

第十三届全国反问题、成像及其应用会议

The 13th Conference on
Inverse Problems, Imaging and Applications

会议手册

主办单位：CSIAM反问题与成像专委会

承办单位：山东理工大学数学与统计学院

中国 淄博

2024年5月31日—2024年6月2日

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会议信息

反问题与成像及其应用研究是国内外数学及交叉科学领域的前沿和热点课题。为进一步促进国内外反问题研究领域的学术交流与合作，了解反问题各分支领域的最新研究动态，提高研究生和青年教师的科研能力，在浙江大学包刚院士、复旦大学程晋教授、中国科学院张波研究员、东南大学刘继军教授等积极倡议下，拟定于 2024 年 5 月 31 日至 6 月 2 日（5 月 31 日全天报到）在山东省淄博市齐盛国际宾馆举办第十三届全国反问题、成像及其应用暨 CSIAM 反问题与成像专委会 2024 学术会议。

会议议题包括电磁散射反问题、地质探测反问题、图像反问题、一般不适定问题、偏微分方程与分数阶微分方程反问题、多参数反演算法与正则化等一系列当前研究的热点问题。

学术委员会

主席：包刚（浙江大学）

委员（按拼音字母为序）：

程晋（复旦大学）

董彬（北京大学）

李功胜（山东理工大学）

李培军（中国科学院数学与系统科学研究院）

刘继军（东南大学）

陆帅（复旦大学）

马坚伟（哈尔滨工业大学）

王彦飞（中国科学院地质与地球物理研究所）

张波（中国科学院数学与系统科学研究院）

邹军（香港中文大学）

程序委员会（按拼音字母为序）

胡广辉（南开大学）

赖俊（浙江大学）

李景治（南方科技大学）

李志远（宁波大学）

刘晓东（中科院数学与系统科学研究院）

王海兵（东南大学）

王泽文（广州航海学院）

徐翔（浙江大学）

杨家青（西安交通大学）

张德悦（吉林大学）

张磊（浙江工业大学）

张晔（深圳北理莫斯科大学）

赵振宇（山东理工大学）

组织委员会

主 席：李玉霞（山东理工大学）

委 员：（按拼音字母为序）

李功胜、孙俊涛、王建锋、徐夫义、徐翔、赵艳雷、朱光明

会务组联系方式

住宿就餐 赵振宇15913594229， 巩天鹏18053351231

会务会场 贾现正15864950618， 孙雪

会议手册 王迎美15762893386， 贾现正15864950618

会务交通 巩天鹏18053351231， 巩本学15069331397
司苏亮15611536579

报到注册 郑明文15269367060， 王迎美15762893386
乔瑜18252047675， 薛艳

会议指南

一、会议报到

报到时间：2024年5月31号 09:00—22:00

报到地点：山东齐盛国际宾馆（山东省淄博市张店区北京路69号）

住宿杏园宾馆的人员，请到杏园宾馆（山东理工大学校内）报到

二、交通路线

1、济南遥墙机场

乘飞机来参会的专家学者，请前往济南遥墙机场，然后乘坐由遥墙机场至鲁中候机楼（淄博）的大巴。

机场大巴乘车地点：候机楼一楼5、6号出口右侧斜对过，长途客运站。全程约100公里，行程约1小时20分钟，票价60元。

遥墙机场—鲁中候机楼大巴车发车时刻表：

08:00 09:10 09:50 10:30 11:00 11:30 12:00 12:30 13:15 14:00 14:30

15:20 16:10 16:40 17:10 17:40 18:20 19:00 19:40 20:30 21:30 22:30

抵达鲁中候机楼之后，由鲁中候机楼步行365米至火炬公园公交站乘坐156路或K156路（山东农业工程学院方向）至中润大道北京路路口公交站，步行200米至齐盛国际宾馆，全程大约需要33分钟。

由鲁中候机楼打车至齐盛国际宾馆，全程6公里，大约需要15元。

2、淄博北站

公交信息：淄博北站出站口步行342米至淄博北站公交站，乘坐263路或K263路（客运中心站方向）至齐盛国际宾馆公交站下车，步行70米至齐盛国际宾馆，全程大约需要43分钟。

打车信息：由淄博北站打车至齐盛国际宾馆，全程10公里，大约需要20元。

3、淄博站

公交信息：出站口—负二层B区，步行约400米至淄博火车站（王舍路）公交站（齐盛湖公园南门方向）至齐盛湖公园南门公交站下车，步行530米至齐盛国际宾馆，全程大约需要1小时5分钟。

打车信息：由淄博站打车至齐盛国际宾馆，全程13公里，大约需要25元。

三、会场WIFI信息

用户名：齐盛国际宾馆全拼（qishengguojibinguan）无密码，直接连接

四、会议地点

◆ 6月1日上午、2日上午大会报告地点：齐盛宾馆会议中心一楼西多功能厅

◆ 6月1日下午分组报告地点：

M1	一楼西 高青厅	M7	一楼东 经开厅
M2	一楼西 桓台厅	M8	二楼西 淄川厅
M3	一楼西 临淄厅	M9	二楼西 第三会议室
M4	一楼西 第二会议室	M11	一楼东 淄矿厅
M6	一楼东 张店厅		

◆ 6月2日下午分组报告地点：

M1	一楼西 高青厅	M7	二楼西 淄川厅
M2	一楼西 桓台厅	M10	一楼西 第二会议室
M4	一楼西 临淄厅	M11	二楼西 第三会议室
M5	一楼东 张店厅	M11	一楼东 淄矿厅
M6	一楼东 经开厅		

会议期间，安排车接送住宿杏园宾馆的参会人员。1日上午8:00，杏园至齐盛；2日上午7:30，杏园至齐盛；2日晚上20:00，齐盛至杏园。

五、会议用餐

齐盛宾馆	时间	地点
早餐	07:00-09:00	西餐厅
午餐	12:00-13:30	西餐厅或风味厅
晚餐	18:00-20:00	西餐厅或风味厅

早餐凭房卡就餐；午晚餐凭会议发放的餐券就餐。

住宿杏园宾馆的参会人员，31日的晚餐在杏园宾馆宴会厅；早餐在杏园宾馆就餐，6月1日午餐，2日午餐、晚餐在齐盛宾馆。

6月1日18:00，全体参会人员在齐盛宾馆乘车到杏园宴会厅就餐。

六、会议温馨提示

天气：以晴朗为主 温度：20-34摄氏度。

建议穿夏季衣服，做好防晒，附带外套。

七、会议网站

会议网站主页：<https://www.smartchair.org/hp/IP2024/TOP/>

八、承办单位简介

山东理工大学数学与统计学院

山东理工大学创建于1956年，山东省高水平大学建设单位，首批国家级“卓越工程师教育培养计划”试点单位、全国教育信息化试点优秀单位、国家知识产权试点高校、山东省智慧教育示范校创建单位等。学校占地3600亩，现有27个学院，有全日制本科在校生35000余人，博士、硕士研究生5800余人。学校学科专业涵盖工学、理学、农学等9个学科门类，设有3个博士后科研流动站，拥有4个博士学位授权一级学科，25个硕士学位授权一级学科；有本科招生专业76个，其中国家级一流本科专业建设点25个，14个专业通过了工程教育专业认证，2个专业通过了师范类二级专业认证。

山东理工大学数学与统计学院1978年开始培养数学教育专科生，1998年开始培养数学与信息科学本科生，2007年开始培养应用数学硕士研究生，2017年6月正式更名为数学与统计学院。学院现有教职工112人，其中博士学位教师70人，有教授19人、特聘教授3人；拥有全国优秀教师、山东省泰山学者青年专家、省杰青等各类省部级人才12人，有省级教学团队2支、省青创人才引育团队2支、省青创科技创新团队2支。

学院有数学一级学科硕士点和应用统计专业硕士点，有数学与应用数学（含师范）、信息与计算科学、统计学3个本科专业，设有万哲先数学实验班，在校生1500余人。数学与应用数学专业是国家级一流本科专业建设点，数学师范专业通过了国家二级认证，信息与计算科学专业是山东省一流专业建设点。应用数学为山东省“十二五”重点学科，数学学科入选山东省博士点精准培育学科，逐步形成了科学计算与反问题、代数学及其应用、微分方程与动力系统、优化理论与控制、图论与组合、大数据分析与经济金融统计等学科方向，尤其在偏微分方程与反问题，代数编码与图论研究领域形成了团队优势。

近五年来，学院教师主持省部级以上课题70余项，其中国家自然科学基金面上项目16项、省杰出青年基金1项，2023年获批国家基金8项（面上3项）；在德国数学年刊等国内外重要期刊发表学术论文200余篇，先后获得山东省科技进步二等奖和自然科学二等奖各1项、山东省教学成果二等奖1项。近三年，学生在全国大学生数学建模大赛、数学竞赛等学科专业赛事和科技创新活动中，获得国家级奖励349人次，省级奖励282人次，其中薛佳辉同学连续获得2023年、2024年全国大学生数学竞赛决赛一等奖。

发展没有止境，目标催人奋进。学院将围绕数学博士点申报、数学与应用数学国家一流专业建设等核心工作，凝心聚力，真抓实干，为早日建成一流数学强院而努力奋斗。

会议日程总览

5月31日全天	6月1日上午 6月2日上午	6月1日下午 6月2日下午	6月3日
会议报到	开幕式 大会报告	分组报告	离会

5月31日 山东齐盛国际宾馆	
09:00-22:00	会议报到
17:30-20:00	晚餐

6月1日上午		6月2日上午	
一楼西 多功能厅		一楼西 多功能厅	
08:30-09:00	开幕式	08:00-08:45	季霞
		08:45-09:30	金邦梯
09:00-10:00	林芳华	09:30-10:15	陈曦
10:00-10:20	茶歇	10:15-10:30	茶歇
10:20-11:05	王海兵	10:30-11:15	殷涛
11:05-11:50	胡广辉	11:15-12:00	张文龙
12:00-13:30	午餐	12:00-13:30	午餐

6月1日下午 分组报告

报告厅	一楼西 高青厅	一楼西 桓台厅	一楼西 临淄厅	一楼西 第二会 议室	一楼东 张店厅	一楼东 经开厅	二楼西 淄川厅	二楼西 第三会 议室	一楼东 淄矿厅
报告分组	M1	M2	M3	M4	M6	M7	M8	M9	M11
14:00-14:25	张建平	江渝	吕俊良	孙瑶	冯晓莉	董和平	付树军	孙鸿鹏	钟雨龙 朱琳琳 张金锐 易颖笛 王静
14:25-14:50	高益铭	丁亮	刁怀安	张海文	井晓华	窦芳芳	曹静杰	曾芳	
14:50-15:15	李季	杨鹏亮	孟品超	陈博	孙亮亮	高忆先	李尤发	岳俊宏	
15:15-15:40	李爻	王茂胜	尹伟石	孙凤麟	温瑾	郭玉坤	安美建	向建立	
15:40-16:00	茶歇								
16:00-16:25	张道平	佟珊珊	王超	杨志鹏	张文龙	蒋代军	罗守胜	刘春	李佳磊 周嘉鑫 葛美宝 王天骄 尹运文 田亦濛
16:25-16:50	聂梓伟	陈瑜	史庆祥	司苏亮	张云	李晓菲	宋义壮	马冠球	
16:50-17:15	洪源	付振武	古惠鹏	张萌萌	张植栋		王迎美	张佳毅	
17:15-17:40	惠庆磊	赵囡	唐瑞祥	郭红霞	郑祥成				
17:40-18:05			常燕						
18:30-20:30	晚宴								

6月2日下午 分组报告

报告厅	一楼西 高青厅	一楼西 柜台厅	一楼西 临淄厅	一楼东 张店厅	一楼东 经开厅	二楼西 淄川厅	一楼西 第 二会议室	二楼西 第 三会议室	一楼东 淄矿厅
报告分组	M1	M2/M9	M4	M5	M6	M7	M10	M11	M11
14:00-14:25	郭红波	张晓嫣	向建立	邱凌云	宋义壮	许伯熹	程丽	程智勇 于沈文 常燕 朱丽艳 孔令政	张柳颖 吕沛岷 胡利 江许岩
14:25-14:50	王媛	吴法选	徐小绪	王玉亮	郑光辉	姚青云	凌舒扬		
14:50-15:15	霍利美	郜广宇	罗晟	李文彬	燕雄斌	张惠	赵泽宇		
15:15-15:40	李雨桐	齐洪宇	吴昊	陈鸿初		张萌萌	张冉		
15:40-16:00	茶歇								
16:00-16:25	陈仁栋	郑光辉	李铭辉	柳文	付军良	赵璐	刘海霞	武新 严学威 曹翔 许靖波 朱凯	罗玉花 沈俊 陈树立 王迎奥 朱巧
16:25-16:50	江杰	李宏杰	赵晓萌	汪奇生	王凤丹	赵越	熊傲昇		
16:50-17:15	庞彤瑶	刘海阳	贾玉	霍星亮					
17:15-17:40									
18:00-20:00	晚餐								

会议报告安排

大会邀请报告				
地点：一楼西 多功能厅				
	时间	报告人	题目	主持人
6月1日上午	09:00-10:00	林芳华 (纽约大学)	TBD	包刚 (浙江大学)
	10:00-10:20	茶歇		
	10:20-11:05	王海兵 (东南大学)	Inverse problems for time-dependent PDE models	程晋 (复旦大学)
	11:05-11:50	胡广辉 (南开大学)	依赖频率的声波反源问题研究	董彬 (北京大学)
6月2日上午	08:00-08:45	季霞 (北京理工大学)	A new method using COIPG for the transmission eigenvalue problem	李培军 (中科院数学与系统科学研究院)
	08:45-09:30	金邦梯 (香港中文大学)	Solving Nonlinear Inverse Problems Using Neural Networks and Conditional Stability	刘继军 (东南大学)
	09:30-10:15	陈曦 (复旦大学)	Inverse Problems of Hyperbolic PDEs: Theory and Numerics	张波 (中科院数学与系统科学研究院)
	10:15-10:30	茶歇		
	10:30-11:15	殷涛 (中科院数学与系统科学研究院)	Boundary integral equation method: from frequency-domain to time-domain	王彦飞 (中科院地质与地球物理研究所)
	11:15-12:00	张文龙 (南方科技大学)	一些简单线性反问题的不确定性量化理论和快速算法研究	马坚伟 (哈尔滨工业大学)

大会邀请报告人简介

1. **林芳华**，美国纽约大学柯朗研究所 Silver 首席教授，美国科学与艺术院院士。1985 年博士毕业于明尼苏达大学，1990 年在国际数学家大会作 45 分钟报告，2002 年荣获美国数学学会 Bocher 奖。林芳华院士是偏微分方程、几何测度论、几何分析等领域国际公认的领军人物和顶尖专家，特别在椭圆方程、几何分析等方向做出了众多开创性和影响深远的成果。在国际著名期刊共发表论文 200 余篇(包括数学顶尖杂志 Acta Math., Ann. Math. 等)，他和合作者所著的《Elliptic Partial Differential Equations》，已成为偏微分方程的经典教材。
2. **王海兵**，东南大学教授，博士生导师，主要从事偏微分方程反问题的研究。2012 年获得北海道大学和东南大学的理学博士学位。现任中国数学会计算数学分会常务理事。目前主持一项国家自然科学基金面上项目，代表性研究成果发表于 SIAM 系列，IP, JDE, JCP 等学术刊物。
3. **胡广辉**，南开大学数学科学学院科学与工程计算系教授、系主任、博士生导师。2009 年获中国科学院数学与系统科学研究院博士学位。2009 至 2016 年在德国莱布尼茨协会维尔斯特拉斯研究所做博士后工作，2012 至 2015 年独立主持德国研究协会科研项目。2016 年 3 月份入选国家海外高层次青年人才计划，2016.09-2020.05 工作于北京计算科学研究中心，2020 年 3 月获得德国洪堡资深学者奖学金。主要从事波方程的数学理论研究和偏微分方程反问题及其计算方法研究，在 ARMA, JMPA, JDE, JFA, M3AS, IP, SIAM 系列等杂志发表学术论文 90 余篇。
4. **季霞**，北京理工大学教授。本科和博士毕业于北京大学，美国北卡夏洛特校博士后，先后在中国科学院数学与系统科学研究院和北京理工大学工作。在 SIAM 系列杂志，Journal of Computational Physics, ACM Transactions on Mathematical Software, Inverse Problems 等国际知名学术期刊上发表多篇论文。
5. **金邦梯**，香港中文大学教授。2008 年获香港中文大学数学博士学位。曾任伦敦大学学院计算机科学系教授（2014-2022），加州大学河滨分校数学助理教授（2013-2014），得克萨斯农工大学客座助理教授（2010-2013），不来梅大学 Alexandre von Humboldt 博士后研究员（2009-2010）。研究兴趣包括反问题、数值分析和机器学习等。目前担任五个国际期刊的编委，包括《反问题》《计算数学杂志》等。
6. **陈曦**，复旦大学上海数学中心青年研究员。2015 年在澳大利亚国立大学获得博士学位（导师：Andrew Hassell），2015 年至 2021 年在复旦大学和剑桥大学做博士后研究工作，2021 年入选国家海外高层次青年人才计划，主要从事微局部分析、反问题、数学物理等方面的研究，研究成果发表于 JEMS、CMP、AIHP、APDE、CPDE、AIF 等期刊。

