偏微分方程及其应用学术研讨会

程序册

哈尔滨工业大学数学研究院/数学学院

2021 年 7 月 26 日-7 月 29 日

哈工大数学研究院成立 5 周年

暨数学学科博士点设立 35 周年系列学术活动

偏微分方程及其应用专题研讨会

时间：2021 年 7 月 26 日-29 日
会议地点：哈尔滨工业大学一校区明德楼 B 区 201-1 学术报告厅
住宿酒店：哈尔滨国际饭店

与会专家（按姓名首字母排序）：

曹道民	中国科学院&广州大学
陈　化	武汉大学
邓引斌	华中师范大学
桂长峰	德州大学圣安东尼奥分校
黄飞敏	中国科学院
楼　元	上海交通大学&俄亥俄州立大学
穆春来	重庆大学
彭双阶	华中师范大学
陶有山	上海交通大学
王春朋	吉林大学
王　术	北京工业大学&广州大学
王学锋	香港中文大学（深圳）
王智诚	兰州大学
吴雅萍	首都师范大学
辛周平	香港中文大学
赵会江	武汉大学
朱长江	华南理工大学
周蜀林	北京大学

组委会：

王明新：mxwang@hit.edu.cn
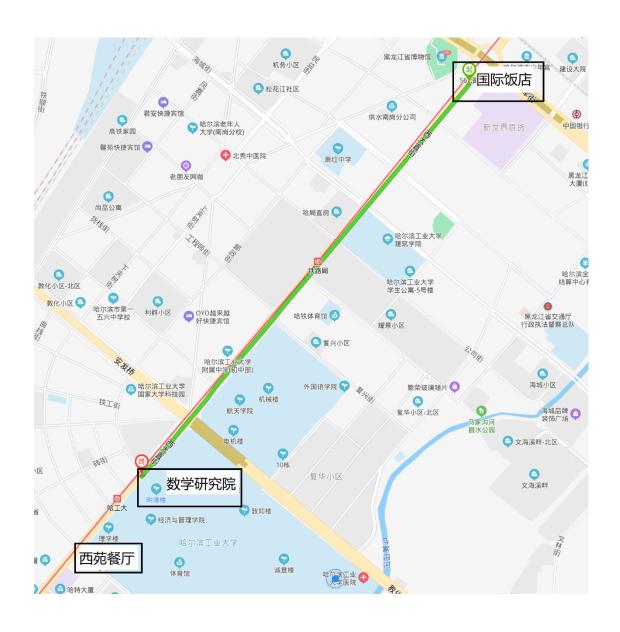张　超：czhangmath@hit.edu.cn
王国栋：wangguodong@hit.edu.cn

会议联系人：

肖雪莹：0451-86413107，xiaoxueying@hit.edu.cn

交通示意图

住宿地点：国际饭店（黑龙江省哈尔滨市南岗区西大直街 4 号）

会议地点：哈尔滨工业大学一校区明德楼

用餐地点：西苑餐厅（南岗区法院街 2 号近哈工大西门）

会议日程

7 月 27 日 上午

08:30-08:50	欢迎致辞、合影

主持人：许全华		
08:50-09:35	辛周平	On subsonic flows around a profile with a vortex line
09:35-10:20	朱长江	Global classical solutions to compressible Navier-Stokes equations with vacuum
10:20-10:35		茶歇
主持人：赵会江		
10:35-11:20	陈 化	Eigenvalue Problems of Hörmander Operators on Non-equiregular sub-Riemannian Manifolds
11:20-12:05	邓引斌	临界指标所对应的临界维现象
12:15		午餐（西苑餐厅）

7 月 27 日 下午

主持人：王明新		
14:00-14:45	彭双阶	The number of positive solutions for elliptic problems

14:45-15:30	穆春来	On effects of the nonlinear signal production to the boundedness and finite-time blow-up in a flux-limited chemotaxis model
15:30-15:50	茶歇	
主持人：方健		
15:50-16:35	楼　元	On principal eigenvalue for time-periodic parabolic operators
16:35-17:20	吴雅萍	Spectral Stability of Bacteria Pulses for the Keller-Segel Chemotactic Model
17:20-18:05	王　术	电流体中 Planck-Nernst-Poisson-Navier-Stokes 模型的拟中性极限问题
18:15	晚宴	

