



上海交通大学

SHANGHAI JIAO TONG UNIVERSITY

上海市数学会青年学者论坛

——偏微分方程论坛

会议手册

2021年12月18日-19日

上海交通大学

目录

1 基本信息	2
2 日程安排	4
2.1 第 1 天 :12-18 (周六)	4
2.2 第 2 天 : 12-19 (周日)	5
3.摘要.....	6
3.1 第 1 天 : 12-18 (周六)	6
3.2 第 2 天 : 12-19 (周日)	12

1 基本信息

日期

2021 年 12 月 18 日 - 19 日

会议地点

上海市闵行区鹤庆路 900 号碧江广场 5 号楼 2 楼多功能厅

线上会议——腾讯会议

2021年12月18日

会议ID:426-338-857

密码: 211218

2021年12月19日

会议ID:854-179-550

密码: 211219

会议组委会 (按姓氏拼音排序)

- 杜荣, 华东师范大学
- 吴昊, 同济大学
- 谢春景, 上海交通大学
- 张国华, 复旦大学

邀请会议报告人 (按姓氏拼音排序)

- 曹玥, 上海交通大学
- 陈可, 复旦大学
- 何小清, 华东师范大学

- 黄耿耿，复旦大学
- 黄侠，华东师范大学
- 赖耕，上海大学
- 李思然，上海交通大学
- 吕英姝，复旦大学
- 尚朝阳，上海立信会计金融学院
- 王飞，上海交通大学
- 汪文军，上海理工大学
- 张鑫，同济大学
- 周鹏，上海师范大学

资助单位

- 上海交通大学数学科学学院
- 上海交通大学自然科学研究院
- 科学工程计算教育部重点实验室
- 上海市现代分析前沿研究基地
- 国家自然科学基金委

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2 日程安排

2.1 第 1 天 :12-18 (周六)

时间	报告人	题目	主持人
08:45 - 09:00	开幕式		
09:00 - 09:40	黄耿耿	Regularity of free boundary for the Monge-Ampere obstacle problem	叶东
09:40 - 10:20	黄侠	Hardy-Rellich inequalities revisited	周春琴
10:20 - 10:40	Tea Break		
10:40 - 11:20	汪文军	The Cauchy problem for a simplified model arising in radiation hydrodynamics	刘宪高
11:20 - 12:00	曹玥	Global regular solutions for 1D degenerate compressible Navier-Stokes equations with large data and far field vacuum	周忆
12:00 - 14:00	Lunch Time		
14:00 - 14:40	赖耕	Two-dimensional pseudosteady flows around a sharp corner	张永前
14:40 - 15:20	吕英姝	steady solutions for the Euler system in an infinitely long nozzle	娄本东
15: 20-15: 40	Tea Break		
15:40 - 16:20	王飞	On the Euler+Prandtl expansion for the Navier-Stokes equations	王维克
16:20 - 17:00	张鑫	Global wellposedness of 3D compressible Navier-Stokes equations with free surface in exterior domain	盛万成
17:00 - 17:40	陈可	Well-posedness and global behavior of the Peskin problem	周风

2.2 第 2 天 : 12-19 (周日)

时间	报告人	题目	主持人
09:00 - 09:40	何小清	Concavity of principal eigenvalue for linear second order operators and its application in population dynamics	楼元
09:40 - 10:20	周鹏	On an elliptic eigenvalue problem and its application	陶有山
10:20 - 10:40	Tea Break		
10:40 - 11:20	尚朝阳	Global Well-posedness and Exponential Decay Rates of the Strong Solutions to the 2D Full Compressible MHD Equations	朱佩成
11:20 - 12:00	李思然	Isometric Immersions from geometric and PDE perspectives	李亚纯

3.摘要

3.1 第 1 天 : 12-18 (周六)

Regularity of free boundary for the Monge-Ampere obstacle problem

黄耿耿, 复旦大学

09:00 - 09:40

In this talk, we talk about the regularity of the free boundary in the Monge-Ampère obstacle problem

$$\begin{aligned} \det D^2v &= f(y)\chi_{\{v>0\}}, & \text{in} \\ & & \Omega \\ v &= v_0, & \text{on } \partial\Omega. \end{aligned} \tag{1}$$

Assume that Ω is a bounded convex domain in \mathbb{R}^n , and $f, v_0 > 0$. Then $\Gamma = \partial\{v = 0\}$ is smooth if f is smooth; and Γ is analytic if f is analytic. This is a joint work with Prof. Tang Lan and Prof. Wang Xu-Jia.