优秀青年学术奖获奖人简介

1. **殷涛**，中国科学院数学与系统科学研究院副研究员。2015 年博士毕业于重庆大学，期间在德国柏林工业大学联合培养，先后在浙江大学、法国格勒诺布尔大学、美国加州理工学院从事博士后研究工作。入选国家海外高层次人才青年项目和中科院引才计划，主持国家自然科学基金面上项目。主要研究边界积分方程、波散射正反问题的理论和数值方法，研究工作发表在 SIAM 系列, Numer. Math., J. Comput. Phys., J. Math. Pures Appl., Inverse Problems 等期刊。
2. **张文龙**，南方科技大学助理教授。本科毕业于南京大学，先后在中国科学院，巴黎高等师范学校获得硕士、博士学位。主持国家自然科学基金青年基金和面上基金项目，主持深圳市博士启动项目，获得深圳市海外高层次人才 C 类。研究方向包括反问题理论数值计算、不确定性量化、数值分析等，研究工作发表在 SIAM 系列, Inverse Problems 等期刊。

6月1日下午 分组报告 一楼西 高青厅

M1: 图像计算与反问题

时间	报告人	题目	主持人
14:00-14:25	张建平 (湘潭大学)	Deep Unrolled Reconstructions for CT imaging and Remote Sensing Blind Deblurring	董彬 (北京大学)
14:25-14:50	高益铭 (南京航空航天大学)	Spatially adaptive oscillation total generalized variation for image restoration with structured textures	
14:50-15:15	李季 (首都师范大学)	Fourier相位恢复的扩散生成式算法	贺小伟 (西北大学)
15:15-15:40	李爻 (哈尔滨工业大学)	A diffusion equation for improving the robustness of deep learning speckle removal model	
15:40-16:00	茶歇		
16:00-16:25	张道平 (南开大学)	Registration-Based Image Segmentation Models	段玉萍 (北京师范大学)
16:25-16:50	聂梓伟 (南京大学)	医学图像非刚性配准的非光滑正则化模型	
16:50-17:15	洪源 (浙江师范大学)	深度学习在脊柱病灶诊断中的应用	王艳 (重庆师范大学)
17:15-17:40	惠庆磊 (安阳师范学院)	基于深度学习的智能骨龄评估方法及应用	

6月1日下午 分组报告 一楼西 柜台厅

M2: 迭代正则化算法理论及其在全波形反演中的应用

时间	报告人	题目	主持人
14:00-14:25	江渝 (上海财经大学)	光CT成像的若干统计反演算法	陈勇 (哈尔滨工业大学)
14:25-14:50	丁亮 (东北林业大学)	$\alpha l_1 - \beta l_2$ sparsity regularization for nonlinear ill-posed problems	
14:50-15:15	杨鹏亮 (哈尔滨工业大学)	3D marine controlled-source electromagnetic inversion by frequency-domain multigrid modeling	
15:15-15:40	王茂胜 (哈尔滨工业大学)	3D frequency-domain elastic wave modeling based on an optimal second-order staggered-grid finite-difference method	
15:40-16:00	茶歇		
16:00-16:25	佟珊珊 (陕西师范大学)	Iterative Runge-Kutta-Type methods with convex penalty for inverse problems in Hilbert spaces	陈勇 (哈尔滨工业大学)
16:25-16:50	陈瑜 (上海财经大学)	A mechanism learning based method for image inpainting	
16:50-17:15	付振武 (哈尔滨工业大学)	An accelerated Bouligand-Landweber method based on projection and Nesterov acceleration for nonsmooth ill-posed problems	
17:15-17:40	赵囡 (大连海事大学)	Hybrid adaptive method based on dictionary learning and rank-reduction for seismic denoising	

6月1日下午 分组报告 一楼西 临淄厅

M3: 反散射问题的理论与数值算法

时间	报告人	题目	主持人
14:00-14:25	吕俊良 (吉林大学)	Factorization Method for Inverse Elastic Scattering Problem with Neumann boundary condition	刘晓东 (中科院数学与系统 科学院)
14:25-14:50	刁怀安 (吉林大学)	Spectral properties of an acoustic-elastic transmission eigenvalue problem with applications	
14:50-15:15	孟品超 (长春理工大学)	Reconstruction of sound sources and obstacles based on neural networks	
15:15-15:40	尹伟石 (长春理工大学)	Efficient Synchronous Retrieval of OAM Modes and AT Strength using Multi-Task Neural Network	
15:40-16:00	茶歇		
16:00-16:25	王超 (深圳北理莫斯科 大学)	Error estimates for a mixed finite element method for the Maxwell's transmission eigenvalue problem	郭玉坤 (哈尔滨工业大学)
16:25-16:50	史庆祥 (中科院)	Uniqueness and numerical scheme for spherical shell-structured sources from the sparse far field patterns	
16:50-17:15	古惠鹏 (南方科技大学)	Convergence Analysis of a Global-in-Time Iterative Decoupled Algorithm for Biot's Model	
17:15-17:40	唐瑞祥 (吉林大学)	Unique determination by a single far-field measurement for an inverse elastic problem	
17:40-18:05	常燕 (哈尔滨工业大学)	A novel Newton method for inverse elastic scattering problems	

6月1日下午 分组报告 一楼西 第二会议室

M4: 波动方程的反散射问题

时间	报告人	题目	主持人
14:00-14:25	孙瑶 (中国民航大学)	Simultaneously determine elastic impedance and shape by a Newton-type iterative method	赵越 (华中师范大学)
14:25-14:50	张海文 (中科院数学与系统科学研究院)	Inverse scattering with phaseless data	
14:50-15:15	陈博 (中国民航大学)	Numerical schemes for time domain acoustic inverse source problems	
15:15-15:40	孙凤麟 (天津师范大学)	Direct sampling method to inverse frequency-dependent electromagnetic source problems	
15:40-16:00	茶歇		
16:00-16:25	杨志鹏 (兰州大学)	Convexification Numerical Method for a Coefficient Inverse Problem for the Radiative Transport Equation	胡广辉 (南开大学)
16:25-16:50	司苏亮 (山东理工大学)	Uniqueness, stability and algorithm for an inverse wave-number-dependent source problem	
16:50-17:15	张萌萌 (河北工业大学)	Conditional well-posedness and data-driven method for identifying the dynamic source in a coupled diffusion system from one single boundary measurement	
17:15-17:40	郭红霞 (南开大学)	Inverse wave-number-dependent source problems for the Helmholtz equation with partial information on radiating period	

6月1日下午 分组报告 一楼东 张店厅

M6: 扩散中的反问题建模与计算

时间	报告人	题目	主持人
14:00-14:25	冯晓莉 (西安电子科技大学)	Inverse random source problems for some stochastic fractional diffusion equations	李志远 (宁波大学)
14:25-14:50	井晓华 (长安大学)	Simultaneous uniqueness for multiple parameters identification in a fractional diffusion-wave equation	
14:50-15:15	孙亮亮 (西北师范大学)	Simultaneous recovery of the potential and order for a sub-diffusion model with unknown initial state and source	
15:15-15:40	温瑾 (西北师范大学)	Solving the backward problem for time-fractional wave equations by the quasi-reversibility regularization method	
15:40-16:00	茶歇		
16:00-16:25	张文龙 (南方科技大学)	A data-driven model reduction method for parabolic inverse source problems	孙春龙 (南京航空航天大学)
16:25-16:50	张云 (西安电子科技大学)	Inverse potential problem of a generalized time-fractional super-diffusion equation with a nonlinear source	
16:50-17:15	张植栋 (中山大学-珠海)	Well-posedness of the stochastic time-fractional diffusion and wave equations and inverse random source problems	
17:15-17:40	郑祥成 (山东大学)	Subdiffusion of variable exponent: Analysis, computation and inverse problem	

6月1日下午 分组报告 一楼东 经开厅

M7: 发展方程相关反问题理论与计算

时间	报告人	题目	主持人
14:00-14:25	董和平 (吉林大学)	Uniqueness of an inverse cavity scattering problem for the time-harmonic biharmonic wave equation	王海兵 (东南大学)
14:25-14:50	窦芳芳 (电子科技大学)	A Cauchy problem for stochastic hyperbolic equation	
14:50-15:15	高忆先 (东北师范大学)	Gel'fand's inverse problem on connected weighted graphs	
15:15-15:40	郭玉坤 (哈尔滨工业大学)	A direct imaging scheme for the time-domain inverse scattering problems in acoustics	
15:40-16:00	茶歇		
16:00-16:25	蒋代军 (华中师范大学)	Convergence of semismooth Newton methods for parabolic Robin inverse problem with sparse constraints	张磊 (浙江工业大学)
16:25-16:50	李晓菲 (浙江工业大学)	Finiteness of the stress in presence of closely located inclusions with imperfect bonding	
16:50-17:15			
17:15-17:40			

6月1日下午 分组报告 二楼西 淄川厅

M8: 成像相关不适定问题的理论与算法

时间	报告人	题目	主持人
14:00-14:25	付树军 (山东大学)	基于稀疏低秩和深度先验的图像复原研究	李尤发 (广西大学)
14:25-14:50	曹静杰 (河北地质大学)	基于Cook距离的低秩约束绕射波分离与成像	
14:50-15:15	李尤发 (广西大学)	Single-shot phase retrieval by interference intensity: a holography-driven problem for periodic signals	付树军 (山东大学)
15:15-15:40	安美建 (中国地质科学院)	层析成像结果可靠吗?	
15:40-16:00	茶歇		
16:00-16:25	罗守胜 (浙江师范大学)	A new boundary-based method for convexity characterization using binary function	赵振宇 (山东理工大学)
16:25-16:50	宋义壮 (山东师范大学)	Sparse-view X-ray CT based on a box-constrained nonlinear weighted anisotropic TV regularization	
16:50-17:15	王迎美 (山东理工大学)	基于多尺度特征融合网络的医学DR图像增强算法	

6月1日下午 分组报告 二楼西 第三会议室

M9: 波的传播、散射与反散射的理论及算法

时间	报告人	题目	主持人
14:00-14:25	孙鸿鹏 (中国人民大学)	Sparse reconstructions of acoustic sources by semismooth Newton methods with boundary measurements	杨家青 (西安交通大学)
14:25-14:50	曾芳 (重庆师范大学)	Bayesian approach for the shape reconstruction of inverse cavity scattering problem in elasticity	
14:50-15:15	岳俊宏 (太原理工大学)	Research on the cavity scattering problem for flexural waves in infinite thin plates based on the variational method	曲风龙 (烟台大学)
15:15-15:40	向建立 (三峡大学)	Uniqueness in inverse elastic source/medium problem with a single far field pattern	
15:40-16:00	茶歇		
16:00-16:25	刘春 (南开大学)	Uniqueness to inverse acoustic and elastic medium scattering problems with hyper-singular source	刘可伋 (上海财经大学)
16:25-16:50	马冠球 (南开大学)	Inverse time-dependent source problems for a moving extend source with unknown pulse moment	
16:50-17:15	张佳毅 (南开大学)	Radiation conditions for the Helmholtz equation in an infinitely inhomogeneous periodic medium	

6月1日下午 分组报告 一楼东 溜矿厅

M11: 研究生论坛

时间	报告人	题目	主持人
14:00-14:20	钟雨龙 (南开大学)	共振情形下一类内散射问题的适定性	王泽文 (广州航海学院)
14:20-14:40	朱琳琳 (南开大学)	Stability of grating diffraction problems for plane wave incidence: Explicit dependence on wave numbers and incident angles	
14:40-15:00	张金锐 (浙江大学)	A fast solver for multi-particle elastic scattering in a layered medium	
15:00-15:20	易颖笛 (东南大学)	Target reconstruction based on 3-dimensional acoustic wave inverse scattering	
15:20-15:40	王静 (中科院数学与系统科学研究院)	Hearing the triangles: A numerical perspective	
15:40-16:00	茶歇		
16:00-16:20	李佳磊 (中科院数学与系统科学研究院)	基于多频稀疏数据的电磁波与弹性波多尺度源重构	张德悦 (吉林大学)
16:20-16:40	周嘉鑫 (浙江大学)	Superresolution imaging via subwavelength concentric annular hole resonances	
16:40-17:00	葛美宝 (杭州医学院)	一类原位管癌生长的数学模型及参数识别算法	
17:00-17:20	王天骄 (浙江大学)	Increasing stability for inverse random scattering problems	
17:20-17:40	尹运文 (东南大学)	Active imaging or passive imaging?	
17:40-18:00	田亦濛 (上海财经大学)	ALM-Bayes-PINNS algorithms for solving nonlinear inverse problems	

6月2日下午 分组报告 一楼西 高青厅

M1: 图像计算与反问题

时间	报告人	题目	主持人
14:00-14:25	郭红波 (西北大学)	光学分子断层成像中的逆问题求解方法研究	陈冲 (中科院数学与系统科学院)
14:25-14:50	王媛 (浙江理工大学)	Image Denoising Based on A New Anisotropic Mean Curvature Model	
14:50-15:15	霍利美 (河南科技大学)	Stable Image Reconstruction by TV Type Methods	吴春林 (南开大学)
15:15-15:40	李雨桐 (天津师范大学)	CurvPnP: Plug-and-play blind image restoration with deep curvature denoiser	
15:40-16:00	茶歇		
16:00-16:25	陈仁栋 (曲阜师范大学)	肝癌消融治疗效果实时预测的同质化微扰理论及应用	张建峰 (浙江师范大学)
16:25-16:50	江杰 (华南师范大学)	振荡Fredholm积分方程的自适应深度学习算法	
16:50-17:15	庞彤瑶 (清华大学丘成桐数学中心)	Self-supervised Deep Learning Methods In Imaging	

6月2日下午 分组报告 一楼西 柜台厅

M2: 迭代正则化算法理论及其在全波形反演中的应用

时间	报告人	题目	主持人
14:00-14:25	张晓嫣 (哈尔滨工业大学)	An efficient frozen Levenberg-Marquardt-Kaczmarz method with convex penalty terms for ill-posed problems	付振武 (哈尔滨工业大学)
14:25-14:50	吴法选 (哈尔滨工业大学)	Elastic full-waveform inversion using a weighted Tikhonov-TV regularization	
14:50-15:15	郜广宇 (哈尔滨工业大学)	An accelerated inexact Newton regularization scheme with a learned feature-selection rule for non-linear inverse problems	
15:15-15:40	齐红宇 (哈尔滨工业大学)	A Hybrid Structural Sparsification Error Constraint for Full Waveform Inversion	

15:40-16:00

茶歇

M9: 波的传播、散射与反散射的理论与算法

16:00-16:25	郑光辉 (湖南大学)	Microscale hydrodynamic cloaking and shielding for electro-osmotic model	李建樑 (湖南师范大学)
16:25-16:50	李宏杰 (清华大学)	A time-domain direct sampling approach for inverse acoustic scattering problems	
16:50-17:15	刘海阳 (北京大学)	A Nyström Method for Scattering by a Two-layered Medium with a Rough Boundary	

