学术沙龙

程序册

数学与统计学院

2026 年 1 月 6 日

目录

一、学术沙龙简介

兰州大学数学与统计学院拟于2026年1月6日举办“数学与统计学院学术沙龙第一期”本次研讨会邀请数学与统计学院五名副教授进行讨论流体力学中的偏微分方程理论与数值计算方面最新成果。

时间：2026年1月6日(周二)

组织者：李佳音，李精伟，徐浩，燕雄斌，杨志鹏

地点：城关区天水中路3号盛达中心C座24楼

二、会议日程

1月6日		城关区天水中路3号盛达中心C座24楼	
时间	主持人	报告人	题目
08:40-09:00	领导致辞		
09:00-09:30	李佳音	李精伟	**Structure-preserving stabilized exponential time differencing schemes for Allen-Cahn type equations with application to cancer cell growth model with a generalized tumor cell mobility**
09:30-10:00		燕雄斌	**A Deep Learning Approach for Solving the Inverse Problem of the Wave Equation**
10:00-10:20	茶歇		
10:20-10:50	李精伟	李佳音	**Vertex-based auxiliary space multigrid method and its application to linear elasticity equations**
10:50-11:20		杨志鹏	**Bayesian Approach to Determining the Orientation and Position of Sound-soft Obstacles with Partial Phaseless Data via Quadratic Wasserstein Metric**
11:20-11:50	燕雄斌	徐浩	**Global stability of large solutions to the three-dimensional full compressible Navier-Stokes equations with vacuum**
12:00-13:00	午餐		
14:30-17:30	自由讨论		
18:00-20:00	晚餐		

三、报告题目与摘要

Vertex-based auxiliary space multigrid method and its application to linear elasticity equations

李佳音 副教授

In this talk, a vertex-based auxiliary space multigrid (V-ASMG) method as a preconditioner of the PCG method is proposed for solving the large sparse linear equations derived from the linear elasticity equations. The main key of such V-ASMG method lies in an auxiliary region-tree structure based on the geometrically regular subdivision. The computational complexity of building such a region-tree is O (qN log2 N), where N is the number of the given original grid vertices and q is the power of the ratio of the maximum distance d_max to minimum distance d_min between the given original grid vertices. The process of constructing the auxiliary region-tree is similar to the method in [L. Grasedyck, L. Wang, J.C. Xu, Numerische Mathematik, 2016], but the selection of the representative points is changed. To be more specific, instead of choosing the barycenters, the correspondence between each grid layer is constructed based on the position relationship of the grid vertices. There are two advantages for this approach: the first is its simplicity, there is no need to deal with hanging points when building the auxiliary region-tree, and it is possible to construct the restriction/prolongation operator directly by using the bilinear interpolation function, and it is easy to be generalized to other problems as well, due to all the information we need is only the grid vertices; the second is its strong convergence, the corresponding relative residual can quickly converge to the given tolerance(It is taken to be 10^−6 in this paper), thus obtaining the desired numerical solution. Two- and three-dimensional numerical experiments are given to verify the strong convergence of the proposed V-ASMG method as a preconditioner of the PCG method.

Structure-preserving stabilized exponential time differencing schemes for Allen-Cahn type equations with application to cancer cell growth model with a generalized tumor cell mobility

李精伟 副教授

Allen-Cahn equation is widely used in simulating the multi-phase fluid problems. As a special case of the semilinear parabolic equation, Allen-Cahn equation inherits the maximum bound principle, which states that the solution of the time-dependent equation is always piecewisely bounded by a specific constant. Maximum bound principle is also important for the variants of Allen-Cahn type equations such as conservative Allen-Cahn equation, convective Allen-Cahn equation, vector-valued Allen-Cahn equation and dynamic boundary Allen-Cahn equation. In this talk, we will consider the structure-preserving stabilized exponential time differencing schemes for Allen-Cahn type equations with application to the cancer cell growth model with a generalized tumor cell mobility. Cancer cell growth model is widely used to investigate tumor invasion, metastasis, and treatment resistance. In this study, we present an accurate and efficient numerical method for a cancer cell growth model coupled with a generalized tumor cell mobility. The model consists of two reaction–diffusion equations and one ordinary differential equation. We develop two efficient exponential time differencing schemes with stabilized term to solve this model. The proposed schemes are linear decoupled numerical algorithms, designed to preserve the unconditional maximum bound principle and non-negativity of the tumor cell concentrations, extracellular matrix and matrix metalloproteinases. Rigorous convergence analysis in the L^∞ norm is also established. Extensive numerical experiments in two and three dimensions are performed to validate the theoretical findings and predict tumor growth dynamics. This work is joint with Feng Xinlong, Hou Yabin and Qiao Yuanyang (XJU).

Global stability of large solutions to the three-dimensional full compressible Navier-Stokes equations with vacuum

徐浩 副教授

This talk is concerned with large-time behavior of global solutions to the Cauchy problem of three-dimensional (3D) full compressible Navier-Stokes equations with large data and initial vacuum. It is shown that if the Serrin's type criterion is satisfied, i.e., the quantity $\|\rho\|_{L^{\infty} (0,\infty;L^{\infty})} + \|u\|_{L^{(2r)/(r-3)}(0,\infty; L^r)}$ is bounded for any $3<r\leq\infty $, then the problem has a global unique strong solution (ρ,u,θ) on $\mathbb{R}^3\times(0,\infty)$. The exponential decay estimates for the lower-higher order norms of both velocity and temperature are also derived. It is worth pointing out that the L^2-L^q-norms of the gradient of density with $3<q<6$ are uniformly bounded for all $t \geq 0$, which is in sharp contrast to that in [J. Li, J. Li, B. Lv, Global classical solutions to the full compressible Navier-Stokes equations in 3D exterior domains. arXiv: 2208.11925v1] and [J. Li, B. Lv, X. Wang, Global existence of classical solutions to full compressible Navier-Stokes equations with large oscillations and vacuum in 3D bounded domains. arXiv: 2207.00441v1] for the initial-boundary value problem with the Navier's slip boundary condition for velocity and the thermal-insulated boundary condition for temperature.

