARS-CoV-2 Omicron Variant

王宾国，兰州大学

A SVEIR SARS-CoV-2 Omicron variant model is proposed to provide some insight to coordinate non-pharmaceutical interventions(NPIs) and vaccination. Mathematically, we define the basic reproduction number $\mathscr{R}_{0}$ and the effective reproduction number $\mathscr{R}_{e}$ to measure the infection potential of Omicron variant and formulate a optimal disease control strategy.

Our inversion results imply that the sick period of Omicron variant in the United States is longer than that of Delta variant in Indian; The decreasing of the infectious period of the infection with infectiousness implies that the risk of hospitalization is reduced; but the increasing period of the infection with non-infectiousness signifies that Omicron variant lengthens the period of nucleic acid test being negative; Optimistically, Omicron's death rate is only a quarter of Delta's. Moreover, we forecast that the cumulative cases will exceed 100 million in the United States on 28 February, 2022 and the daily confirmed cases will reach a peak on 2 February, 2022. The results of parameters sensitivity analysis imply that NPIs is helpful to reduce the number of confirmed cases. Especially, NPIs are indispensable even if all the people were vaccinated when the efficiency of vaccine is relatively low. By simulating the relation ships of the effective reproduction number $\mathscr{R}_{e}$, the vaccination rate and the efficacy of vaccine, we find that it is impossible to achieve the herd immunity without NPIs while the efficiency of vaccine is lower than 88.7%. Therefore, the herd immunity area is defined by the evolution of relationships between the vaccination rate and the efficacy of vaccine. Finally, we present that the disease-induced mortality rate demonstrates the periodic oscillation and an almost periodic function is deduced to match the curve. A discussion completes the paper.

旋转球坐标下海洋环流方程解的存在性

王锦荣，贵州大学数学与统计学院

海洋环流数学模型在海洋科学和大气科学中发挥着重要作用，对其进行深入研究并取得进展对于深入理解海洋环流和大气动力学具有重要科学意义。报告从无粘性的欧拉方程和质量守恒方程出发，根据流体静压分布，选取合适的比例因子，引入流函数，根据秩定理，将控制方程转化为非线性海洋涡度方程。在此基础上，运用球极投影变换将非线性海洋涡度方程转化为相应的二阶常微分方程，进而研究南极绕极流的周期、积分、非局部边值问题和北极环流的渐近边值问题；运用墨卡托投影变换将非线性海洋涡度方程转化为相应的二阶椭圆方程，进而研究南极绕极流的狄利克雷和诺依曼边值问题。研究结果有助于解释和判断海洋模拟的合理性，也为深入理解复杂的海洋环流的动力学行为提供理论指导。

Global dynamics of a Holling-II amensalism system with nonlinear growth rate and Allee effect on the first species

王其如，中山大学数学学院

Of concern is the global dynamics of a two species Holling-II amensalism system with nonlinear growth rate. The existence and stability of trivial equilibrium, semi-trivial equilibria, interior equilibria and infinite singularity are studied. Under different parameters, there exist two stable equilibria which means that this model is not always globally asymptotically stable. Together with the existence of all possible equilibria and their stability, saddle connection and close orbits, we derive some conditions for transcritical bifurcation and saddle-node bifurcation. Furthermore, global dynamics of the model is performed. Next, we incorporate Allee effect on the first species and offer a new analysis of equilibria and bifurcation discussion of the model. Finally, several numerical examples are performed to verify our theoretical results.

Invariant manifolds for infinite-dimensional nonautonomous dynamical systems

王荣年，上海师范大学

We consider an abstract nonautonomous dynamical system defined on a general Banach space. We prove that if a geometrical assumption, called local strong squeezing property, and several technical assumptions, called controllability, inverse Lipschitz, and (partial) compactness property, are satisfied, then the system admits a finite-dimensional Lipschitz invariant manifold with an exponential tracking property

acting on a local range. We then apply this general framework to two types of nonautonomous evolution equations: Reaction-diffusion equations and FitzHugh-Nagumo systems, driven by time-dependent additive/multiplicative forces, on a 2-D rectangular domain or a 3-D cubic domain. It is significant that on the 3D domain the spectrum of the linear unbounded operator in the principal part does not have arbitrarily large gaps. We prove the existence of an inertial manifold of non-autonomous type for the former while a finite-dimensional global manifold for the latter. Each manifold controls the long-time behavior of solutions of the corresponding system.

Propagation dynamics of a nonlocal time-space periodic reaction-diffusion model with delay

王智诚，兰州大学数学与统计学院

In this talk, we consider a nonlocal time-space periodic reaction-diffusion model with stage structure. We first prove the existence and global attractivity of time-space periodic solution for the model. Next, by a family of principal eigenvalues associated with linear operators, we characterize the asymptotic speed of spread of the model in the monotone and non-monotone cases. Furthermore, we introduce a notion of transition semi-waves for the model, and then by constructing appropriate upper and lower solutions, and using the results of the asymptotic speed of spread, we show that transition semi-waves exist when their wave speeds are above than a critical speed, and transition semi-waves do not exist anymore when their wave speeds are less than the critical speed. It turns out that the asymptotic speed of spread coincides with the critical wave speed of transition semi-waves. Finally, numerical simulations for various cases are carried out to support our theoretical results.

Persistence of lower dimensional degenerate invariant tori with prescribed frequencies in Hamiltonian systems with small parameter

徐君祥，东南大学数学学院

In this paper we develop some KAM technique to prove the persistence of lower dimensional elliptic-type degenerate invariant tori with prescribed frequencies in Hamiltonian systems. The proof is based on a formal KAM theorem, which allows us to solve the equation of equilibrium points and choose the parameter of small divisors after the KAM iteration, instead of in each KAM step. The proof is also based on the Leray-Schauder Continuation Theorem, which insures the existence of a path of real

roots of an approximating odd-order real polynomial which depends continuously on parameters.

Bifurcations of degenerate homoclinic orbits

朱长荣，重庆大学

Consider an autonomous ordinary differential equation in R that has a homoclinic solution asymptotic to a hyperbolic equilibrium.The homoclinic solution is degenerate in the sense that the linear variational equation has d bounded, linearly independent solutions.We study bifurcation of the homoclinic solution under periodic perturbations. Using exponential dichotomies and Lyapunov-Schmidt reduction, we obtain general conditions under which the perturbed system can have transverse homoclinic solutions and nearby periodic or chaotic solutions.