6月2日下午 分组报告 一楼西 临淄厅

M4: 波动方程的反散射问题

时间	报告人	题目	主持人
14:00-14:25	向建立 (三峡大学)	Uniqueness of inverse source problem in determining a nonconvex polygon with a single far field pattern	赵越 (华中师范大学)
14:25-14:50	徐小绪 (西安交通大学)	Detection of a piecewise linear crack with one incident wave	
14:50-15:15	罗晟 (西安交通大学)	New solvers for the acoustic scattering by 2D layered periodic medium	
15:15-15:40	吴昊 (西安交通大学)	Shape derivative and Newton iterative method for inverse scattering in a layered medium	
15:40-16:00	茶歇		
16:00-16:25	李铭辉 (南开大学)	电磁场中移动点源的轨道反演算法	胡广辉 (南开大学)
16:25-16:50	赵晓萌 (东北师范大学)	Stability estimate for the discrete Calderon problem from partial data	
16:50-17:15	贾玉 (西安交通大学)	Recovering discontinuous viscosity coefficients for inverse Stokes problems by boundary measurements	

6月2日下午 分组报告一楼东 张店厅

M5: 波动方程反问题应用与算法

时间	报告人	题目	主持人
14:00-14:25	邱凌云 (清华大学)	Multipollutant Traceability via Dynamic CGO Solutions	赖俊 (浙江大学)
14:25-14:50	王玉亮 (北京师范大学-香港浸会 大学联合国际学院)	Computational imaging of small-amplitude biperiodic surfaces with double negative material	
14:50-15:15	李文彬 (哈尔滨工业大学(深圳))	Attempts in developing learning methods for inverse problems in imaging	
15:15-15:40	陈鸿初 (浙江大学)	高超声速飞行器气动热反演辨识	
15:40-16:00	茶歇		
16:00-16:25	柳文 (湘潭大学)	电离层探测中的参数反演	杨伟 (湘潭大学)
16:25-16:50	汪奇生 (湘潭大学)	GNSS电离层TEC反演中的码偏差参数独立高效估计	
16:50-17:15	霍星亮 (中科院精密测量科学与 技术创新研究院)	GNSS电离层层析扩展同步代数重构方法研究	

6月2日下午 分组报告 一楼东 经开厅

M6: 扩散中的反问题建模与计算

时间	报告人	题目	主持人
14:00-14:25	宋义壮 (山东师范大学)	Inverse problems in magnetic resonance electrical impedance and properties tomography	孙春龙 (南京航空航天大学)
14:25-14:50	郑光辉 (湖南大学)	A geometric method for Bayesian inference	
14:50-15:15	燕雄斌 (上海交通大学)	ODE-DPS: ODE-based Diffusion Posterior Sampling for Inverse Problems in Partial Differential Equation	
15:40-16:00	茶歇		
16:00-16:25	付军良 (东南大学)	On the recovery of initial status for linearized shallow-water wave equation by data assimilation with error analysis	李志远 (宁波大学)
16:25-16:50	王凤丹 (华北水利水电大学)	An l_p regularization model based on weighted natural frequencies and strain modes for alight damage identification	

6月2日下午 分组报告 二楼西 淄川厅

M7: 发展方程相关反问题理论与计算

时间	报告人	题目	主持人
14:00-14:25	许伯熹 (上海财经大学)	Linearized inverse potential problems at a high frequency	赵璐 (中国民航大学)
14:25-14:50	姚青云 (南京信息工程大学)	Numerical solutions of the forward and inverse boundary value problem for the time-fractional diffusion equation	
14:50-15:15	张惠 (东南大学)	On the data assimilation of initial distribution for 2-dimensional shallow-water equation model	
15:15-15:40	张萌萌 (河北工业大学)	Solving the inverse potential problem in the parabolic equation by the deep neural networks method	
15:40-16:00	茶歇		
16:00-16:25	赵璐 (中国民航大学)	Inverse scattering problem by locally rough surfaces in the time domain	许伯熹 (上海财经大学)
16:25-16:50	赵越 (华中师范大学)	Uniqueness of inverse moving source problems	

6月2日下午 分组报告 一楼西 第二会议室

M10: New advances in data-driven numerical algorithms for inverse problems

时间	报告人	题目	主持人
14:00-14:25	程丽 (丽水学院)	Convergent bivariate subdivision scheme with nonnegative mask whose support is non-convex	Davide Bianchi (中山大学)
14:25-14:50	凌舒扬 (上海纽约大学)	Near-optimal bounds for generalized orthogonal Procrustes problem via generalized power method	
14:50-15:15	赵泽宇 (北京大学)	Stochastic methods for seismic full waveform inversion	
15:15-15:40	张冉 (上海财经大学)	The modifications and applications of Prony method based on the data-driven model	
15:40-16:00	茶歇		
16:00-16:25	刘海霞 (华中科技大学)	Bridging fairness gaps: A (conditional) distance covariance perspective in fairness learning	Florian Bossmann (哈尔滨工业大学)
16:25-16:50	熊傲昇 (兰州大学)	反问题方法在非微扰物理问题中的应用	

6月2日下午 分组报告 二楼西 第三会议室

M11: 研究生论坛

时间	报告人	题目	主持人
14:00-14:20	程智勇 (吉林大学)	Uniqueness and reconstruction method for inverse elastic wave scattering with phaseless data	徐翔 (浙江大学)
14:20-14:40	于沈文 (清华大学丘成桐数学中心)	Traceability of multipollutant in water: An inversion scheme via dynamic complex geometrical optics solutions	
14:40-15:00	常燕 (哈尔滨工业大学)	Analysis and computation of an inverse source problem for the biharmonic wave equation	
15:00-15:20	朱丽艳 (中南大学)	Optimal estimate of electromagnetic field concentration between two nearly-touching inclusions in the quasi-static regime	
15:20-15:40	孔令政 (中南大学)	Mathematical theory of multi-layer structures and its applications	
15:40-16:00	茶歇		
16:00-16:20	武新 (哈尔滨工业大学)	Resonant collision of lumps and breathers in the third-type Davey-Stewartson equation	龚荣芳 (南京航空航天大学)
16:20-16:40	严学威 (哈尔滨工业大学)	Prediction of general high-order lump solutions in the Davey-Stewartson II equation	
16:40-17:00	曹翔 (上海交通大学)	Dual-Domain Deep D-bar Method for Solving Electrical Impedance Tomography	
17:00-17:20	许靖波 (上海交通大学)	Fast diffusion posterior sampling algorithm for CT reconstruction	
17:20-17:40	朱凯 (东南大学)	On the two-point gradient algorithm in Kaczmarz type for Acousto-Electric Tomography	

6月2日下午 分组报告 一楼东 溜矿厅

M11: 研究生论坛

时间	报告人	题目	主持人
14:00-14:20	张柳颖 (武汉大学)	Stochastic mirror descent method for linear ill-posed problems in Banach spaces	吴斌 (南京信息工程大学)
14:20-14:40	吕沛岷 (电子科技大学)	Stability and regularization for ill-posed Cauchy problem of a stochastic parabolic differential equation	
14:40-15:00	胡利 (宁波大学)	Well-posedness of the recovery of multifactor source in fractional diffusion equations by integral type observation	
15:00-15:20	江许岩 (宁波大学)	Unique determination of the initial values of fractional wave equation by lateral Cauchy data	
15:20-15:40	罗玉花 (兰州大学)	Uniqueness and numerical method for determining a spatial source term in a time-fractional diffusion wave equation	
15:40-16:00	茶歇		
16:00-16:20	沈俊 (南京航空航天大学)	Tumor Treating Fields: Modeling and a numerical algorithm	张文 (东华理工大学)
16:20-16:40	陈树立 (东南大学)	Approximation peak time to time-domain fluorescence diffuse optical tomography for finite fluorescence lifetime	
16:40-17:00	王迎奥 (北京理工大学)	On a class of linear regression methods	
17:00-17:20	朱巧 (北京理工大学)	Double-activation neural network for solving parabolic equations with time delay	

报告题目和摘要

大会报告

(报告摘要按照报告顺序排序)

TBD

林芳华 纽约大学柯朗研究所

Abstract:

Inverse problems for time-dependent PDE models

王海兵 东南大学

Abstract: Inverse problems for time-dependent PDE models arise in diverse areas of engineering and applied sciences, such as geophysical exploration, thermal imaging and thermoacoustic tomography. In this talk, we will show our recent results on inverse problems for wave equations and diffusion equations. First, we discuss an inverse source problem for the time-domain wave equation. A novel approach will be presented to reconstruct the space-time dependent source function from the measurement collected at a single point. This approach is based on an asymptotic expansion of the wave field after injecting a small scaled droplet enjoying high contrast into the domain to image. It can be extended to reconstruct not only the source function but also the locally variable wave speed. Second, we consider the reconstruction of defects (such as cavities, inclusions and cracks) inside a diffusion medium from boundary measurements, which is formulated as an inverse boundary value problem for a diffusion equation. Two kinds of sampling methods will be presented to numerically reconstruct the geometric information on the defects. Finally, we discuss inverse problems for diffusion equations with a discontinuous coefficient or initial condition. Conditional stability and numerical algorithms will be shown.

依赖频率的声波反源问题研究

胡广辉 南开大学

摘要: 当声源强度依赖于时间变量时, 时域声波源问题经傅里叶变换可以转化为右端项既依赖频率又依赖空间变量的非齐次Helmholtz方程。与仅依赖于空间变量的反源问题或对频率的依赖性先验可知的反源问题相比, 依赖频率/时间的反源问题在分析和数值重构方面都有本质的困难。报告人将首先介绍频域反源问题和时域反源问题的关联, 然后展示利用多

频数据反演依赖频率的声波源函数和重构移动点源运行轨迹的唯一性、稳定性结果和数值计算方法。

A new method using C0IPG for the transmission eigenvalue problem

季霞 北京理工大学

Abstract: The talk presents a new proof of the C^0 IPG method (C^0 interior penalty Galerkin method) for the transmission eigenvalue problem. Instead of using the proof following the structure of discontinuous Galerkin method, we rewrite the problem as the eigenvalue problem of a holomorphic Fredholm operator function of index zero. The convergence for C^0 IPG is proved using the abstract approximation theory for holomorphic operator functions. We employ the spectral indicator method which is easy in coding to compute the eigenvalues. Numerical examples are presented to validate the theory.

Solving Nonlinear Inverse Problems Using Neural Networks and Conditional Stability

金邦梯 Chinese University of Hong Kong

Abstract: Using neural networks to solve nonlinear inverse problems has become very popular in recent years. However, the reconstruction algorithms often do not have theoretical justifications. Inspired by conditional stability estimates, we shall propose novel reconstruction algorithms for several nonlinear PDE inverse problems, including conductivity imaging and point source identification, and discuss its convergence behaviour.

Inverse Problems of Hyperbolic PDEs: Theory and Numerics

陈曦 复旦大学

Abstract: Imaging and detection problems can be formulated mathematically as inverse medium problems from local measurements. The underlying media (e.g. curved spaces, electromagnetic fields) usually have complex features, such as time-dependence, curvature, singularities, non-compactness, non-commutativity, conjugate points. In physical models, Noether's theorem and the principle of least action converts inverse medium problems to inverse problems of hyperbolic PDEs in complex media.

The Dirichlet-to-Neumann maps and the source-to-solution maps of such equations can be expressed in the form of Fourier Integral Operators. Their microlocal structures help to construct the special solutions to solve inverse problems. One may exploit the features of these solutions to

establish the uniqueness of inversion, estimate the quantitative stabilities of inversion, and develop novel algorithm of numerical solutions.

Boundary integral equation method: from frequency-domain to time-domain

殷涛 中国科学院

Abstract: This talk will present some recent progresses on the fast and high-order boundary integral equation solvers for solving both the frequency-domain and time-domain wave scattering problems. For the frequency-domain problems, some regularization techniques and the associated theoretical analysis of the singular integral operators on closed/open-surfaces are developed to reduce the singular integrals to combinations of weakly-singular integral operators and surface differential operators whose numerical evaluations can be achieved by means of a novel Chebyshev-based rectangular-polar solver. For the time-domain problem, a multi-patches/multiple-scattering frequency-time hybrid solver is proposed for problems of wave scattering by obstacles. The problem is treated on the basis of a partition of the domain boundary into a user-prescribed number of patches and an associated sequence of wave equation multiple-scattering problems which do not suffer from the wave trapping challenges and therefore, allow the use of Fourier transform. Numerical examples will be presented to show the accuracy and efficiency of the proposed solvers.

一些简单线性反问题的不确定性量化理论和快速算法研究

张文龙 南方科技大学

摘要: 在这个报告中, 我们研究了偏微分方程控制的简单反问题的正则化解的不确定性量化, 并在随机噪声逐点测量数据下, 证明了这些解的随机收敛性和最优有限元概率收敛。正则化误差估计和有限元误差估计依赖于噪声大小、正则化参数、网格大小和时间步长等。基于误差估计, 还提出了一种用于确定最优正则化参数的迭代算法。对于抛物方程反源问题, 我们还提出了一种基于数据的模型约简方法。我们找出一类正问题中抛物型方程解的低维结构, 并构造了适当的POD基函数, 以实现显著的降维计算。在抛物型偏微分方程的弱正则性假设下, 证明了POD算法求解抛物型反问题解的收敛性。

M1: 图像计算与反问题

(报告摘要按照报告顺序排序)

Deep Unrolled Reconstructions for CT imaging and Remote Sensing Blind Deblurring

张建平 湘潭大学

Abstract: Proximal gradient-based optimization is a widely used approach for addressing the inverse problem in CT imaging and remote sensing blind deblurring, known for its simplicity in implementation. However, this method often results in significant artifacts during image reconstruction and restoration. A common approach to alleviate these artifacts is the fine-tuning of the regularization parameter, though this can lead to higher computational demands and may not always be effective. In this talk, we introduce a novel unrolled blind deblurring learning framework that employs alternating iterations of shrinkage thresholds. This framework updates blurring kernels and images, with a theoretical foundation in network design, emphasizing the learning of deep geometric prior features to improve image restoration. Furthermore, we introduce a deep geometric incremental learning framework that utilizes the second Nesterov proximal gradient optimization for CT reconstruction. Our comprehensive end-to-end network is capable of effectively learning both high- and low-frequency image features and theoretically ensures the reconstruction of geometric texture details from initial linear reconstructions. We compare the reconstruction performance of the proposed methods with existing state-of-the-art methods to demonstrate their superiority.

Oscillation total generalized variation and its spatially adaptive version for image restoration with structured textures

高益铭 南京航空航天大学

Abstract: Cartoon and texture are the main components of an image, and decomposing them has gained much attention in various image restoration tasks. In this talk, we firstly introduce a new type of regularization functional for images called oscillation total generalized variation (TGV) which can represent structured textures with a specified direction and scale. An infimal convolution type with respect to several directions and scales is then used to model structured oscillatory textures of an image. Later, we will further discuss a spatially adaptive version, which is capable of capturing structured textures with varying orientations and frequencies in localized regions. Some basic analyses are also included here, such as the lower semicontinuity of the new functional and the existence of the solutions to the proposed model. Numerical experiments on image

decomposition, denoising and inpainting demonstrate that the proposed model excels in preserving textures and is competitive against existing variational and learning-based models.

Fourier相位恢复的扩散生成式算法

李季 首都师范大学

摘要: Fourier相位恢复问题解不是唯一确定的, 解经过180度旋转后仍是问题的解。相位恢复问题解的不唯一性使得其数值求解变得困难。传统的迭代算法比如HIO、RAAR算法能成功恢复单通道的灰度图像。因为相位恢复问题解存在等价类解, 传统迭代算法求解多通道图像问题时各通道不能很好地对齐, 使得恢复图像与真解存在较大的误差。为了解决这一问题, 我们提出利用扩散生成模型的先验约束传统迭代算法, 结合传统迭代和扩散生成两方面的优点, 以此解决各通道的对齐问题。基于传统迭代算法的迭代特性, 我们提出了高效的信息融合策略, 使得生成模型的迭代生成与传统迭代算法能很好地结合起来。数值实验验证了基于扩散生成模型的强大先验能很好地解决Fourier相位恢复问题解各通道的对齐问题。

A diffusion equation for improving the robustness of deep learning speckle removal model

李爻 哈尔滨工业大学

Abstract: Speckle removal aims to smooth noise while preserving image boundaries and texture information. In recent years, speckle removal models based on deep learning methods have attracted a lot of attention. However, it was found that these models are less robust to adversarial attacks. The adversarial attack makes the image recovery of deep learning methods significantly less effective when the speckle noise distribution is almost unchanged. In purpose of addressing the above problem, we propose a diffusion equation-based speckle removal model that can improve the robustness of deep learning algorithms in this paper. The model utilizes a deep learning image prior and an image grayscale detection operator together to construct the coefficient function of the diffusion equation. Among them, there is a high possibility that the deep learning image prior is inaccurate or even incorrect, but it will not affect the performance and the properties of the proposed diffusion equation model for noise removal. Moreover, we analyze the robustness of the proposed diffusion equation model in terms of theoretical and numerical properties. Experiments show that our proposed diffusion equation speckle removal model is not affected by adversarial attacks in any way and has stronger robustness.