Hardy-Rellich inequalities revisited

黄侠, 华东师范大学

09:40 - 10:20

Hardy-Rellich type inequalities have broad applications in different fields of analysis and geometry, they have been studied extensively since Hardy's seminal works one century ago. In this talk, we will revise firstly various first order Hardy inequalities, and point out that most of them can be obtained by a simple and unified equality. This approach permits us to get some new or improved first order Hardy inequalities. We will explain also our approach to obtain higher order Hardy-Rellich type equalities which imply and improve many classical Hardy-Rellich inequalities. This is a joint work with Professor Dong YE at ECNU.

The Cauchy problem for a simplified model arising in radiation hydrodynamics

汪文军, 上海理工大学

10:40 - 11:20

In this talk, we consider a simplified model for radiating flows in \mathbb{R}^3 . It consists of the compressible Navier-Stokes system with a P_1 -approximation of the transport equation. The global well-posedness of strong solutions in the Sobolev space $H^2(\mathbb{R}^3)$ for associated Cauchy problem is established when initial data are a small perturbation of a stable radiative equilibrium. Based on the energy method combined with the low-medium-high frequency decomposition, we develop a way to obtain the estimates of the solution and hence global existence. Furthermore, the optimal time decay rates of all-order spatial derivatives of the solutions are shown when the initial perturbation is additionally bounded in $L^1(\mathbb{R}^3)$.

Global regular solutions for 1D degenerate compressible Navier-Stokes equations with large data and far field vacuum

曹玥, 上海交通大学

11:20 - 12:00

In this talk, the Cauchy problem for the 1D isentropic compressible Navier-Stokes equations is considered. When the viscosity depends on the density in a sublinear power law, we prove the global-in-time well-posedness of regular solutions with large data and far field vacuum. The key to the proof is the introduction of a well-designed reformulated structure by introducing some new variables and initial compatibility conditions, which, actually, can transfer the degeneracies of the time evolution and the viscosity to the possible singularity of some special source terms. Then, combined with the BD entropy estimates and transport properties of the so-called effective velocity, one can obtain the required uniform a priori estimates of corresponding solutions. It is worth pointing out that the well-posedness theory established here can be applied to the viscous Saint-Venant system for the motion of shallow water. This talk is based on a joint work with Dr. Hao Li (Fudan) and Dr. Shengguo Zhu (SJTU).

Two-dimensional pseudosteady flows around a sharp corner

赖耕, 上海大学

14:00 - 14:40

We consider two-dimensional (2D) pseudosteady flows around a sharp corner. This problem can be seen as a 2D Riemann initial and boundary value problem (IBVP) for the compressible Euler system. The initial state of the flow is composed of a uniform incoming flow and a vacuum. The flow satisfies the slip condition on the wall of the sharp corner. By a self-similar transformation, the 2D Riemann IBVP can be changed

into a boundary value problem (BVP) for the 2D self-similar Euler system. Existence of global piecewise smooth (or Lipschitz continuous) solution to the BVP is established. One of the main difficulties for the global existence is that the type of the 2D self-similar Euler system is a priori unknown. In order to use the characteristic method to construct a global solution, we establish an a priori estimate for the hyperbolicity of the system. The other main difficulty is that when the incoming flow is sonic or subsonic, the hyperbolic system becomes degenerate at the origin. Moreover, there is a multi-valued singularity at the origin. To solve this degenerate hyperbolic boundary value problem, we first establish some uniform interior $C^{0,1}$ norm estimates for the solutions of a sequence of regularized hyperbolic boundary value problems, and then use the Arzela-Ascoli theorem and a standard diagonal procedure to construct a global Lipschitz continuous solution. The method used here may be also used to construct continuous solutions of some other degenerate hyperbolic boundary value problems and sonic-supersonic flow problems. This is a joint work with Prof. Wancheng Sheng.

Steady solutions for the Euler system in an infinitely long nozzle

吕英姝, 复旦大学

14:40 - 15:20

Flows with stagnation points, very challenging in analysis, are interesting and important phenomenon in fluids. We first prove a Liouville type theorem for Poiseuille flows for steady Euler system in an infinitely long strip. Because of stagnation points, the nonlinearity of the semi-linear equation corresponding to the stream function is not Lipschitz continuous which makes it hard to apply classical analysis methods. In addition, a class of steady incompressible Euler flows, tending to Poiseuille flows in the upstream, are proved to be unique and exist in an infinitely long nozzle via variational approach. This is a joint work with Professor Congming Li and Professor Chunjing Xie.