A Deep Learning Approach for Solving the Inverse Problem of the Wave Equation

燕雄斌 副教授

Full-waveform inversion (FWI) is a powerful geophysical imaging technique that infers high-resolution subsurface physical parameters by solving a non-convex optimization problem. However, due to limitations in observation, e.g., limited shots or receivers, and random noise, conventional inversion methods are confronted with numerous challenges, such as the local-minimum problem. In recent years, a substantial body of work has demonstrated that the integration of deep neural networks and partial differential equations for solving full-waveform inversion problems has shown promising performance. In this work, drawing inspiration from the expressive capacity of neural networks, we provide a new deep learning approach aimed at accurately reconstructing subsurface physical velocity parameters. This method is founded on a re-parametrization technique for Bayesian inference, achieved through a deep neural network with random weights. Notably, our proposed approach does not hinge upon the requirement of the labeled training dataset, rendering it exceedingly versatile and adaptable to diverse subsurface models. Furthermore, uncertainty analysis is effectively addressed through approximate Bayesian inference. Extensive experiments show that the proposed approach performs noticeably better than existing conventional inversion methods.

Bayesian Approach to Determining the Orientation and Position of Sound-soft Obstacles with Partial Phaseless Data via Quadratic Wasserstein Metric

杨志鹏 副教授

In this talk, we consider to reconstruct the orientation and position of an acoustically sound-soft obstacle from few phaseless far-field observation directions with respect to one single incident wave in two dimensions. The Bayesian approach is adopted to deal with the small number of observation data and to design robust inversion algorithms against different initial guesses and wavenumbers. The quadratic Wasserstein metric is utilized to measure the distance between two observation data to improve the Bayesian approach. The first-order convergence rate for computing the quadratic Wasserstein metric and the well-posedness of the posterior distribution are verified. The advantages of using the Wasserstein metric over the L2-norm and the effectiveness of the proposed method are illustrated.

四、主办单位简介

兰州大学数学学科点创建于1946年、形成于20世纪50年代，以陈文堉教授、陈庆益教授和郭聿琦教授等为学科带头人，在非线性泛函分析、偏微分方程和代数学等三个方向开展研究，形成了优势和特色，并于1984年获得了基础数学博士授权点。期间，兰州大学数学学科以基础数学博士点为依托，在持续保持上述三个传统方向优势和特色的基础上，通过多年的艰苦努力和奋斗，在科学研究、人才培养、学科建设和服务经济社会发展等方面取得了突出成绩，发展形成了非局部发展方程、无穷维动力系统、图论及其应用、偏微分方程及应用、科学与工程计算方法、概率统计等学科方向，产生了一批年轻有为的学术带头人，在国内外产生了重要的影响。2001 年获准设立了数学博士后科研流动站，2003 年获得应用数学博士点，2005年获准建立了数学一级学科博士学位授权点。现已具有国务院学位委员会批准的数学一级学科博士点（基础数学、计算数学、概率论与数理统计、应用数学），数学学科博士后流动站，数学一级硕士学位授权点，应用统计专业硕士学位授权点，以及甘肃省数学一级重点学科。

培养高水平研究型和应用型人才、建设世界一流数学学科，是我们一直追求的目标。进入本世纪以来，数学学科发展迅速，在队伍建设、科学研究、人才培养、国际合作与交流等方面取得了很大的成绩。在队伍建设方面，形成了结构合理、创新意识和科研攻关能力强、在诸多领域有重要影响的学术团队。截止2024年11月，学院现有教职工92人（教师82人，教学辅助人员 14 人），其中博士生导师 27 人、硕士生导师 52 人；教授 31 人、副教授 35 人。国家杰出青年基金获得者 1 人、国家优秀青年基金获得者1人、国家人才计划（青年学者）2人，享受国务院政府津贴3人，“教育部高校青年教师奖”获得者2人，教育部新世纪人才计划获得者6人，宝钢教育基金优秀教师奖获得者 5 人，“甘肃省领军人才”获得者 7 人，甘

肃省“飞天学者”特聘教授 1 人、青年学者 2 人，甘肃省教学名师 1 人。甘肃省 333 科技人才 1 人，甘肃省 555 创新人才 4 人。

在科学研究与平台建设方面，瞄准国内外学术前沿和地方发展需求，不断提升高水平研究数量和质量，产生了一批有重要影响的高水平的科研成果。获甘肃省自然科学一等奖 2 项，二等奖 6 项，三等奖 1 项，甘肃省科技进步奖二等奖 1 项，三等奖 4 项，教育部高校自然科学二等奖 1 项。今后，兰州大学数学学科将继续坚持“培养高水平研究型和应用型人才、建设世界一流数学学科”的目标，在巩固保持已有优势与特色的基础上奋勇前行，力争在队伍建设和科研水平上取得新突破，在优势学科方向产生若干有国际影响力的学术团队、一批特色研究课题和相关领域的国际知名领军人物，产生一批有国际影响力的高质量科研成果，形成结构合理、整体实力强、创新意识强、科研攻关能力强的学术队伍，不断提高人才培养质量，努力培养拔尖创新人才，早日实现国际一流学科的目标。