Registration-Based Image Segmentation Models

张道平 南开大学

Abstract: Image segmentation is to extract meaningful objects from a given image. For degraded images due to occlusions, obscurities or noises, the accuracy of the segmentation result can be severely affected. To alleviate this problem, prior information about the target object is usually introduced. In Chan et al. (J Math Imaging Vis 60(3):401–421, 2018), a topology-preserving registration-based segmentation model was proposed, which is restricted to segment 2D images only. In this talk, we will talk about the registration-based 3D segmentation, convexity-preserving segmentation and interactive segmentation.

医学图像非刚性配准的非光滑正则化模型

聂梓伟 南京大学

摘要: 非刚性配准是医学图像处理与分析领域的经典问题，旨在将两幅给定的图像在空间上进行密集对应。在变分框架下，一般将非刚性配准建模为求解满足某种正则性的位移场的变分极小化问题。已有的文献中绝大多数假定待配准图像之间发生的是微分同胚的形变，从而相应的位移场是光滑的。从力学角度，这是在假设图像中的对象都是弹性体。但是医学图像由于成像噪声、病灶、呼吸作用等的影响，不同的器官与组织之间的形变可能是不连续的，我们认为将它们建模为弹塑性体更为合适。本次报告中，我们将介绍本研究团队基于弹塑性体假设（即允许位移场具有不连续性）在非刚性配准问题上的几个模型和相应的算法，同时给出数值实验结果及分析。

深度学习在脊柱病灶诊断中的应用

洪源 浙江师范大学

摘要: 近年来，深度学习在脊柱病灶诊断中的应用得到了快速发展，特别是在脊柱诊断方面。本报告概述了深度学习在脊柱病灶诊断中的一些研究，涵盖了数据预处理、模型架构、训练方法及评估指标等方面。报告介绍了基于脊柱MRI的脊柱感染的检测和分割，包括用于二维的分割模型和三维的检测模型。此外，还探讨了多模态学习在提高模型性能和泛化能力方面的作用。

基于深度学习的智能骨龄评估方法及应用

惠庆磊 安阳师范学院

摘要: 骨龄评估是医学图像处理领域中的一个分支, 在人体骨骼发育过程中, 骨化速度及骨骺与干骺端闭合时间及其形态的变化呈现一定的规律性, 这种规律用时间表示即为骨龄。当受到内分泌、营养以及环境等因素影响时, 骨龄就会提前或者落后, 因此相较于实际年龄, 骨龄可以更准确地反映青少年生长发育情况。目前临床医生依据既定的骨龄评测标准, 如GP图谱法TW计分法, 通过人工观察骨骼图像来计算骨龄, 阅片评估过程耗时长, 且主观性强, 鲁棒性较差。近年来基于深度学习的骨龄评估方法取得长足发展, 深度学习能够有效提取深度特征, 快速自动化评估骨龄。基于此, 围绕手腕骨X射线影像, 模拟临床医生评估流程, 对骨龄评估展开研究, 研发的骨龄评估系统已部署于多家医院进行科研合作。

光学分子断层成像中的逆问题求解方法研究

郭红波 西北大学

摘要: 光学分子断层成像作为一种新型的分子影像成像模式, 由于特异性、灵敏度高, 设备简单等优势, 在预临床研究中得到了广泛的研究。然而光在生物组织中的高散射特性、生物体表面已知测量数据的有限性、以及生物过程的复杂性, 导致光学分子断层成像是一个不适定性问题, 其重建结果的准确性、稳定性、分辨率仍然面临着巨大的挑战。近些年, 基于L1范数、LP范数 ($0 < P < 1$) 等理论的稀疏正则化的光源重建算法得到了广泛的研究, 显著提高了解的稀疏性, 实现了肿瘤的准确定位。研究在国家自然科学基金等项目支持下, 主要针对光学分子断层成像方法在肿瘤的高分辨率重建以及形态学恢复方面存在的挑战性难题, 结合多模态先验信息, 在稀疏正则化研究基础上融合图流形学习、拉普拉斯矩阵、TV范数等思想, 构建了混合正则化重建框架; 并针对多光源检测问题, 结合盲源分离、可行区域迭代收缩等思想构建了高效鲁棒的多光源重建算法; 针对目前深度学习算法泛化性和可解释性问题, 基于数据驱动和模型驱动, 探索了深度学习重建算法, 希望为光学分子断层成像逆问题研究提供新的思路与解决方案。

Image Denoising Based on A New Anisotropic Mean Curvature Model

王媛 浙江理工大学

Abstract: A number of variational models for image denoising have been proposed in the last few years in order to advance the denoising performance. To improve the denoising quality, it is very significant to describe the local structure of image in the proposed models. To this end, this paper proposes a novel denoising model which combines the gradient operator ∇ with the adaptive

weighted matrix W in the mean curvature regularized term such that the proposed model can describe the local features in image efficiently. Since the proposed model is a high-order nonlinear and nonconvex optimization problem, the augmented Lagrangian method can be applied to solve it. Numerical experiments demonstrate that the proposed model yields good performance compared with other well-known gradient-based models.

Stable Image Reconstruction by TV Type Methods

霍利美 河南科技大学

Abstract: Total variation (TV) regularization is widely applied in the field of imaging problems due to its excellent edges preserving ability. We investigate TV type methods and propose two methods combining TV regularization for image restoration. Our first work focuses on transformed L1 (TL1) regularization which has been shown to have comparable signal recovery capability with L1-L2 regularization and L1/L2 regularization, regardless of whether the measurement matrix satisfies the restricted isometry property (RIP). This motivates us to combine ideas from transformed L1 regularization and total variation (TV) regularization to propose a new regularizer, transformed total variation (TTV), for compressive image reconstruction. An optimal error bound, up to a logarithmic factor, of robust image recovery from compressed measurements via the TTV minimization model is established, and the RIP based condition is improved compared with total variation minimization. Another work we are interested in is the deep image prior (DIP), which does not require training sets and is characterized by an early stop mechanism. In order to improve the sparse expression ability of the model, we combine the DIP with TTV regularization and propose a new DIP-TTV method. In addition, we provide an adaptive weight selection strategy and the corresponding model called DIP-WTTV. The ADMM scheme is employed to solve the proposed DIP-TTV and DIP-WTTV models. Numerical results of image reconstruction demonstrate our theoretical results, and illustrate the efficiency of proposed models among state-of-art methods.

CurvPnP: Plug-and-play blind image restoration with deep curvature denoiser

李雨桐 天津师范大学

Abstract: Due to the development of deep learning-based denoisers, the plug-and-play strategy has achieved great success in image restoration problems. However, existing plug-and-play image restoration methods are designed for non-blind Gaussian denoising, the performance of which visibly deteriorate for unknown noises. To push the limits of plug-and-play image restoration, we propose a novel framework with blind Gaussian prior, which can deal with more complicated image

restoration problems in the real world. More specifically, we build up a new image restoration model by regarding the noise level as a variable, which is implemented by a two-stage blind Gaussian denoiser consisting of a noise estimation subnetwork and a denoising subnetwork, where the noise estimation subnetwork provides the noise level to the denoising subnetwork for blind noise removal. We also introduce the curvature map into the encoder-decoder architecture and the supervised attention module to achieve a highly flexible and effective convolutional neural network. The experimental results on image denoising, deblurring and single-image super-resolution are provided to demonstrate the advantages of our deep curvature denoiser and the resulting plug-and-play blind image restoration method over the state-of-the-art model-based and learning-based methods. Our model is shown to be able to recover the fine image details and tiny structures even when the noise level is unknown for different image restoration tasks.

肝癌消融治疗效果实时预测的同质化微扰理论及应用

陈仁栋 曲阜师范大学

摘要：热消融是一种微创型肿瘤原位治疗技术，临床上已广泛应用于治疗不宜手术切除的实体肿瘤。与开放式手术不同，热消融中，医生并不能够直接观测到手术部位，而是需借助影像引导将消融针经皮穿刺到患者体内目标肿瘤区域，主观性强、手术难度大、复发率高。通过建立数理模型预测消融效果进而拟定合理的治疗计划是当前多学科交叉背景下提高消融精准性的关键步骤。本报告将介绍热消融治疗肝癌的建模流程，以及一种基于同质化微扰理论的消融效果实时预测的方法。

振荡 Fredholm 积分方程的自适应深度学习算法

江杰 华南师范大学

摘要：本研究探讨了深度神经网络（DNNs）在求解第二类振荡Fredholm积分方程数值解中的应用。首先，我们通过设计一种适应于DNNs的振荡积分的数值求积法，在此基础上证明了DNNs近似解的误差受训练损失和求积误差的约束。随后，我们提出了一个自适应多级深度学习模型，以克服传统神经网络优先学习低频部分的问题（谱分量偏差）。通过数值实验，我们证明了自适应多级深度学习模型在提取振荡解的多尺度信息以及克服标准DNNs模型所面临的谱分量偏差问题上非常有效。

Self-supervised Deep Learning Methods In Imaging

庞彤瑶 清华大学丘成桐数学中心

Abstract: Image restoration refers to recovering high-quality images from degraded or limited measurements, which has applications in many fields, such as science and medicine. Recently, deep learning has emerged as a prominent tool for many problems including image restoration. Most of the deep learning methods are supervised which requires large amount of paired training data including truth images. In this talk, I will introduce several self-supervised methods which only use the on-hand measurements for training while still showing comparable performance to supervised learning. These proposed self-supervised methods have great potential for real-world image restoration tasks, where it can be difficult to collect clean images and build high-quality training datasets.

M2: 迭代正则化算法理论及其在全波形反演中的应用

(报告摘要按照报告顺序排序)

光 CT 成像的若干统计反演算法

江渝 上海财经大学

摘要: 光 CT 成像 (DOT) 是一种利用可见光或近红外光的成像方式, 在生物医学领域有广阔应用前景。光 CT 成像作为一种先进的医学成像技术, 依赖于精确反演生体组织内部的光传播特性参数, 如散射系数和吸收系数, 以获取组织结构和功能的重要信息。光 CT 成像反问题即人体组织光学参数图像重构问题, 常用的传统方法如梯度下降法等容易受限于初始猜测, 极易于陷入局部最优。本文针对光 CT 成像反问题, 立足扩散方程模型、引入 Rytov 近似, 构造了最小化目标函数, 并基于若干统计反演算法给出了数值反演方案并进行了数值实验。数值实验结果验证了这些算法在处理光 CT 成像反问题中的有效性和可行性。

$\alpha l_1 - \beta l_2$ sparsity regularization for nonlinear ill-posed problems

丁亮 东北林业大学

Abstract: In this report, the $\alpha \|\cdot\|_{l_1} - \beta \|\cdot\|_{l_2}$ sparsity regularization with parameters $\alpha \geq \beta \geq 0$ is studied for nonlinear ill-posed inverse problems. The well-posedness of the regularization is investigated. Compared to the case where $\alpha > \beta \geq 0$, the results for the case $\alpha = \beta > 0$ are weaker due to the lack of coercivity and Radon-Riesz property of the regularization term. Under certain conditions on the nonlinearity of F, sparsity is shown for every minimizer of the $\alpha \|\cdot\|_{l_1} - \beta \|\cdot\|_{l_2}$ regularized inverse problem. Moreover, for the case $\alpha > \beta \geq 0$, convergence rates $O(\delta^{\frac{1}{2}})$ and $O(\delta)$ are proved for the regularized solution towards a sparse exact solution, under different yet commonly adopted conditions on the nonlinearity of F. The iterative soft thresholding algorithm is shown to be useful to solve the $\alpha \|\cdot\|_{l_1} - \beta \|\cdot\|_{l_2}$ regularized problem for nonlinear ill-posed equations. Numerical results illustrate the efficiency of the proposed method.

3D marine controlled-source electromagnetic inversion by frequency-domain multigrid modeling

杨鹏亮 哈尔滨工业大学

Abstract: Controlled-source electromagnetics (CSEM) has been a well-established technology in geophysical exploration to complement classic seismic techniques for reservoir and mineral exploration, thanks to its good sensitivity to highly saturated hydrocarbons and resistive sediments. CSEM imaging, often coined resistivity tomography, is a powerful tool to decipher the resistivity distributions quantitatively. This leads to a nonlinear optimization problem in which the difference between the observed data and the synthetic EM fields are minimized iteratively. Because each iteration requires 3D forward modelling several times, 3D CSEM inversion is known to be computationally expensive. In this work, we present an efficient frequency-domain multigrid modelling scheme to simulate 3D CSEM fields and invert for resistivity properties. The Maxwell equation is discretized using finite integration method, while the geometrical multigrid (GMG) solver is constructed by recursively solving the same equation at each grid level. We have designed a compact yet efficient GMG code. using the reverse communication strategy. In order to achieve better convergence for 3D CSEM inversion, we incorporated a preconditioner by cascading depth weighting with triangle smoothing in nonlinear optimization procedure. The numerical test confirms the efficiency of GMG solver. A synthetic test has been examined for 3D VTI anisotropic CSEM inversion.

3D frequency-domain elastic wave modeling based on an optimal second-order staggered-grid finite-difference method

王茂胜 哈尔滨工业大学

Abstract: This work proposes an optimal second-order staggered-grid finite-difference method (OSSFD) based on average first-order derivatives to simulate the 3D frequency-domain elastic wave equation. The mass acceleration term in the equation is discretized using the anti-lumped mass technique. To determine the weighting coefficients in the finite-difference equation, we minimize the deviation of the normalized phase velocity from unity within the framework of the classical dispersion relationship. The minimization process uses an optimization algorithm that combines the simulated annealing method (SA) and the Levenberg-Marquardt (LM) method. We compared OSSFD with the classic fourth-order staggered-grid difference scheme (FSFD) and the classic second-order staggered-grid difference scheme (SSFD). The dispersion curves of the OSSFD are more clustered than the other two formats. Quantitative analysis shows that when the upper limit of the phase velocity error is set to 1%, the OSSFD format only requires 3.61 grid points per

minimal wavelength, while the FSFD format requires 5.04 and the SSFD format requires 13.03. This means that OSSFD can be used with a coarser mesh which leads to less computation burden. The numerical experiments compares the computational cost of the three methods. It shows that the OSSFD method requires less memory when the direct method is used to solve the linear system. If using the iterative method, it converges faster than the other two methods when the same accuracy is achieved. By comparing with the analytical solution, OSSFD exhibits its higher accuracy and its capability of handling high-frequency problems.

Iterative Runge-Kutta-Type Methods with Convex Penalty for Inverse Problems in Hilbert Spaces

佟珊珊 陕西师范大学

Abstract: An s-stage Runge-Kutta-type iterative method with the convex penalty for solving nonlinear ill-posed problems is proposed and analyzed in this talk. The approach is developed by using a family of Runge-Kutta-type methods to solve the asymptotical regularization, which can be seen as an ODE with the initial value. The convergence and regularity of the proposed method are obtained under certain conditions. The reconstruction results of the proposed method for some special cases are studied through numerical experiments on both elliptical parameter identification and diffuse optical tomography. The numerical results indicate that the developed methods yield stable approximations to true solutions, especially the implicit schemes have obvious advantages on allowing a wider range of step length, reducing the iterative numbers, and saving computation time.

A mechanism learning based method for image inpainting

陈瑜 上海财经大学

Abstract: This talk is concerned with an inpainting method based on mechanism learning, from the perspective of inverse problems. The underlying data mechanism, characterized by linear differential equations, is identified from data on the known area and then exploited to infer that on the missing part. Attention is paid to incorporation of historical or prior information as higher order mechanism. Numerical examples show effectiveness, robustness and flexibility of the method and it performs well over mechanism/scientific data. This is a joint work with Prof. Jin Cheng.