7月28日　上午

主持人：张超		
08:30-09:15	黄飞敏	Asymptotical stability of wave patterns for viscous conservation laws under periodic perturbations
09:15-10:00	陶有山	Taxis-driven formation of hotspots in a reaction-diffusion model for virus infection
10:00-10:20	茶歇	
主持人：盛伟杰		
10:20-11:05	曹道民	二维不可压缩欧拉方程及相关问题的一些结果
11:05-11:50	周蜀林	Entropy and Renormalized Solutions for Quasilinear Equations with L^1 Data
12:00	午餐（西苑餐厅）	

7 月 28 日　下午

自由活动

7 月 29 日　上午

主持人：王国栋		
08:30-09:15	王学锋	The asymptotic propagation speed of the Fisher-KPP equation with effective boundary condition on a road
09:15-10:00	桂长峰	New Sharp Inequalities in Analysis and Geometry
10:00-10:20	茶歇	
主持人：矫贺明		
10:20-11:05	王春朋	Hölder continuity of two-dimensional bounded subsonic-sonic flows
11:05-11:50	王智诚	Curved fronts of bistable reaction-diffusion equations in spatially periodic media
12:00	午餐（西苑餐厅）	

报告题目与摘要

On subsonic flows around a profile with a vortex line

辛周平

香港中文大学

Abstract. In this talk, I will present a result on the existence of 2-dimensional subsonic steady compressible flows around a finite thin profile with a vortex line at the trailing edge, which is a special case in the celebrated lifting line theory by Prandtl. Such a flow pattern is governed the two-dimensional steady compressible Euler equations. The vortex line attached to the trailing edge is a free interface corresponding to a contact discontinuity. Such a flow pattern is obtained as a consequence of structural stability of a uniform contact discontinuity. The problem is formulated and solved by an application of the implicit function theorem in a suitable weighted space. The main difficulties are the possible singularities at the fitting of the profile and the vortex line and the subtle instability of the vortex line. Some ideas of the analysis will be presented. This talk is based on joint works with Jun Chen and Aibin Zang at Yichun University.

Global classical solutions to compressible Navier-Stokes equations with vacuum

朱长江

华南理工大学

Abstract. In this paper, we establish the existence of a global classical solution to 3D Cauchy problem of the isentropic compressible Navier-Stokes equations with large initial data and vacuum under the assumption that
$$(\gamma-1)^\frac{1}{6}E_0^{\frac{1}{2}}\mu^{-\frac{1}{2}}$$
is suitably small. It is showed that the initial energy E_0 can be large if the adiabatic exponent γ is near 1 or the viscosity coefficient μ is taken to be large. This is a joint work with Xiaofeng Hou and Hongyun Peng.

Eigenvalue Problems of Hörmander Operators on Non-equiregular sub-Riemannian Manifolds

陈化

武汉大学

Abstract. We shall report some results on eigenvalue problems for degenerate elliptic operators, which including the results on closed eigenvalue problem and Dirichlet eigenvalue problem of self-adjoint Hörmander operators on non-equiregular sub-Riemannian manifolds. By Rayleigh-Ritz formula and the subelliptic heat kernel estimates ect., we establish the Weyl's asymptotic formula and the precise lower and upper bounds of eigenvalues which depend on the volume of subunit ball and the measure of the manifold. Under a certain condition, we obtain the explicit lower and upper bounds of eigenvalues which have the polynomially growth in k with the optimal order related to the non-isotropic dimension of the manifold.

临界指标所对应的临界维现象

邓引斌

华中师范大学

摘要. 我们将结合 Brezis-Nirenberg 问题，介绍含临界增长的半线性或拟线性椭圆问题所导致的临界维现象。

7 月 27 日下午

The number of positive solutions for elliptic problems

彭双阶

华中师范大学

Abstract. We will talk about how to determine the exact number of positive solutions or positive blow-up solutions of elliptic problems with critical exponent. The main arguments are based on the local Pohozaev identities, blow-up analysis and the properties on the Green's function. This talk is based on joint papers with Prof. Daomin Cao, Prof. Shusen Yan, Dr. Peng Luo, etc.

On effects of the nonlinear signal production to the boundedness and finite-time blow-up in a flux-limited chemotaxis model

穆春来

重庆大学

Abstract. We study herein the initial-boundary value problem for the flux-limited chemotaxis model with nonlinear signal production subject to no-flux boundary conditions in a ball, it is proved that the corresponding solution is global bounded when $p > \max\{k,q\}$. Moreover, under the condition $1 \leqslant p \leqslant q$ and $k > 1$, it is shown that if x is sufficiently large, then the corresponding solution blows up at finite time T.