On the Euler+Prandtl expansion for the Navier-Stokes equations

王飞, 上海交通大学

15:40 - 16:20

We establish the validity of the Euler+Prandtl approximation for solutions of the Navier-Stokes equations in the half plane with Dirichlet boundary conditions, in the vanishing viscosity limit, for initial data which are analytic only near the boundary, and Sobolev smooth away from the boundary. Our proof does not require higher order correctors, and works directly by estimating an L^1 -type norm for the vorticity of the error term in the expansion Navier-Stokes-(Euler+Prandtl). An important ingredient in the proof is the propagation of local analyticity for the Euler equation, a result of independent interest.

Global wellposedness of 3D compressible Navier-Stokes equations with free surface in exterior domain

张鑫, 同济大学

16:20 - 17:00

In this talk, we discuss about the problem concerning the motion of the barotropic compressible Navier-Stokes equations (CNS) in the smooth exterior domain with some free surface. By applying the method of Lagrangian coordinates, the nonlinear problem reduces to the study of the Lamé system with the free boundary condition. Then the classical theory of the L_p - L_q decay estimate is established for such linearized system, by taking advantage of the local energy approach. At last, we apply the L_p - L_q decay theory to construct the global solution of (CNS).

Well-posedness and global behavior of the Peskin problem

陈可, 复旦大学

17:00 - 17:40

The Peskin problem models the dynamics of a closed elastic filament immersed in an incompressible fluid. In this talk we will present local and global well-posedness results for the 2D Peskin problem in critical spaces. Specifically, we will prove the local well-posedness for any initial data in VMO_1 satisfying the so-called well-stretched assumption. Then, we will show that when the initial string configuration is sufficiently close to an equilibrium in BMO_1 , global-in-time solution uniquely exists and it will converge to an equilibrium as $t \rightarrow \infty$. This is based on a joint work with Prof. Quoc-Hung Nguyen.

3.2 第 2 天 : 12-19 (周日)

Concavity of principal eigenvalue for linear second order operators and its application in population dynamics

何小清, 华东师范大学

09:00 - 09:40

In this talk, we first introduce the concavity property of the principal eigenvalue of a family of parametrized second order elliptic/time-periodic parabolic eigenvalue problems. Then we discuss its application to the dynamics of a two species Lotka-Volterra competition-diffusion system in heterogeneous environments.

On an elliptic eigenvalue problem and its application

周鹏, 上海师范大学

09:40 - 10:20

A linear eigenvalue problem governed by a second order elliptic equation with separate and general boundary conditions is considered and a new monotonicity result on the principal eigenvalue with respect to the coefficient of the advection term is established. The main approach is based on the functional proposed by Liu and Lou and a key finding lies in the nice properties of the associated Frechet operator when coned at suitable points and function spaces. As an application, this monotonicity result is used to study a class of competitive parabolic systems and the so-called "exclusion principle" is observed in a larger parameter region than several existing works, which is a nontrivial improvement.

Global Well-posedness and Exponential Decay Rates of the Strong Solutions to the 2D Full Compressible MHD Equations

尚朝阳 , 上海立信会计金融学院

10:40 - 11:20

In this talk, we introduce the initial-boundary value problem for the two-dimensional viscous, compressible, and heat conducting magnetohydrodynamics equations with vacuum. When all the coefficients of viscosity, heat conductivity and magnetic diffusivity are constants, first, we show that for general initial data and any time $T > 0$, the local strong solution in the sense of Sobolev norms will never blow-up provided that the density is bounded from above and the temperature belongs to some Sobolev spaces. Second, based on the above blow-up criterion and the delicate analysis of the nonlinear strong coupling equations, we establish the global existence of strong solutions when the initial mass of the fluid and the initial energy of the magnetic field are suitable small, where the refined Zlotnik inequality and the decoupling of the full compressible MHD equations play an essential role in proving the uniform upper bound of the density and the higher-order a priori uniform in time estimates, respectively. It is worth mentioning that the initial velocity and temperature can be large. Moreover, in contrast to the classical theory of the polynomial decay rates for the full compressible MHD equations, we obtain exponential decay rates of the global strong solutions. This is a joint work with Prof. Yachun Li.

Isometric Immersions from geometric and PDE perspectives

李思然 , 上海交通大学

11:20 - 12:00

We report our recent work on a classical problem in geometric analysis: isometric immersions and/or embeddings of Riemannian and semi-Riemannian manifolds. The underlying PDE (partial differential equation) is the Gauss–Codazzi–Ricci equations. Existence of isometric immersions is studied under various curvature conditions, via elliptic and hyperbolic PDE techniques. Weak continuity of isometric immersions is investigated with the help of the theory of compensated compactness. Connections to other problems, including harmonic maps and Coloumb gauges, will also be discussed.

Our talk contains joint works with Gui-Qiang Chen and Marshall Slemrod.