An accelerated Bouligand-Landweber method based on projection and Nesterov acceleration for nonsmooth ill-posed problems

付振武 哈尔滨工业大学

Abstract: In this paper, we propose an accelerated Bouligand-Landweber method which is based on projection and Nesterov acceleration. This approach incorporates Nesterov acceleration technique into the Bouligand Landweber method whose step sizes are determined by projection. It is designed to solve nonsmooth ill-posed problems and to reduce the computational time. When the data is exact, we show the convergence result of the proposed method. When the data is contaminated by noise, we prove its regularization property by utilizing the concept of asymptotic stability. Moreover, some numerical experiments on nonsmooth inverse problems are performed to demonstrate the efficiency and the acceleration effect of the method.

Hybrid adaptive method based on dictionary learning and rank-reduction for seismic denoising

赵囡 大连海事大学

Abstract: In this report, the $\alpha \|\cdot\|_{l_1} - \beta \|\cdot\|_{l_2}$ sparsity regularization with parameters $\alpha \geq \beta \geq 0$ is studied for nonlinear ill-posed inverse problems. The well-posedness of the regularization is investigated. Compared to the case where $\alpha > \beta \geq 0$, the results for the case $\alpha = \beta > 0$ are weaker due to the lack of coercivity and Radon-Riesz property of the regularization term. Under certain conditions on the nonlinearity of F, sparsity is shown for every minimizer of the $\alpha \|\cdot\|_{l_1} - \beta \|\cdot\|_{l_2}$ regularized inverse problem. Moreover, for the case $\alpha > \beta \geq 0$, convergence rates $O(\delta^{\frac{1}{2}})$ and $O(\delta)$ are proved for the regularized solution towards a sparse exact solution, under different yet commonly adopted conditions on the nonlinearity of F. The iterative soft thresholding algorithm is shown to be useful to solve the $\alpha \|\cdot\|_{l_1} - \beta \|\cdot\|_{l_2}$ regularized problem for nonlinear ill-posed equations. Numerical results illustrate the efficiency of the proposed method.

An efficient frozen Levenberg-Marquardt-Kaczmarz method with convex penalty terms for ill-posed problems

张晓嫣 哈尔滨工业大学

Abstract: In this paper, we present a frozen iteratively regularized approach for solving ill-posed problems and conduct a thorough analysis of its performance. This method involves incorporating Nesterov's acceleration strategy into the Levenberg-Marquardt-Kaczmarz method and maintaining a constant Fréchet derivative of F_i at an initial approximation solution x_0 throughout the iterative process, which called the frozen strategy. Moreover, convex functions are employed as penalty terms to capture the distinctive features of solutions. We establish convergence and regularization analysis by leveraging some classical assumptions and properties of convex functions. These theoretical findings are further supported by a number of numerical studies, which demonstrate the efficacy of our approach. Additionally, to verify the impact of initial values on the accuracy of reconstruction, the data-driven strategy is adopted in the third numerical example for comparison.

Elastic full-waveform inversion using a weighted Tikhonov-TV regularization

吴法选 哈尔滨工业大学

Abstract: Elastic full-waveform inversion (FWI) can construct high-resolution P-wave velocity, S-wave velocity, and density models in complex geological settings. However, elastic full waveform inversion is a nonlinear and ill-posed inverse problem, requiring a regularization method to obtain a reasonable result. In this article, we introduce a weighted Tikhonov-TV regularization strategy, which combines Tikhonov and TV term, for the elastic full waveform inverse problem. The weights imposed on these two terms can be dynamically adjusted by the sigmoid function during the inversion process. To improve the computational efficiency, we use mini-batch technique in both forward and inversion processes. Numerical experiments based on synthetic models are carried out to demonstrate the effectiveness of our methods.

An accelerated inexact Newton regularization scheme with a learned feature-selection rule for non-linear inverse problems

郜广宇 哈尔滨工业大学

Abstract: With computational inverse problems, it is desirable to develop an efficient inversion algorithm to find a solution from measurement data through a mathematical model connecting the unknown solution and measurable quantity based on the first principles. However, most of mathematical models represent only a few aspects of the physical quantity of interest, and some of them are even incomplete in the sense that one measurement corresponds to many solutions

satisfying the forward model. In this paper, in light of the recently developed iNETT method in (Inverse Problems, 39: 055002, 2023), we propose a novel iterative regularization method for efficiently solving non-linear ill-posed inverse problems with potentially non-injective forward mappings and (locally) non-stable inversion mappings. Our approach integrates the inexact Newton iteration, the non-stationary iterated Tikhonov regularization, the two-point gradient acceleration method, and the structure-free feature-selection rule. The main difficulty in the regularization technique is how to design an appropriate regularization penalty, capturing the key feature of the unknown solution. To overcome this difficulty, we replace the traditional regularization penalty with a deep neural network, which is structure-free and can identify the correct solution in a huge null space. A comprehensive convergence analysis of the proposed algorithm is performed under standard assumptions of regularization theory. Numerical experiments with comparisons with other state-of-the-art methods for two model problems are presented to show the efficiency of the proposed approach

A hybrid structural sparsification error constraint for full waveform inversion

齐红宇 哈尔滨工业大学

Abstract: Full-waveform inversion (FWI) represents an advanced geophysical imaging technique focused on intricately depicting subsurface physical properties by iteratively minimizing the differences between the simulated and observed seismograms. Unfortunately, the conventional FWI utilizing a least-squares loss function suffers from various drawbacks, including the challenge of local minima and the necessity for human intervention in parameter fine-tuning. It is particularly problematic when handling noisy data and inadequate initial models. Recent work has exhibited promising performance in two-dimensional FWI by integrating structural sparse representation to procure adaptive dictionaries. Drawing inspiration from the competitiveness of structural sparse representation, we introduce a paradigm of group sparse residuals that integrates two types of complementary prior information by harnessing both the internal and external subsurface media model. The proposed algorithm is based on an alternate minimization algorithm to guarantee workflow flexibility and efficient optimization capabilities. We experimentally validate our method for two baseline geological models, and a comparison of the results demonstrates that the proposed algorithm faithfully recovers the velocity models and consistently outperforms other traditional or learning-based algorithms. A further benefit from the group sparse coding used in this method is that it reduces the sensitivity to data noise.

M3: 反散射问题的理论与数值算法

(报告摘要按照报告顺序排序)

Factorization method for inverse elastic scattering problem with Neumann boundary condition

吕俊良 吉林大学

Abstract: In this talk, I will concern the inverse elastic scattering problem to determine the shape and location of an elastic obstacle from the full far-field data, or the compressional part of far-field data, or the compressional part of far-field data, or the limited aperture data. Properties of the data-to-pattern operator and the normal derivative of the double-layer potential operator are rigorously proved to verify the validity of the factorization method. Numerous numerical experiments are conducted to show the feasibility and effectiveness of the proposed method, and to analyze the impact of factors, such as polarization direction, frequency, wave number, and multi-scale scatterers on the accuracy of the reconstructed results.

Spectral properties of an acoustic-elastic transmission eigenvalue problem with applications

刁怀安 吉林大学

Abstract: In this talk, we are concerned with a coupled-physics spectral problem arising in the coupled propagation of acoustic and elastic waves, which is referred to as the acoustic-elastic transmission eigenvalue problem. There are four major contributions in this work which are new to the literature. First, under a mild condition on the medium parameters, we prove the existence of an acoustic-elastic transmission eigenvalue. Second, we establish a geometric rigidity result of the transmission eigenfunctions by showing that they tend to localize on the boundary of the underlying domain. Moreover, we also consider the vanishing property of the underlying transmission eigenfunctions near a 2D corner or 3D edge corner under generic regularity assumptions on the transmission eigenfunctions. The geometrical characterization of transmission eigenfunctions can be used to established unique results for determining the polygonal scatterer by finite many far field patterns.

Reconstruction of sound sources and obstacles based on neural networks

孟品超 长春理工大学

Abstract: This report explores the mechanism of a new audio life detector that enables the localisation of trapped people and the identification of the shape of buried debris. Based on the

practical situation, the above process can be modelled as a "double inverse" model. The far-field data of different sound sources and obstacles are collected in both finite aperture and full aperture, and a parallel neural network is constructed to solve the problem of decreased computational accuracy caused by the lack of information in the double inverse model. Numerical experiments show the effectiveness of the method and the robustness of the network to noise.

Efficient Synchronous Retrieval of OAM Modes and AT Strength using Multi-Task Neural Network

尹伟石 长春理工大学

Abstract: Orbital Angular Momentum (OAM) beams transmitted in atmospheric channels are subject to random fluctuations in refractive index caused by atmospheric turbulence, resulting in beam phase aberrations and dispersion of light intensity, which can lead to severe signal crosstalk. The high degree of randomness that atmospheric turbulence (AT) has, the orbital angular momentum pattern recognition method must have good stability in order to ensure the communication quality. We establish the equivalence between the continuous dynamical system and the neural network RUEM to ensure the stability of the constructed RUEM network, and propose a multi-task neural network model embedded in the RUEM to achieve efficient and simultaneous recognition of turbulence intensity in atmospheric turbulence environments and orbital angular momentum patterns in free-space optical communication systems.

Error estimates for a mixed finite element method for the Maxwell's transmission eigenvalue problem

王超 深圳北理莫斯科大学

Abstract: In this paper, we analyze a numerical method combining the Ciarlet-Raviart mixed finite element formulation and an iterative algorithm for the Maxwell's transmission eigenvalue problem. The eigenvalue problem is first written as a nonlinear quad-curl eigenvalue problem. Then the real transmission eigenvalues are proved to be the roots of a non-linear function. They are the generalized eigenvalues of a related linear self-adjoint quad-curl eigenvalue problem. These generalized eigenvalues are computed by a mixed finite element method. We derive the error estimates using the spectral approximation of compact operators, the theory of mixed finite element method for quad-curl problems, and the derivatives of eigenvalues.

Uniqueness and numerical scheme for spherical shell-structured sources from the sparse far field patterns

史庆祥 中科院

Abstract: It is well known that the far field patterns at finitely many frequencies are not enough to uniquely determine a general source. To establish uniqueness, we consider the acoustic scattering of spherical shell-structured sources. We show that the spherical shell-structured sources can be identified from the far field patterns with at most two frequencies. Precisely, we show that the number and the centers (i.e., locations) of the spherical shells can be uniquely determined by the far field patterns at a fixed frequency. Furthermore, the scattering strengths, the inner and outer diameters are uniquely determined by the far field patterns at two frequencies. Motivated by the uniqueness arguments, a numerical scheme is proposed for reconstructing the spherical shell structured sources. A migration series method is designed to located the centers. The numerical simulations show that the reconstruction quality is the same as the direct sampling method. Furthermore, an iterative method is designed for computing the inner diameters and outer diameters.

Convergence Analysis of a Global-in-Time Iterative Decoupled Algorithm for Biot's Model

古惠鹏 南方科技大学

Abstract: In this talk, we focus on investigating the convergence behavior of a global-in-time iterative decoupled algorithm based on a three-field formulation. During each iteration, the algorithm involves solving a reaction-diffusion subproblem across the entire temporal domain, followed by resolving a Stokes subproblem over the same time interval. This algorithm is recognized for its “partially parallel-in-time” property, enabling the implementation of a parallel procedure when addressing the Stokes subproblem. We establish its global convergence with a new technique by confirming that the limit of the sequence of numerical solutions of the global-in-time algorithm is the numerical solution of the fully coupled algorithm. Numerical experiments validate the theoretical predictions and underline the efficiency gained by implementing the parallel procedure within the proposed global-in-time algorithm.

Unique determination by a single far-field measurement for an inverse elastic problem

唐瑞祥 吉林大学

Abstract: This paper is concerned with the unique identification of the shape of a scatterer through a single far-field pattern in an inverse elastic medium scattering problem with a generalized transmission boundary condition. The uniqueness issue by a single far-field measurement is a challenging problem in inverse scattering theory, which has a long and colorful history. In this paper,

we demonstrate the well-posedness of the direct problem by the variational approach. We establish the uniqueness results by a single far-field measurement under a generic scenario when dealing with underlying elastic scatterers exhibiting polygonal-nest or polygonal-cell structures. Furthermore, for a polygonal-nest or polygonal-cell structure scatterer associated with density and boundary impedance parameters as piecewise constants, we show that these physical quantities can be uniquely determined simultaneously by a single far-field measurement. The corresponding proof relies heavily on examining the singular behaviour of a coupled PDE system near a corner in a microlocal manner.

A novel Newton method for inverse elastic scattering problems

常燕 哈尔滨工业大学

Abstract: This work concerns an inverse elastic scattering problem of identifying the unknown rigid obstacle embedded in an open space filled with a homogeneous and isotropic elastic medium. A Newton-type iteration method relying on the boundary condition is designed to identify the boundary curve of the obstacle. Based on the Helmholtz decomposition and the Fourier-Bessel expansion, we explicitly derive the approximate scattered field and its derivative on each iterative curve. Rigorous mathematical justifications for the proposed method are provided. Numerical examples are presented to verify the effectiveness of the proposed method.

M4: 波动方程的反散射问题

(报告摘要按照报告顺序排序)

Simultaneously determine elastic impedance and shape by a Newton-type iterative method

孙瑶 中国民航大学

Abstract: This talk focuses on an indirect boundary integral equation method for the inverse elastic impedance and the geometry problem by a Cauchy data pair on the access part of the boundary in a two-dimensional case. A uniqueness result is given for the corresponding problem, and a non-iterative algorithm is proposed to solve the data completion problem using a Cauchy data pair on an accessible part of the solution domain's boundary. Next, we introduce a Newton-type iterative method for reconstructing the missing boundary and the impedance function using the completion data on the unknown boundary, which is governed by a specific type of boundary conditions. This method should not deal with the singularities of the kernels of hypersingular integral from Frechet derivative.

Inverse scattering with phaseless data

张海文 中国科学院数学与系统科学研究院

Abstract: Inverse scattering with phased data (i.e., data with phase information) has been widely studied mathematically and numerically over the past decades due to its significant applications in such diverse scientific areas as radar and sonar detection, remote sensing, geophysics, medical imaging, and nondestructive testing. However, in many practical applications, it is much harder to obtain data with accurate phase information compared with only measuring the modulus or intensity of the data. Therefore, it is often desirable to study inverse scattering problems with phaseless data (i.e., data without phase information). In this talk, we will introduce our recent work on inverse scattering problems with phaseless data.

Numerical schemes for time domain acoustic inverse source problems

陈博 中国民航大学

Abstract: The time domain acoustic inverse source problems of the wave equation have been widely used in many fields, such as radar detection and underwater sonar. Recently, we are concerned with the numerical schemes for time domain acoustic inverse source problems. Basing on the Green's function of the d'Alembert operator, imaging methods such as sampling methods are proposed to reconstruct acoustic sources, including point sources, curve sources and moving point sources.

Direct sampling method to inverse frequency-dependent electromagnetic source problems

孙凤麟 天津师范大学

Abstract: In this talk, we are concerned with a inverse electromagnetic source problems which imaging the support of a frequency-dependent source term from the knowledge of multi-frequency electric or magnetic far-field patterns at sparse observation directions. The source term is given by the Fourier transform of a time-dependent source, and its radiating period in the time domain is known. The time-dependent source is supposed to be stationary in the sense that its compact support does not change over time. Via the extending of direct sampling method about acoustic wave, we show that the smallest strip containing the source support and perpendicular to the observation direction can be recovered from far-field patterns at a fixed observation angle. Further, with multiple but sparse observations directions, the shape of the source support can be determined. Finally, Numerical experiments have demonstrated the effectiveness of the proposed method.

Convexification Numerical Method for a Coefficient Inverse Problem for the Radiative Transport Equation

杨志鹏 兰州大学

Abstract: In this talk, we concern the coefficient inverse problem for the stationary radiative transport equation. Based on Carleman estimate, the globally convergent so-called convexification numerical method is developed and its convergence analysis is provided. For the numerical implementation, an orthonormal basis is used. Extensive numerical studies in the 2-D case are presented. This talk is based on the joint works with M. V. Klibanov, J. Li, L. H. Nguyen, and V. G. Romanov.