On principal eigenvalue for time-periodic parabolic operators

楼元

上海交通大学 & 俄亥俄州立大学

Abstract. We will discuss some recent progress on the asymptotic behavior of principal eigenvalues of time-periodic parabolic operators. We will focus on the dependence of principal eigenvalues on diffusion rate and drift rate. The talk is based on joint works with Shuang Liu, Rui Peng, Maolin Zhou.

Spectral Stability of Bacteria Pulses for the Keller-Segel Chemotactic Model

吴雅萍

首都师范大学

Abstract. In this talk I shall about our recent work on the stability/instability of a family of traveling waves for a Keller-Segel chemotactic model with singular chemotactic term but with zero chemical diffusion. By applying detailed spectral analysis, Evan's function method and numerical simulation, we shall prove that in some range of the parameters all the waves are spectrally stable in some appropriate exponentially weighted spaces, and in some range of parameters all the waves are spectrally unstable

in any exponentially weighted spaces. I shall also talk about our work on the local well-posedness of classical solutions for the singular chemotactic model.

It's a joint work with Yi Li, Yong Li and Hao Zhang.

电流体中 Planck-Nernst-Poisson-Navier-Stokes 模型的拟中性极限问题

王术

北京工业大学 & 广州大学

摘要. 研究电流体 Planck-Nernst-Poisson-Navier-Stokes（PNP-NS）模型的拟中性极限问题，总述数学上严格建立拟中性理论的主要进展。拟中性是半导体、等离子体等物理过程中的一种基本物理假设，首先由美国贝尔实验室 W. Van Roosbroeck 提出。本报告首先介绍半导体漂流扩散方程拟中性极限问题-边界层、初始层和混合层等多尺度结构稳定性理论；然后介绍电流体 PNP-NS 模型的适定性与小参数极限问题；最后介绍我们在这些领域的研究成果。

7 月 28 日上午

Asymptotical stability of wave patterns for viscous conservation laws under periodic perturbations

黄飞敏

中国科学院数学与系统科学研究院

Abstract. In this lecture, I will present recent works on the asymptotical stability of wave patterns for viscous conservation laws under periodic perturbations.

Taxis-driven formation of hotspots in a reaction-diffusion model for virus infection

陶有山

上海交通大学

Abstract. This talk reports a recent joint work with Michael Winkler (Paderborn), and it concerns a three-component chemotaxis model which accounts for spatially heterogeneous dynamics of viral infection. In contrast to the classical Keller-Segel type systems, the considered attractant is produced in an inherently nonlinear mechanism. We develop an approach capable of detecting taxis-driven blow-up in this complex model, as known virus hotspot formation phenomena observed in biological experiments.

二维不可压缩欧拉方程及相关问题的一些结果

曹道民

中国科学院数学与系统科学研究院&广州大学

摘要. 报告人将报告新近对二维不可压欧拉方程所得到的一些研究结果，特别地要介绍在涡对行波解（travelling vortex pairs)、 旋转对称解的存在性和及推广的面拟地转方程（surface quasi-geostrophic equation）的旋转对称解和行波解的存在性。报告人介绍的结果主要来源于和赖善发、詹伟城及和秦国林、詹伟城、邹昌君合作的论文。

Entropy and Renormalized Solutions for Quasilinear Equations with L^1 Data

周蜀林

北京大学

Abstract. In this talk I will survey our work on quasilinear equations with L1 data under the frameworks of entropy solutions and renormalized solutions and talk about some recent progress on more general quasilinear elliptic equations.

These results were obtained with Prof. Chao Zhang in Harbin Institute of Technology, and Prof. Yongyong Cai in Beijing Normal University and Prof. Kaimin Teng in Taiyuan University of Technology, Prof. Fengping Yao and Dr. Ying Li in Shanghai University.

The asymptotic propagation speed of the Fisher-KPP equation with effective boundary condition on a road

王学锋

香港中文大学（深圳）

Abstract. Of concern is the Fisher-KPP equation on the xy-plane with an "effective boundary condition" imposed on the x-axis. This model, recently derived by Huicong Li and me, is meant to model the scenario of fast diffusion on a "road" in a large "field". In our work, the asymptotic propagation speed of this model in the horizontal direction is obtained, showing that the fast diffusion on the road does enhance spreading speed in the horizontal direction in the field.   In the new joint work with Xinfu Chen and Junfeng He, we study the propagation speed in ALL directions, showing that away from the $y-$axis by a certain angle (which can be explicitly calculated in terms of parameters), the fast diffusion on the x-axis increases propagation speed, with the speed getting larger when the direction is closer to the x-axis. We also obtain the asymptotic spreading shape for the model. These results are parallel to the ones obtained by Berestycki et al. for a different model which is meant to model the same physical phenomenon. However, our method differs from theirs in that we are forced to abandon the idea using lower solutions (when deriving a lower bound for the spreading speed) and have to use the fundamental solution of the linearized problem to come up with very delicate lower bound estimates for the nonlinear problem.

