2021 Online Workshop on Inverse Problems

反问题是现代数学物理和计算数学中的一个十分活跃的重要研究领域，在近半个世纪内，一直受到了国内外众多学者的广泛关注。近些年来，关于反问题的理论不断被发展与完善，相关的数学理论和数值方法研究在科学计算中日益活跃，其研究内容越来越丰富，涉及到的研究领域越来越广泛,比如医学成像、雷达探测、地质勘探、光学、材料和控制等众多重要的科学技术领域。

为促进国内学者在反问题研究的学术交流,深入探讨当前研究进展，推动和提高西安电子科技大学反问题团队的研究水平，兹定于2021年11月6日举办线上会议“2021 Online Workshop on Inverse Problems”。会议主题包括反问题及相关领域的当前研究的热点问题。主旨是交流反问题及相关领域研究的最新学术动态和研究成果。今年恰逢我校九十华诞，因此，本次会议也属于校庆学术活动的一部分。

会议时间：2021 年 11 月 6 日(星期六)

会议平台：腾讯会议 ID 347 882 774

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西安电子科技大学数学与统计学院

2021 年 11 月 1 日

2021 Online Workshop on Inverse Problems

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会议链接：https://meeting.tencent.com/dm/mI3s6YOzfKR4

时　间	主题报告	报告人	主持人
08:30-08:50	开幕式		
08:50-09:20	基于非局部线性 COVID-19 疫情模型的境外输入风险评估	程晋 （复旦大学&上海财经大学）	魏婷 （兰州大学）
09:20-09:50	**Stability for inverse source problems in wave equations**	李培军 （Purdue University）	
09:50-10:00	休　息		
10:00-10:30	**Identification of the zeroth-order coefficients for time-fractional diffusion-wave equations**	魏婷 （兰州大学）	张磊 （黑龙江大学）
10:30-11:00	**A numerical scheme for the time-fractional diffusion equation by layer potentials**	王海兵 （东南大学）	
11:00-11:30	**An inverse source problem for the stochastic wave equation**	王旭 （中国科学院）	
11:30-14:00	午　休		
14:00-14:30	**The dynamical model for COVID-19 with asymptotic analysis and numerical implementations**	刘继军 （东南大学）	王海兵 （东南大学）
14:30-15:00	**2D vorticity-stream function formulation and its application in vortex merging**	张磊 （黑龙江大学）	
15:00-15:30	**Sampling methods for inverse exterior Stokes problems**	杨家青 （西安交通大学）	
15:30-15:40	休　息		
15:40-16:10	模型与数据双驱动反问题数值解法及典型应用	王彦飞 （中国科学院）	刘继军 （东南大学）
16:10-16:40	**Uniqueness to inverse grating diffraction problems with infinitely many plane waves**	胡广辉 （南开大学）	
会议闭幕			

报告摘要

1. 程晋　复旦大学 & 上海财经大学

题目：基于非局部线性 COVID-19 疫情模型的境外输入风险评估

摘要：新冠病毒的传播仍然是目前国际面临的一个及其严重的问题。从传播机理的角度，建立合适的数学模型来刻画疫情的发展是我们团队在 2020 年 1 月开始的一项研究，取得了比较突出的研究成果。比较好地预测了中国以及各个省市的第一波病毒的传播。在全世界经济迫切需要开放的大环境下，我们的模型是否可以提供一些有益的建议？我们做了一些尝试，基于我们的非局部线性 COVID-19 的模型，建立一种风险评价体系。为上海市的精准防控提供一些决策的依据。

2. 李培军　Purdue University

题目：Stability for inverse source problems in wave equations

摘要：In this talk, our recent progress will be discussed on stability of the inverse source problems for time-harmonic wave equations. We show that the increasing stability can be achieved by using the multi-frequency data for the wave equations in homogeneous and inhomogeneous media.

3. 魏婷 兰州大学

题目：Identification of the zeroth-order coefficients for time-fractional diffusion-wave equations

摘要：In this talk, I will give some introductions to identification problems of the zeroth-order coefficients for time-fractional diffusion-wave equations. Including the inverse time-dependent zeroth-order coefficient by using the boundary measured data at a point and by an additional integral condition. The existence, uniqueness and regularity of the solution for the direct problems are provided. Based those, we try to give some uniqueness and conditional stability estimates for the inverse zeroth-order coefficient problems. The Levenberg-Marquardt regularization method and two points gradient method are proposed to solve the inverse coefficient problems. Some numerical examples in one-dimensional case or in two-dimensional case are provided to show the effectiveness of the proposed methods.