Uniqueness, stability and algorithm for an inverse wave-number-dependent source problem

司苏亮 山东理工大学

Abstract: This talk concerns an inverse wavenumber/frequency-dependent source problem for the Helmholtz equation. In two and three dimensions, the unknown source term is supposed to be compactly supported in spatial variables but independent on one spatial variable. The dependence of the source function on wavenumber/frequency is supposed to be unknown. Based on the Fourier Transform and explicit bounds for analytic continuation, Uniqueness proof and increasing stability analysis are carried out in terms of the boundary measurement data of Dirichlet kind.

Conditional well-posedness and data-driven method for identifying the dynamic source in a coupled diffusion system from one single boundary measurement

张萌萌 河北工业大学

Abstract: This work considers the inverse dynamic source problem arising from the time-domain fluorescence diffuse optical tomography (FDOT). We recover the dynamic distributions of fluorophores in biological tissue by the one single boundary measurement in finite time domain. We build the uniqueness theorem of this inverse problem. After that, we introduce a weighted norm and establish the conditional stability of Lipschitz type for the inverse problem by this weighted norm. The numerical inversions are considered under the framework of the deep neural networks (DNNs). We establish the generalization error estimates rigorously derived from Lipschitz conditional stability of inverse problems. Finally, we propose the reconstruction algorithms and give several numerical examples illustrating the performance of the proposed inversion schemes.

Inverse wave-number-dependent source problems for the Helmholtz equation with partial information on radiating period

郭红霞 南开大学

Abstract: In this talk, we address a factorization method for imaging the support of a wave-number-dependent source function from multi-frequency data measured at a finite pair of symmetric receivers in opposite directions. The source function is given by the inverse Fourier transform of a compactly supported time-dependent source whose initial moment or terminal moment for radiating is unknown. Using the multi-frequency far-field data at two opposite observation directions, we provide a computational criterion for characterizing the smallest strip containing the support and perpendicular to the directions. In comparison our previous work (H. Guo and G. Hu, to appear in: SIAM J. Numer. Anal., arXiv: 2305.07459) where the radiation period is completely known, a new parameter is introduced into the design of test functions for imaging the source support and for indicating the unknown initial moment or terminal moment. The data from a finite pair of opposite directions can be used to recover the Θ -convex polygon of the support, if partial information on the radiating period is given. Uniqueness in recovering the convex hull of the support is obtained as a by-product of our analysis using all observation directions. Extensive numerical tests in both two and three dimensions are implemented to show effectiveness and feasibility of the approach. The theoretical framework explored here should be seen as the frequency-domain analysis for acoustic source localization problems in the time domain. This is a joint work with G. Hu and G. Ma.

Uniqueness of inverse source problem in determining a nonconvex polygon with a single far field pattern

向建立 三峡大学

Abstract: We consider a time harmonic inverse source problem with a single far field pattern in two dimensions, where the source term is compactly supported in an a priori given homogeneous background medium. For polygonal source terms, there already exist many uniqueness results to recover the convex source support together with the source function at corner points. For a nonconvex polygon, the key point is to make clear of the possible geometric relationship between two different polygons. Then, based on the corner singularity analysis of solutions to the inhomogeneous Laplace equation with a piecewise continuous source term in a sector, we prove that the nonconvex polygonal source support can be uniquely determined by a single far-field pattern.

Detection of a piecewise linear crack with one incident wave

徐小绪 西安交通大学

Abstract: This talk is concerned with inverse crack scattering problems for time-harmonic acoustic waves. We prove that a piecewise linear crack with the sound-soft boundary condition in two dimensions can be uniquely determined by the far-field datum corresponding to a single incident plane wave or point source. We propose two non-iterative methods for imaging the location and shape of a crack. The first one is a contrast sampling method, while the second one is a variant of the classical factorization method but only with one incoming wave. Newton's iteration method is then employed for getting a more precise reconstruction result. Numerical examples are presented to show the effectiveness of the proposed hybrid method. This talk is based on a joint work with Guanqiu Ma and Guanghui Hu.

New solvers for the acoustic scattering by 2D layered periodic medium

罗晟 西安交通大学

Abstract: In this talk, we consider the problem of scattering by a multi-layered penetrable periodic structure. The structure is assumed to separate the whole space into three parts: the medium above and below the structure is assumed to be homogeneous with different wave numbers, and the medium inside the structure is assumed to be inhomogeneous with the refractive index. We propose some new solvers to solve this scattering problem numerically. These new solvers rely on an equivalent Lippmann-Schwinger-type integral equation, which is established by constructing a quasi-periodic Green's function associated with one straight line. Based on this technique, we

propose two algorithms, namely the direct Fourier transform method and cubature method, to solve this integral equation numerically. Finally, some numerical examples follow to illustrate the validity of these algorithms.

Shape derivative and Newton iterative method for inverse scattering in a layered medium

吴昊 西安交通大学

Abstract: In this talk, we consider the inverse acoustic scattering of time-harmonic point sources by a locally perturbed interface with bounded obstacles embedded in the lower half-space. A Newton-type iterative method is proposed to simultaneously reconstruct the locally rough interface and embedded obstacles by taking partial near-field measurements in the upper half-space. The method relies on a differentiability analysis of the scattering problem with respect to the locally rough interface and the embedded obstacle, which is established by introducing a kind of new shape derivatives and reducing the original model to an equivalent system of integral equations defined in a bounded domain. With a slight modification, the inversion algorithm can be easily generalized to reconstruct local perturbations of a global rough interface. Finally, numerical results are presented to illustrate the effectiveness of the inversion algorithm with the multi-frequency data.

电磁场中移动点源的轨道反演算法

李铭辉 南开大学

摘要: 移动点源轨道的实时监测在诸多领域中具有重要意义, 如导弹追踪、飞行器定位等。本研究提出了一种简洁的轨道反演算法, 仅需在边界上设置四个观测点, 通过收集电磁波的磁矢势数据, 并求解常微分方程和线性方程组, 即可有效地计算出移动点源的轨道。此外, 我们还对算法的稳定性进行了详细分析。经实验验证, 所提出的方法能够准确地反演移动点源的轨道, 为实时监测移动点源提供了一种简单而有效的解决方案。

Stability estimate for the discrete Calderon problem from partial data

赵晓萌 东北师范大学

Abstract: In this paper, we focus on the analysis of discrete versions of the Calderon problem with partial boundary data in dimension $d \geq 3$. In particular, we establish logarithmic stability estimates for the discrete Calderon problem on an arbitrarily small portion of the boundary under suitable a priori bounds. For this end, we will use CGO solutions and derive a new discrete Carleman estimate and a key unique continuation estimate. Unlike the continuous case, we use a

new strategy to prove the key discrete unique continuation estimate by utilizing the new Carleman estimate with boundary observations for a discrete Laplace operator.

Recovering discontinuous viscosity coefficients for inverse Stokes problems by boundary measurements

贾玉 西安交通大学

Abstract: In this talk, we introduce the inverse Stokes problems of determining a discontinuous viscosity coefficient μ in a bounded domain $\Omega \subset R^3$. By analyzing a detailed singularity of Dirichlet Green's functions of the Stokes equations and constructing a specifically coupled Stokes-Brinkman system in a localized domain, we prove a global uniqueness theorem that the discontinuous viscosity coefficient can be determined by a local boundary measurement defined on an arbitrary small open subset of the boundary $\partial\Omega$. This talk is based on the joint works with J. Yang, M. Liu, C. Wu.

M5: 波动方程反问题应用与算法

(报告摘要按照报告顺序排序)

Multipollutant Traceability via Dynamic CGO Solutions

邱凌云 清华大学

Abstract: This work introduces a novel inversion framework using dynamic Complex Geometrical Optics (CGO) solutions for the precise identification of pollution sources in environmental systems. Our research broadens the application of CGO solutions to address the challenges presented by the simultaneous tracking of multiple contaminants, each characterized by distinct diffusion coefficients and interactions. By developing an approach that utilizes the capabilities of CGO solutions and integrates a broad spectrum of environmental dynamics, including diffusion, convection, and inter-pollutant reactions, we lay the groundwork for a comprehensive framework designed to trace the origins of pollutants and accurately reconstruct emission concentrations in the multiple pollutant traceability problem.

Computational imaging of small-amplitude biperiodic surfaces with double negative material

王玉亮 北京师范大学-香港浸会大学联合国际学院

Abstract: We consider the problem of imaging a periodic surface by acoustic waves. A slab of double negative metamaterial is placed above the surface and the scattered field is measured on the top boundary of the slab. The imaged surface is assumed to be a small perturbation of the flat surface so that we can make a transformed field expansion to linearize the problem and obtain a simple reconstruction formula. We show by analysis of the formula and numerical experiments that the resolution of the reconstruction can be greatly enhanced due to the double negative slab.

Attempts in developing learning methods for inverse problems in imaging

李文彬 哈尔滨工业大学 (深圳)

Abstract: We will briefly report out attempts in developing learning methods for inverse problems in imaging. (1) Learning on the correctness class: end-to-end learning approaches are efficient but lack of reliability; learning on the correctness class is helpful to alleviate this problem, and we will discuss it in the domain inverse problems of gravimetry. (2) Two-step neural networks with iterative algorithms: including model-based iterative algorithms into the construction of neural networks, it is helpful to improve the generalization ability of the learning methods. (3) Data-driven

regularization: build a data-driven regularizer for the inversion algorithm through neural networks and learning techniques, where we will briefly mention the iNETT method and the graphLaNet algorithm.

高超声速飞行器气动热反演辨识

陈鸿初 浙江大学

摘要: 准确预测高超声速飞行器表面的气动热载荷是热防护系统设计的先决条件。然而, 由于高超声速飞行器飞行过程中防隔热层表面高温高压高热流的极端条件, 热电偶无法直接安装在防隔热层表面, 需将热电偶内置在防隔热层内部, 然后反演其测温数据来辨识受热表面的热边界条件, 这就形成了导热反问题, 本报告将讨论传统导热反问题求解方法的瓶颈以及如何有效克服该瓶颈, 提高气动热辨识的精度, 为热防护系统的精准设计提供坚实的基础。

电离层探测中的参数反演

柳文 湘潭大学

摘要: 介绍了电离层地基探测手段在电离层科学研究及工程应用中作用, 重点聚焦电离层垂直探测, 介绍了垂直探测及参数反演的基本原理和参数反演的现状, 最后围绕模型细化、多信息源反演、深度学习在反演中应用等方面介绍了团队目前开展的一些工作。

GNSS电离层TEC反演中的码偏差参数独立高效估计

汪奇生 湘潭大学

摘要: 在GNSS电离层总电子含量 (Total electron content, TEC) 层析反演中, 码偏差参数是影响斜路径电离层TEC提取精度的重要误差源, 需要被精确确定。常规的估计方法主要是采用函数拟合或使用已有信息消除, 需要依赖函数模型和全球电离层图 (Global ionosphere maps, GIM), 无法做到直接估计。本文首先采用15年的GIM数据, 对相邻格网点TEC的变化情况和每个格网4个格网点TEC的差异情况进行了分析。结果表明, 格网TEC在经度方向上的变化均值范围约为0.26-1.86TECu, 在纬度方向上的变化均值范围则为0.36-2.76TECu, 大部分相邻格网点TEC的差值都在 ± 2 TECu之内。然后在次基础上, 尝试基于单站观测数据, 通过简化对TEC的处理来直接估计获取逐站的卫星和接收机的码偏差组合值, 然后联合区域或全球的测站来进一步获取卫星和接收机的码偏差值, 实现一种新的码偏差估计方法。来自2014年 (太阳活动高年) 和2020年 (太阳活动低年) 第一个月的两个

数据集被选择进行实验分析，估计的所有测站TEC相对于GIM的RMS大部分都在3TECu之内，它们均值则分别为4和2TECu左右。以CODE提供的差分码偏差（Differential code bias, DCB）产品做参考，估计的GPS和GLONASS卫星DCB在2014年和2020年的RMS分别为0.14、0.42和0.07、0.18ns，具有较好的一致性，验证了方法的有效性。

GNSS电离层层析扩展同步代数重构方法研究

霍星亮 中国科学院精密测量科学与技术创新研究院

摘要：基于全球卫星导航系统（GNSS）观测数据的电离层层析反演技术具有空间大尺度电子密度三维监测能力，在电离层物理研究及相关的卫星导航定位及雷达探测等应用领域受到日益重视。然而，GNSS观测射线视角有限，水平方向观测射线相对缺乏，同时地面监测站布设不均匀且观测稀疏等因素多重影响，层析反演模型中的不适定问题是影响GNSS电离层层析反演精度及其推广应用的重要因素。为了生成高精度的电离层电子密度（IED）重建结果，本文提出了一种扩展的同步代数重建方法（ESART），ESART方法提出引入GNSS射线与层析像素体的交叉截距乘以对应电子密度作为层析迭代组合参数，而不仅仅是传统方法所采用的GNSS射线截距作为迭代参数。新方法通过从GNSS射线的几何贡献和相应像素体电子密度贡献两方面考虑了电离层层析像素体对GNSS TEC的贡献，确保了层析像素体电子密度的实际修正与相应像素对GNSS TEC的贡献相匹配。本文利用电离层测高仪观测获得的电子密度作为参考值，将ESART方法、传统同步代数重建技术（SART）及IRI2016模型反演的电子密度，分别在2019年1月10-11日地磁静止期间以及2015年3月17-19日地磁暴期间的结果进行对比分析与研究，实验结果表明，与SART方法和IRI2016模型（尤其是NmF2）相比，ESART方法反演的电离层电子密度结果更接近电离层测高仪观测数据，验证了ESART方法的有效性。

波散射快速算法及其在反散射中的应用

赖俊 浙江大学

摘要：波的散射与反散射在地质反演，雷达探测，医学成像和材料设计等方面都具有重要应用，如何实现波动方程快速求解是计算数学广泛关注的问题之一。积分方程为求解波的散射与反散射，特别是无界区域的散射问题，提供了有效的计算工具。但在数值实现中，积分方程方法需要克服数值离散奇异积分，稠密线性矩阵求解等困难。本报告中，我们将针对波在复杂介质中的散射与反散射问题，结合积分方程、散射矩阵和快速多极算法（FMM），设计高效的波散射求解算法，并结合多频数据和逆时成像理论，发展多粒子情形下的反散射快速成像算法。

M6: 扩散与反常扩散中的反问题建模与计算

(报告摘要按照报告顺序排序)

Inverse random source problems for some stochastic fractional diffusion equations

冯晓莉 西安电子科技大学

Abstract: In this talk, we consider some inverse random source problems for some fractional diffusion equations driven by a fractional Brownian motion. According to the different variables involved in fractional Brownian motion, we mainly discuss two categories: spatial fractional Brownian motion and temporal fractional Brownian motion. Regarding the direct problems, the well-posedness is established and the regularity of the solution is characterized for the equation. In the context of the inverse problem, the uniqueness and instability are investigated on the determination of the random source. Furthermore, some numerical experiments are also given.

On the recovery of initial status for linearized shallow-water wave equation by data assimilation with error analysis

付军良 东南大学

Abstract: We recover the initial status of an evaluation system governed by linearized shallow-water wave equations in a 2-dimensional bounded domain by data assimilation technique, with the aim of determining the initial wave height from the measurement of wave distribution in an interior domain. Since we specify only one component of the governed system and the observation is only measured in partly interior domain, due to engineering restriction on the measurement process, this problem is ill-posed. Based on the known well-posedness of the forward problem, this inverse problem is reformulated as an optimizing problem with data-fit term and specified background of the wave amplitude as penalty term. We establish the Euler-Lagrange equation for the optimal solution in terms of its adjoint system. The unique solvability of this E-L equation is rigorously proven. Then the optimal approximation error of the regularizing solution to the exact solution is established in terms of the noise level of measurement data and the a-prior background distribution, based on the Lax-Milgram theorem. Finally, we propose an iterative algorithm to realize this data assimilation process, with several numerical examples to validate the efficacy of our proposed method.