New Sharp Inequalities in Analysis and Geometry

桂长峰

德州大学圣安东尼奥分校

Abstract. The classical Moser-Trudinger inequality is a borderline case of Soblolev inequalities and plays an important role in geometric analysis.   Aubin in 1979 showed that the best constant in the Moser-Trudinger inequality can be improved by reducing to one half if the functions are restricted to the complement of a three dimensional subspace of the Sobolev space H^1, while Onofri in 1982 discovered an elegant optimal form of Moser-Trudinger inequality on sphere. In this talk, I will present new sharp inequalities which are variants of Aubin and Onofri inequalities on the sphere with or without constraints. The main ingredient leading to the above inequalities is a

novel geometric inequality: Sphere Covering Inequality.

One such inequality, for example, incorporates the mass center deviation (from the origin) into the optimal inequality of Aubin on the sphere which is for functions with mass centered at the origin. In another view point, this inequality also generalizes to the sphere the Lebedev-Milin inequality and the second inequality in the Szeg\"o limit theorem on the Toeplitz determinants on the circle, which is useful in the study of isospectral compactness for metrics defined on compact surfaces, among other applications.

Efforts have also been made to show similar inequalities in higher dimensions. Among the preliminary results, we have improved Beckner's inequality for axially symmetric functions when the dimension $n=4, 6, 8$ in a joint work with Yeyao Hu and Weihong Xie. Many questions remain open.

Hölder continuity of two-dimensional bounded subsonic-sonic flows

王春朋

吉林大学

Abstract. In this talk, I introduce a joint work with Professor Zhouping Xin on regularity of two dimensional subsonic-sonic flows, which are governed by a nonlinear degenerate elliptic equation. By a Moser iteration, it is shown that bounded subsonic-sonic flows are locally Holder continuous.

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

王智诚

兰州大学

Abstract. 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.

数学学院简介

　　哈尔滨工业大学数学学院前身是创建于 1958 年的计算数学专业，1981 年开始培养基础数学和计算数学专业硕士，1986 年获得基础数学博士学位授予权（是国内最早的两所工科院校之一），1987 年成立数学系，2019 年成立数学学院。2001 年建立了数学学科博士后流动站，2005 年数学学科成为一级学科硕士学位授权点，2010 年数学学科成为一级学科博士授权点，2011 年统计学成为一级学科博士授权点。基础数学是省重点学科（2001 年）和国防科工委重点学科（2002 年）；应用数学是省重点学科（2001 年）。数学学科 2011 年成为省一级重点学科。2013 年基础数学和应用数学成为工信部重点学科。1997 年入选教育部首批七个"工科基础课程（数学）教学基地"之一；2020 年数学类专业入选教育部强基计划和基础学科拔尖学生培养计划 2.0 基地；2020 年获批成立黑龙江应用数学中心。

　　在教育部第四轮学科评估中，哈尔滨工业大学数学学科位列 A-，统计学位列 B。在 2020 年 10 月《美国新闻和世界报导》（US News）发布的世界大学数学专业排名中，我校数学学科排名全球第 80 位，在内地高校 45 个机构中位于第 14 位。在 2021 年发布的世界大学学科排名（QS World University Rankings）中，我校数学学科排名全球第 126 位，在内地高校 36 个机构中位于第 8 位；统计学排名全球第 101-150 位，在内地高校 17 个机构中并列第 7 位。在最新的 ARWU 排名中，数学学科位列全球第 76-100 位，在内地高校 93 个机构中并列第 5 位。哈尔滨工业大学数学学科自 2013 年 5 月始终保持全球 ESI 前 1%行列。

　　学院现有专任教师 82 人，博士化率 91.5%；其中，国家杰出青年 1 人，中组部首届青年拔尖人才计划 1 人，教育部新世纪人才 1 人，龙江学者 1 人，中组部"万人青拔"1 人，青年长江学者 1 人，黑龙江省杰出青年基金获得者 1 人，黑龙江省教学名师 4 人，龙江青年学者 1 人，宝钢优秀教师奖 7 人，黑龙江省优秀青年基金获得者 1 人；博士生导师 43 人，硕士生导师 63 人，教授 33 人。