4. 王海兵 东南大学

题目： A numerical scheme for the time-fractional diffusion equation by layer potentials

摘要： In this talk, we show a numerical scheme for solving an initial-boundary value problem for the time-fractional diffusion equation. By expressing the solution as a single-layer potential, the initial-boundary value problem is transformed into a boundary integral equation for the unknown density function. To numerically solving the resulting boundary integral equation, we develop a stable discretization scheme for layer potentials. First, we rewrite the layer potential operators as generalized Abel integral operators in time. Then, the asymptotic expansions of those kernels at the initial time are derived by carefully analyzing the fundamental solution of the time-fractional diffusion equation. Consequently, we establish a stable time discretization scheme. The spatial discretization is performed by a standard quadrature rule for boundary integrals of smooth functions. Finally, we present several numerical examples to show the efficiency and accuracy of the proposed numerical scheme. Applications to inverse problems will also be discussed.

5. 王旭 中国科学院

题目： An inverse source problem for the stochastic wave equation

摘要： In this talk, an inverse source problem for the stochastic wave equation driven by a fractional Brownian motion will be introduced. Given the random source, the direct problem is to study the solution of the stochastic wave equation. The inverse problem is to determine the statistical properties of the source from the expectation and covariance of the final-time data. For the direct problem, it is shown to be well-posed with a unique mild solution. For the inverse problem, the uniqueness is proved for a certain class of functions and the instability is characterized. Numerical experiments are presented to illustrate the reconstructions by using a truncation-based regularization method.

6. 刘继军 东南大学

题目： The dynamical model for COVID-19 with asymptotic analysis and numerical implementations

摘要： In this talk, we give our dynamical model for COVID-19 by an integral-differential equation with numerical implementations. This model considers the time-delay effects of some medical factors such as the incubation period. Numerical tests show the validity of the proposed model, provided that the parameters in this model be appropriately specified.

7. 张磊 黑龙江大学

题目： 2D vorticity-stream function formulation and its application in vortex merging

摘要： We are concerned with the development of numerical research for the 2D vorticity-stream function formulation and its application in vortex merging at high Reynolds numbers. A novel numerical method for solving the vorticity-stream function formulation of the Navier-Stokes equations at high Reynolds number is presented. A verification algorithm that has the analytical solution is designed to demonstrate the feasibility and effectiveness of the proposed scheme. Furthermore, the proposed scheme is applied to study the vortex merging problem. Ample numerical experiments are performed to show some essential features of the merging of multiple vortices at high Reynolds numbers. Meanwhile, considering the importance of the inversion for the initial position of the vorticity field, we present an iteration algorithm for the reconstruction of the initial position parameters.

8. 杨家青 西安交通大学

题目： Sampling methods for inverse exterior Stokes problems

摘要： This talk is concerned with an inverse Stokes problem of recovering a solid in an unbounded stationary flow. We proposed three simple imaging techniques for detecting the shape and location of the solid by extending the well-known LSM, FM and GLSM for wave equations, where only the velocity field data are taken on a closed surface around the solid. Moreover, we also provided several numerical examples

to illustrating the effectiveness of the reduced inversion algorithm.

9. 王彦飞 中国科学院

题目：模型与数据双驱动反问题数值解法及典型应用

摘要：长期以来，反问题都是基于数学物理模型研究。近几年由于大数据和人工智能的兴起，越来越多的问题需要模型与数据的融合。在这次报告中，我们将阐述这些问题，并给出典型示范案例。

10. 胡广辉 南开大学

题目：Uniqueness to inverse grating diffraction problems with infinitely many plane waves

摘要：In two dimensional case, we prove that a sound-soft periodic curve can be uniquely determined by the near-field data of infinitely many incident plane waves with distinct directions at a fixed frequency. Our proof is based on Schiffer's idea which consists of two ingredients: i) the total fields incited by distinct incident directions are linearly independent; ii) there exist only finitely many linearly independent Dirichlet eigenfunctions in a bounded domain or in a closed waveguide under additional assumptions on the waveguide boundary. Based on the Rayleigh expansion, we show that the phased near-field data can be uniquely determined by the phaseless near-field data in a bounded domain, with the exception of a finite set of incident angles. Such a phase retrieval result leads to new uniqueness results using the near-field data without phase information. This a joint work with X. Xu, H. Zhang and B. Zhang.