Simultaneous uniqueness for multiple parameters identification in a fractional diffusion-wave equation

井晓华 长安大学

Abstract: We consider two kinds of inverse problems on determining multiple parameters simultaneously for one-dimensional time-fractional diffusion-wave equations with derivative order $\alpha \in (0,2)$. Based on the analysis of the poles of Laplace transformed data and a transformation formula, we first prove the uniqueness in identifying multiple parameters, including the order of the derivative in time, a spatially varying potential, initial values, and Robin coefficients simultaneously from boundary measurement data, provided that all the eigenmodes of an initial value do not vanish. Our main results show that the uniqueness of four kinds of parameters holds simultaneously by such observation for the time-fractional diffusion-wave model where unknown orders α vary order $(0,2)$ including 1, restricted to neither $\alpha \in (0,1]$ nor $\alpha \in (1,2)$. Furthermore, for another formulation of the fractional diffusion-wave equation with input source term in place of the initial value, we can also prove the simultaneous uniqueness of multiple parameters including a spatially varying potential and Robin coefficients by means of the uniqueness result in the case of non-zero initial value and Duhamel's principle.

Inverse problems in magnetic resonance electrical impedance and properties tomography

宋义壮 山东师范大学

Abstract: MR-based impedance imaging includes magnetic electrical impedance tomography (MREIT) and magnetic resonance electrical property tomography. MREIT and MREPT play an important role in modern medical imaging. In this talk, I will present some recent theoretical and experimental developments of the above two imaging modalities in our group.

Simultaneous recovery of the potential and order for a sub-diffusion model with unknown initial state and source

孙亮亮 西北师范大学

Abstract: This talk is concerned with a nonlinear inverse problem on simultaneously determining a fractional order and a time potential from an additional integral measurement for a time-fractional diffusion equation where we do not assume a full knowledge of the initial data and the source term since they may be unavailable in some practical situations. We firstly study the well-posedness and some regularities of the solution to the direct problem by the Banach fixed-point theorem. Then a uniqueness of inversion fractional order, and a nice Hölder type conditional stability of inversion potential are achieved based on the analysis of the solution to the direct problem and some

properties of the Mittag-Leffler function. Also, we transfer the inverse problem into a variational problem. The existence and convergence of the minimizer for the variational problem are proved. Finally, we propose a modified Levenberg-Marquardt method to reconstruct numerically the approximations of two unknown parameters.

An l_p regularization model based on weighted natural frequencies and strain modes for slight damage identification

王凤丹 华北水利水电大学

Abstract: In structural health monitoring, identification of slight damage was significant and relatively difficult. During the identification of slight damage, the two shortcomings of l_1 regularization model based on natural frequencies and displacement modes were that displacement modes were insensitive to the slight damage and l_1 regularization couldn't accurately characterize the sparsity of structural damage. This paper proposed a method based on l_p ($0 < p < 1$) regularization model with weighted natural frequencies and strain modes for the purpose of more accurately identifying the multiple slight damage. The model took advantage of the fact that strain modes were more sensitive to the slight damage and the l_p ($0 < p < 1$) regularization could more accurately characterize sparsity of structural damage. Simultaneously, it took into account the intrinsic properties of the natural frequency and strain modes. Thus, the identification accuracy of the slight damage is further improved. Results illustrate that the proposed model can obtain the stronger anti-noise ability than the l_1 sparse regularization optimization model based on natural frequencies and displacement modes. At the same time, it can achieve a more accurate damage identification when the noise level is the same.

A geometric method for Bayesian inference

郑光辉 湖南大学

Abstract: In this talk, I will discuss a new geometric approach to Bayesian inference that entirely avoids Markov chain simulation, by constructing a reflector surface that “reflect” the prior measure onto the posterior measure. The construction of reflector surfaces leads to a nonlinear partial differential equation of Monge–Ampere type, and is numerical computed by a geometric method, which based on the representation of a reflector as an envelope of a family of confocal ellipsoids of revolution. Finally, several numerical examples are served to validate the efficiency and feasibility of this method.

Solving the backward problem for time-fractional wave equations by the quasi-reversibility regularization method

温瑾 西北师范大学

Abstract: This talk is devoted to the backward problem of determining the initial value and initial velocity simultaneously in a time-fractional wave equation, with the aid of extra measurement data at two fixed times. Uniqueness results are obtained by using the analyticity and the asymptotic of the Mittag-Leffler functions provided that the two fixed measurement times are sufficiently close. Since this problem is ill-posed, we propose a quasi-reversibility method whose regularization parameters are given by the a priori parameter choice rule. Finally, several one- and two-dimensional numerical examples are presented to show the accuracy and efficiency of the proposed regularization method. This is a joint work with Prof. Zhi-Yuan Li and Yong-Ping Wang.

ODE-DPS: ODE-based Diffusion Posterior Sampling for Inverse Problems in Partial Differential Equation

燕雄斌 上海交通大学

Abstract: In recent years we have witnessed a growth in mathematics for deep learning, which has been used to solve inverse problems of partial differential equations (PDEs). However, most deep learning-based inversion methods either require paired data or necessitate retraining neural networks for modifications in the conditions of the inverse problem, significantly reducing the efficiency of inversion and limiting its applicability. To overcome this challenge, in this paper, leveraging the score-based generative diffusion model, we introduce a novel unsupervised inversion methodology tailored for solving inverse problems arising from PDEs. Our approach operates within the Bayesian inversion framework, treating the task of solving the posterior distribution as a conditional generation process achieved through solving a reverse-time stochastic differential equation. Furthermore, to enhance the accuracy of inversion results, we propose an ODE-based Diffusion Posterior Sampling inversion algorithm. The algorithm stems from the marginal probability density functions of two distinct forward generation processes that satisfy the same Fokker-Planck equation. Through a series of experiments involving various PDEs, we showcase the efficiency and robustness of our proposed method.

A data-driven model reduction method for parabolic inverse source problems

张文龙 南方科技大学

Abstract: In this talk, we propose a data-driven model reduction method to solve parabolic inverse source problems with uncertain data efficiently. Our method consists of offline and online stages.

In the off-line stage, we explore the low-dimensional structures in the solution space of parabolic partial differential equations (PDEs) in the forward problem with a given class of source functions and construct a small number of proper orthogonal decomposition (POD) basis functions to achieve significant dimension reduction. Equipped with the POD basis functions, we can solve the forward problem extremely fast in the online stage. Under a weak regularity assumption on the solution of the parabolic PDEs, we prove the convergence of the POD algorithm in solving the forward parabolic PDEs.

Inverse potential problem of a generalized time-fractional super-diffusion equation with a nonlinear source

张云 西安电子科技大学

Abstract: This talk is concerned with the inverse potential problem associated with a general (including three special cases: the classical/multi-term/distributed order) time-fractional super-diffusion equation with a nonlinear source. For such nonlinear equation, we investigate it for both the direct and inverse potential problems. For the direct problem, given the potential function, we obtain the well-posedness of the corresponding initial-boundary value problem. For the inverse potential problem, by utilizing additional integral data and using the Arzelà-Ascoli theorem and Grönwall's inequality, we prove the existence and uniqueness of the solution for such nonlinear problem. This talk also demonstrate the ill-posedness of the inverse problem. Furthermore, the theoretical results are validated through the reconstruction of the potential term from Bayesian perspective. The efficacy of the proposed method is demonstrated through several numerical examples.

Well-posedness of the stochastic time-fractional diffusion and wave equations and inverse random source problems

张植栋 中山大学-珠海

Abstract: In this work, we are concerned with the stochastic time-fractional diffusion-wave equations in a Hilbert space. The main objective of this paper is to establish properties of the stochastic weak solutions of the initial-boundary value problem, such as the existence, uniqueness and regularity estimates. Moreover, we apply the obtained theories to an inverse source problem. The uniqueness of this inverse problem under the boundary measurements is proved.

Subdiffusion of variable exponent: Analysis, computation and inverse problem

郑祥成 山东大学

Abstract: We consider the subdiffusion of variable exponent modeling subdiffusion phenomena with varying memory properties. The main difficulty is that this model could not be analytically solved and the variable-exponent Abel kernel may not be positive definite or monotonic. We develop a tool called the generalized identity function to convert this model to more feasible formulations for mathematical and numerical analysis, based on which we prove its well-posedness and regularity. Then the semi-discrete and fully-discrete numerical methods are developed and their error estimates are proved, without any regularity assumption on solutions or requiring specific properties of the variable-exponent Abel kernel. Finally, we investigate an inverse problem of determining the initial value of the exponent.

M7: 发展方程相关反问题理论和计算

(报告摘要按照报告顺序排序)

Uniqueness of an inverse cavity scattering problem for the time-harmonic biharmonic wave equation

董和平 吉林大学

Abstract: This talk addresses an inverse cavity scattering problem associated with the biharmonic wave equation in two dimensions. The objective is to determine the domain or shape of the cavity. The Green's representations are demonstrated for the solution to the boundary value problem, and the one-to-one correspondence is confirmed between the Helmholtz component of biharmonic waves and the resulting far-field patterns. Two mixed reciprocity relations are deduced, linking the scattered field generated by plane waves to the far-field pattern produced by various types of point sources. Furthermore, the symmetry relations are explored for the scattered fields generated by point sources. Finally, we present two uniqueness results for the inverse problem by utilizing both far-field patterns and phaseless near-field data.

Carleman estimates for the regularization of ill-posed Cauchy problems

窦芳芳 电子科技大学

Abstract: In this paper, we investigate an ill-posed Cauchy problem involving a stochastic hyperbolic equation. We first establish a Carleman estimate for this equation. Leveraging this estimate, we are able to derive the conditional stability and convergence rate of the Tikhonov regularization method for the aforementioned ill-posed Cauchy problem. To complement our theoretical analysis, we employ kernel-based learning theory and finite element method to implement the completed Tikhonov regularization method for several numerical examples.

Gel'fand's inverse problem on connected weighted graphs

高忆先 东北师范大学

Abstract: We investigate the discrete Gel'fand inverse boundary spectral problem for the graph Laplacian on a class of finite, connected and weighted graphs. Given the measure on boundary vertices and edge weights on a graph, we aim to reconstruct the interior vertex measure from the Neumann boundary spectral data. We derive the unique continuation theorem for the wave equation and formulate a reconstruction method for the Neumann-to-Dirichlet map using the Neumann boundary spectral data. Subsequently, we present an algorithm for reconstructing the interior vertex

measure based on this map. The algorithm is based on a discrete version of the boundary control method. To illustrate the effectiveness of the algorithm, we apply it numerically to several examples.

A direct imaging scheme for the time-domain inverse scattering problems in acoustics

郭玉坤 哈尔滨工业大学

Abstract: This talk concerns an inverse scattering problem of determining unknown scatterers from time-dependent acoustic measurements. A novel time-domain direct sampling method is developed to efficiently determine inhomogeneous media's locations and shapes. In particular, our approach is easy to implement since only space-time integrations are involved in evaluating the imaging functionals. Theoretical justifications and numerical results will be provided to validate the feasibility of the proposed method.

Convergence of semismooth Newton methods for parabolic Robin inverse problem with sparse constraints

蒋代军 华中师范大学

Abstract: In this talk, we shall study the inverse problems of reconstructing the sparse Robin coefficients in parabolic systems. The combined L^1 - L^2 regularization is applied to transform the ill-posed inverse problems into stable but non-differentiable minimizations. Two primal-dual active set algorithms are proposed to solve these minimizations, and the equivalence of the proposed algorithms to some semismooth Newton type methods are established. Further, the local superlinear convergence of the proposed algorithms shall be rigorously proved for the nonlinear parabolic Robin inverse problem with sparsity for the first time, under the reasonable Small Residual Assumption. Several numerical experiments are provided to demonstrate the accuracy and efficiency of the algorithms.

Finiteness of the stress in presence of closely located inclusions with imperfect bonding

李晓菲 浙江工业大学

Abstract: If two conducting or insulating inclusions are closely located, the gradient of the solution may become arbitrarily large as the distance between inclusions tends to zero, resulting in high concentration of stress in between two inclusions. This happens if the bonding of the inclusions and the matrix is perfect, meaning that the potential and flux are continuous across the interface. In this paper, we consider the case when the bonding is imperfect. We consider the case when there are two circular inclusions of the same radii with the imperfect bonding interfaces and prove that the gradient of the solution is bounded regardless of the distance between inclusions if

the bonding parameter is finite. This result is of particular importance since the imperfect bounding interface condition is an approximation of the membrane structure of biological inclusions such as biological cells. This talk is based on a joint work with Shota Fukushima, Yong-Gwan Ji and Hyeonbae Kang.

Linearized inverse potential problems at a high frequency

许伯熹 上海财经大学

Abstract: We investigate the recovery of the potential function from many boundary measurements at a high frequency for linear or nonlinear equations. By considering such a linearized form, we obtain Hölder type stability which is a big improvement over logarithmic stability in low frequencies. Increasing stability bounds for these coefficients contain a Lipschitz term with a factor growing polynomially in terms of the frequency, a Hölder term, and a logarithmic term that decays with respect to the frequency as a power. Based on the linearized problem, a reconstruction algorithm is proposed aiming at the recovery of sufficiently many Fourier modes of the potential function. By choosing the high frequency appropriately, the numerical evidence sheds light on the influence of the growing frequency and confirms the improved resolution. This is the joint work with Prof. Victor Isakov, Prof. Shuai Lu, Prof. Mikko Salo, and Mr. Sen Zou.

Numerical solutions of the forward and inverse boundary value problem for the time-fractional diffusion equation

姚青云 南京信息工程大学

Abstract: We consider the forward and inverse problems for the time-fractional diffusion equation. Based on the boundary integral equation method, a numerical scheme for solving the forward problem of time-fractional diffusion equation is developed. We express the boundary integral operator as a generalized Abel integral operator in time of $\alpha/2 - 1$ order, whose kernel function is a time-dependent boundary integral. An inverse boundary problem of the time-fractional diffusion equation is to reconstruct the geometric information of the inner cavity of the medium, such as the position, size and shape, from the Cauchy data on the outer boundary. We establish the uniqueness of the inverse problem and formulate it as an ill-posed nonlinear operator equation. Based on Fréchet derivatives, we developed a Newton iterative method with regularization. Using the properties of the diffeomorphism, the Fréchet differentiability of the operator is analyzed. Moreover, the Fréchet derivative can be calculated by Neumann data of the corresponding initial boundary value problem. Finally, the validity of the algorithm is verified numerically.

On the data assimilation of initial distribution for 2-dimensional shallow-water equation model

张惠 东南大学

Abstract: The utilization of data assimilation (DA) techniques is prevalent in marine meteorology for the purpose of estimating the complete state of the system. This is done to address the practical limitations associated with measurement data, which can only be specified at finite number of discrete points within a limited domain. We develop an efficient DA algorithm to reconstruct the initial state of the shallow-water equations (SWE) within a 2-dimensional rectangular domain using sparse spatial measurement data. Our algorithm takes into account both the complete Coriolis force and the ocean bottom topography in the SWE model, resulting in accurate recovery of the initial status. After establishing the uniqueness of the solution to the nonlinear SWE with appropriate boundary conditions, we proceed to establish the conservation laws for the suitably defined energy quantity for this traveling wave system. This generalization of the known conservation laws for the simplified SWE system which ignores the Coriolis force and topography, allows us to reveal the influence of nonconstant sea floor topography on wave propagation. In order to restore the initial state through the minimization of a cost functional using DA techniques, we proceed by deriving the adjoint problem for our iteration process. Additionally, we establish a discrete scheme for the governing equations in the Arakawa C-grid framework, from which we rigorously derive the error associated with energy conservation in discrete form. The numerical implementations are also provided to validate our proposed scheme through the verification of energy conservation and the reconstruction effect of the initial state for various configurations.

Solving the inverse potential problem in the parabolic equation by the deep neural networks method

张萌萌 河北工业大学

Abstract: In this work, we consider an inverse potential problem in the parabolic equation, where the unknown potential is a space-dependent function and the used measurement is the final time data. The unknown potential in this inverse problem is parameterized by deep neural networks (DNNs) for the reconstruction scheme. First, the uniqueness of the inverse problem is proved under some regularities assumption on the input sources. Then we propose a new loss function with regularization terms depending on the derivatives of the residuals for partial differential equations (PDEs) and the measurements. These extra terms effectively induce higher regularity in solutions so that the ill-posedness of the inverse problem can be handled. Moreover, we establish the corresponding generalization error estimates rigorously. Our proofs exploit the conditional stability

of the classical linear inverse source problems, and the mollification on the noisy measurement data which is set to reduce the perturbation errors. Finally, the numerical algorithm and some numerical results are provided.