　　学院现有本科专业三个：数学与应用数学（拔尖学生培养计划 2.0、强基计划（2020）、国家一流本科专业（2020））、信息与计算科学（拔尖学生培养计划 2.0、强基计划（2020）、国家一流本科专业（2019））、统计学（省一流本科专

业（2020））。现有在读本科生 307 人，硕士研究生 144 人，博士研究生 195 人。

现有：国家级精品资源共享课程 1 门，国家级精品课程 2 门，国家级精品在线开放课程 3 门，省级精品课程 4 门，省级优秀教学团队 1 个，省级优秀教材 2 部，省头雁团队 1 个（数学与人工智能交叉学科创新研究），省级重点实验室（计算与应用数学）1 个，省级领军人才梯队（计算数学）1 个。已培养本科生近 2000 人，硕士生近 1400 人，博士生近 400 人，其中涌现出一大批优秀学子：与境外高水平大学联合培养博士研究生 100 余人；长江学者、国家杰青等高层次人才 10 余人；8 位大学校长、副校长（如：哈工大副校长、电子科技大学副校长等）；国家百篇优博提名奖 3 人；教育部学术新人奖 3 人；20 余位省级学会和国家二级学会理事长及副理事长；校优秀博士学位论文奖 16 人；世界华人数学家大会"新世界数学奖"博士金奖 1 人、本科生银奖 1 人。

数学学科依据国防和社会发展的需求及主流科研方向前沿发展趋势，形成了以传统优势方向为支撑，以新兴与交叉方向为主要生长点的学科格局。主要科研方向有：泛函分析及其应用、代数与数论、常微分方程与动力系统、科学与工程计算、偏微分方程与调和分析、数学物理反问题、运筹控制与优化、概率论与数理统计等。近年来承担国家重点研发计划等国家级课题 50 余项，科研经费千万余元。获黑龙江省科学技术奖一等奖、教育部高校科研优秀成果奖自然科学奖二等奖等多个科研奖项，每年发表高水平学术论文 100 余篇。在全国 SCI 高产机构的排名中，近几年一直在前 20 名，2012 年发表的 SCI 论文数量位居全国数学学科第 3 位。

网址：math.hit.edu.cn

数学研究院简介

哈尔滨工业大学数学研究院创建于 2016 年 7 月，首任院长由我校讲席教授许全华担任，研究院直接隶属于学校，是数学学院密不可分的合作伙伴。研究院以基础数学为基石，以从事国际一流的原始创新研究和培养杰出青年数学人才为第一要务，致力于推动数学科学的发展以及数学与物理、工程等领域的交叉研究。

研究院现有科研人员 18 人，其中高层次人才 7 人，分别为：菲尔兹奖得主吴宝珠；国家海外引才计划：许全华；国家海外引才计划、长江学者：吴黎明；国家海外引才计划（青年）：尹智、李科、熊枭、熊欢。

研究院探索实行法国宽松管理模式，不片面追求论文数量或杂志级别，而是着力为科研人员提供利于事业发展的有效平台，积极打造一个愉快、舒适、和谐、向上的工作环境，让每名科研人员都能找到适合自己发展的方式和位置。

数学研究院重点打造现代分析、数论-代数-组合以及概率统计及其应用等优势基础学科方向。五年来，获批各类国家自然科学基金 15 项，博士后基金 7 项，2020 年获批国家自然科学基金重点项目 1 项，填补了我校数学学科在此项目中的空白；学院教师先后在《PNAS》，《Memoirs of the American Mathematical Society》，《Communications in Mathematical Physics》等国内外著名期刊发表高水平论文 50 余篇。研究院组织举办了一系列具有国内外重要影响力的学术会议，先后邀请中国科学院院士田刚、美国加州大学圣塔芭芭拉分校张益唐，以及哈佛大学、美国芝加哥大学、俄罗斯科学院等知名专家学者 300 余人到我校访问交流，并促使我校和法国弗朗什-孔泰大学签订双边合作协议。

我们相信，在学校的大力支持下，数学研究院将进一步加快发展步伐，不断开拓创新，促进学科间的交叉与融合，发展成在国内外具有重要影响的数学研究中心，助力学校"双一流"建设。

网址：im.hit.edu.cn