Inverse scattering problem by locally rough surfaces in the time domain

赵璐 中国民航大学

Abstract: This work concerns an inverse acoustic scattering problem which is to determine the shape of the locally rough surface from time-domain scattered field data. By introducing transparent boundary condition, we reduce the scattering problem defined on an unbounded domain into an initial boundary value problem defined on a bounded domain, and consequently we prove the well-posedness of the original problem by using the Laplace transform and energy estimate method. Based on the symmetric continuation technique, we establish a retarded potential boundary integral equation defined on a bounded curve, which is comprised of the local perturbation and the lower part of a circle, to overcome the difficulties brought by the infinite surface, and then we show the equivalence between the reduced problem and the original problem. For the inverse problem, by using the Jacobi polynomials basis, a convolution quadrature method combined with a nonlinear integral equation method is proposed to reconstruct the local perturbation. Numerical results are presented to demonstrate the effectiveness and robustness of the proposed method.

Uniqueness of inverse moving source problems

赵越 华中师范大学

Abstract: In this talk, we discuss two inverse moving source problems. First, we prove the uniqueness of recovering the orbit of the moving source for the Maxwell equations by boundary measurements in a finite time interval. Second, we prove the uniqueness of recovering the orbit of the moving source for a parabolic equation by the final time measurement in a bounded domain.

M8: 成像相关不适定问题的理论与算法

(报告摘要按照报告顺序排序)

基于稀疏低秩和深度先验的图像复原研究

付树军 山东大学

摘要: 数字图像在成像、传输、存储过程中出现噪声、模糊、像素缺失等退化现象, 图像复原根据观察的退化图像重建出细节丰富的高质量原图像. 图像复原是高度病态的反问题, 合适的正则化先验对复原图像的质量至关重要. 本报告主要研究基于低秩正则化和组稀疏性的图像复原算法, 并结合深度先验提升模型性能. 在图像修复、图像去模糊、图像压缩感知和重建以及快速 MRI 重建等图像复原任务上的实验说明了研究方法的先进性. 最后, 讨论一些相关研究及其应用.

基于 Cook 距离的低秩约束绕射波分离与成像

曹静杰 河北地质大学

摘要: 地震绕射波是地下小尺度地质体的地震响应, 因此研究基于绕射波的成像方法对小尺度地质构造的成像, 发现缝洞型油藏、陷落柱等具有重要作用. 绕射波成像的前提是从记录的全波场信号中分离和提取高精度的绕射波, 然而由于绕射波能量弱, 因此绕射波分离的难度较大. 阻尼多道奇异谱分析算法是一种绕射波分离算法, 该算法首先将 $T-X$ 域的地震数据通过 Fourier 变换映射到 $F-X$ 域, 再 $F-X$ 域对频率成分利用 Hankel 算子排布成 Hankel 矩阵, 之后对复数域的矩阵做奇异值分解, 通过研究秩的特点分离出绕射波和反射波.

阻尼多道奇异谱分析算法进行绕射波分离时, 通过奇异值截断将反射波场和绕射波场映射到两个正交子空间, 该算法依赖人工给定反射波场秩, 不适用于海量地震信号处理. 本文提出了一种基于 Cook 距离的阻尼多道奇异谱分析算法用来分离反射波和绕射波, 在多道奇异谱分析的框架下提出基于 Cook 距离自动确定奇异值的个数, 实现计算机精确、自动地求解反射波场的秩, 从而实现了绕射波的自动分离. 模拟和实际数值实验表明, 所提出的算法可以有效地分离反射波场和绕射波场, 成像结果表明了分离的可靠性.

Single-shot phase retrieval by interference intensity: a holography-driven problem for periodic signals

李尤发 广西大学

Abstract: The phase-shifting digital holography (PSDH) is a typical problem in holography. It is traditionally conducted by the measurements from multiple shots. The four- and three-shot approaches to PSDH are commonly utilized for the imaging of static objects. Unlike this, the imaging of dynamic objects requires that PSDH should be conducted by single-shot measurements. Motivated by this, we are interested in the single-shot PSDH for periodic signals. In this talk, I will introduce our recent results on the single-shot phase retrieval for periodic signals. They include the uniqueness and stability. It should be emphasized that the stability is independent of the signal length, which is different from ptychography. This is a joint work with Wei Xiamei and Fan Shengli.

层析成像结果可靠吗？

安美建 中国地质科学院

摘要：在固体地球层析成像中，激发源不可控和观测位置明显受限导致了该问题为明显不适定。由于结果可靠性存疑，人们公布结果的同时也需要对结果可靠性进行评估。但即便使用同样数据，也可能得到明显不同的结果。为此，可靠性评估曾被认为地球科学层析成像所面临的巨大挑战。医学成像不存在这些局限性，无需提供其可靠性评估，但基于医学成像结果所给出的错误诊断司空见惯。显然，可靠性未知的现状降低了层析成像的可信性。反之，有效的可靠性评估方法将有利于提升层析成像工作的权威性，使其更有效地为人们服务。本报告将介绍现有可靠性评估技术及其存在的明显不足之处，以及就如何实现完善的可靠性评估给出建议。

层析成像结果评估方法大致有两类，第一类是对给定理论模型进行恢复的测试。该测试可以很好的评估给定模型的可恢复性，但不能确定给定的模型是否真实。另一类计算从真实模型到解映射的矩阵（也称为分辨率矩阵）。显然，从真实模型到解映射的方程是明显欠定的，那么映射矩阵将有无穷个解；其次，映射方程中的真实模型可能是永远也不会知道的，那么这个方程是无法解的。对于线性反问题来说，人们可以利用观测与模型间线性关系获得精确的混合分辨率矩阵，用其可以对模型进行精确可靠的评估。但已有测试对比发现，该分辨率矩阵可能夸大了模型的可靠性。

如何得到从真实模型到解的映射矩阵呢？既然直接利用原有线性公式计算的混合分辨率矩阵不完善，那么怎样得到更完善的矩阵呢？但人们忽略的一个问题是，这个映射过程

代表的是从获取数据到获得结果的整个分析过程，而并非与真实模型间并不具有必然关系。如果这样的话，基于任意模型获得的观测，只要经历了这个映射过程所得到的解，就可以满足该方程。这样，我们就可以直接从真实模型到解的映射方程中直接计算映射算子。这是一个新的分辨率矩阵。它可以包含整个研究过程的所有因素，称之为完全分辨率矩阵。它能更精确地评估解的可靠性。用其做参照我们会发现，原有利用观测与模型的线性关系所得到的混合分辨率矩阵忽略了研究中一些难以定量的因素，那么会夸大模型的可靠性。以上描述以线性反问题方程为基础，但这些内容也可推广到非线性反问题应用中。在非线性问题中，只要能够得到真实解或接近真实解的解，真实模型与解的空间要复杂一些，但仍可用真实模型与解的线性映射来描述这个研究过程，那么就可以用上述分辨率矩阵来评估解的可靠性。实际测试也说明了这一点。

A new boundary-based method for convexity characterization using binary function

罗守胜 浙江师范大学

Abstract: In real images, the integrities of objects are destroyed by occlusion, illumination bias and noise. Convexity of shapes is one of very important cues for human vision system. Therefore, it is important to incorporate the convexity of shapes for image processing (e.g. segmentation). The characterization of convexity plays a very important role in real implementation. Roughly speaking, level set function (resp. binary function) is used to represent concerned objects for the boundary-based (resp. region-based) methods. In this talk, I will summary some characterization methods first, and then present a new binary-based method for convex object characterization using binary function rather than level set function after reviewing the existing characterizations. Applications for image segmentation are demonstrated.

Sparse-view X-ray CT based on a box-constrained nonlinear weighted anisotropic TV regularization

宋义壮 山东师范大学

Abstract: Sparse-view computed tomography (CT) is an important way to reduce the negative effect of radiation exposure in medical imaging by skipping some X-ray projections. However, due to violating the Nyquist/Shannon sampling criterion, there are severe streaking artifacts in the reconstructed CT images that could mislead diagnosis. Noting the ill-posedness nature of the corresponding inverse problem in a sparse-view CT, minimizing an energy functional composed by an image fidelity term together with properly chosen regularization terms is widely used to reconstruct a medical meaningful attenuation image. In this paper, we propose a regularization,

called the box-constrained nonlinear weighted anisotropic total variation (box-constrained NWATV), and minimize the regularization term accompanying the least square fitting using an alternative direction method of multipliers (ADMM) type method. The proposed method is validated through the Shepp-Logan phantom model, alongside the actual walnut X-ray projections provided by Finnish Inverse Problems Society and the human lung images. The experimental results show that the reconstruction speed of the proposed method is significantly accelerated compared to the existing L_1/L_2 regularization method. Precisely, the central processing unit (CPU) time is reduced more than 8 times.

基于多尺度特征融合网络的医学 DR 图像增强算法

王迎美 山东理工大学

摘要：医学数字化摄影（DR）图像增强广泛应用于临床，在肺、骨和腹部的检查中起着重要的作用。近年来，在计算机层析成像（CT）和光学相干层析成像（OCT）领域中，出现了许多基于深度学习的图像处理方法。然而，由于获取真实的 DR 原始数据的特殊性和困难性，基于深度学习的 DR 图像增强方法相对较少。针对解决 DR 图像中的噪声、边缘模糊、低对比度等问题，本报告提出了两种基于多尺度特征融合的金字塔图像增强（SMFA-Pyramid）网络。最后通过对人体不同部位的真实数据的实验，验证了该算法的有效性和泛化性。结果表明，该算法在深度特征提取、对比度增强、结构细节保存和噪声抑制方面具有较好的性能，具有一定的临床应用价值。

M9: 波的传播、散射与反散射的理论及算法

(报告摘要按照报告顺序排序)

Sparse reconstructions of acoustic sources by semismooth Newton methods with boundary measurements

孙鸿鹏 中国人民大学

Abstract: We developed two types of semismooth Newton methods for reconstructing the acoustic source with boundary measurements. Due to the nonuniqueness of inverse scattering for reconstructing the acoustic sources in the frequency domain, the Radon measure is employed for regularization and sparsity. We also compared with Chambolle and Pock's first-order primal-dual method to show the efficiency of the proposed semismooth Newton methods for two-dimensional cases.

Bayesian approach for the shape reconstruction of inverse cavity scattering problem in elasticity

曾芳 重庆师范大学

Abstract: In this talk, we consider the inverse scattering problem of an impenetrable cavity with Neumann boundary condition. We show that the shape of the cavity can be uniquely determined by the scattered fields measured on some curve in the interior of the cavity. And then Bayesian method is used to reconstruct the shape of the cavity from scattered fields incited by point sources and measured on a closed curve inside the cavity. We discuss the well-posedness of the posterior distribution in the sense of the Hellinger metric and use the preconditioned Crank-Nicolson(pCN) sampling technique to generate the posterior samples. Numerical experiments are provided to demonstrate the effectiveness of the proposed approach.

Research on the cavity scattering problem for flexural waves in infinite thin plates based on the variational method

岳俊宏 太原理工大学

Abstract: Flexural wave scattering plays a crucial role in optimizing and designing structures for various engineering applications. Mathematically, the flexural wave scattering problem on an infinite thin plate is described by a fourth-order biharmonic wave equation on an unbounded domain, making it challenging to solve directly using the regular linear finite element method (FEM). In this talk, we will present some theoretical and numerical results on the diffraction or scattering of flexural waves by an arbitrarily shaped cavity with Navier or clamped boundary conditions. First,

we decompose the fourth-order plate wave equation into the Helmholtz and modified Helmholtz equations. Then, a TBC is used to truncate the unbounded domain into a bounded one. Finally, some finite element methods based on linear triangular elements have been proposed to solve the problems.

Uniqueness in inverse elastic source/medium problem with a single far field pattern

向建立 三峡大学

Abstract: We consider an inverse source/medium scattering problem for recovering the shape of a convex polygon by a single far field pattern in two dimensions. In comparison with the acoustic scattering, the Navier equation in elastic waves cannot be decomposed into a product of two commutative matrices, bringing essential difficulties in proving uniqueness with one plane wave. Our result relies on the absence of analytical continuation of the wave-field in corner domains and also produces some by-products for treating the transmission eigenvalues and eigenfunctions around a corner.

Uniqueness to inverse acoustic and elastic medium scattering problems with hyper-singular source

刘春 南开大学

Abstract: This talk is concerned with inverse scattering problems of determining the support of an isotropic and homogeneous penetrable body from knowledge of multi-static far-field patterns in acoustics and in linear elasticity. The normal derivative of the total fields admits no jump on the interface of the scatterer in the trace sense. If the contrast function of the refractive index function or the density function has a positive lower bound near the boundary, we propose a hyper-singular source method to prove uniqueness of inverse scattering with all incoming plane waves at a fixed energy. It is based on subtle analysis on the leading part of the scattered field when hyper-singular sources caused by the first derivative of the fundamental solution approach to a boundary point. As a by-product, we show that this hyper-singular method can be also used to determine the boundary value of a Hölder continuous refractive index function in acoustics or a Hölder continuous density function in linear elasticity.

Inverse time-dependent source problems for a moving extend source with unknown pulse moment

马冠球 南开大学

Abstract: In this talk, we introduce a factorization method for imaging the support of a time-dependent source and the pulse moment from multi-frequency data measured at sparse directions. Using the multi-frequency far-field data at two opposite observation directions, we provide a computational criterion for indicating the unknown pulse moment. The support of the time-dependent source function can be characterized by the idea in the author's previous work (H. Guo and G. Hu, to appear in: SIAM J. Numer. Anal., arXiv: 2305.07459). The far-field data measured at sparse observation directions can be used to recover the Θ -convex domain of the support. Uniqueness in recovering the convex hull of the support is obtained as a by-product of our analysis using all observation directions. Extensive numerical tests in both two and three dimensions are implemented to show effectiveness and feasibility of the approach.

Radiation conditions for the Helmholtz equation in an infinitely inhomogeneous periodic medium

张佳毅 南开大学

Abstract: In this talk, we propose a new radiation condition for inhomogeneous medium which is periodic in vertical direction. The classical Rayleigh expansion radiation condition is not applicable in our case. We apply the Floquet theory to obtain the wave modes and define the radiation condition. Then we prove the mapping properties of the Dirichlet-to-Neumann map based on the new radiation condition and verify the strongly ellipticity of the sesquilinear form in the variational formulation.

Microscale hydrodynamic cloaking and shielding for electro-osmotic model

郑光辉 湖南大学

Abstract: In this talk, we discuss the recent progress on microscale hydrodynamic cloaking and shielding for electro-osmotic model, which contain single-field cloaking and shielding, enhanced near-cloaking and multi-field cloaking. Based on asymptotic analysis, layer potential techniques and optimal control theory, the core-shell structure contains annulus, confocal ellipses, slightly deformed annulus or confocal ellipses and more general geometry are considered. Especially, the conditions that can ensure the occurrence of above microscale hydrodynamic cloaking and shielding are established. Our theoretical findings are validated and supplemented by a variety of numerical results.

A time-domain direct sampling approach for inverse acoustic scattering problems

李宏杰 清华大学

Abstract: This report is concerned with an inverse scattering problem of determining unknown scatterers from time-dependent acoustic measurements. A novel time-domain direct sampling method is developed to efficiently determine both the locations and shapes of inhomogeneous media. In particular, the approach is very easy to implement since only cheap space-time integrations are involved in the evaluation of the imaging functionals. Based on the Fourier-Laplace transform, we establish an inherent connection between the time-domain and frequency-domain for the direct sampling method. Moreover, rigorous theoretical justifications and numerical experiments are provided to verify the validity and feasibility of the proposed method.

A Nyström Method for Scattering by a Two-layered Medium with a Rough Boundary

刘海阳 北京大学

Abstract: In this talk, we consider the problems of scattering of time-harmonic acoustic waves by a two-layered medium with a non-locally perturbed boundary in two dimensions, where a Dirichlet or impedance boundary condition is imposed on the boundary. The two-layered medium is composed of two unbounded media with different physical properties and the interface between the two media is considered to be a planar surface. We formulate the considered scattering problems as the boundary value problems and prove that each boundary value problem has a unique solution by utilizing the integral equation method associated with the two-layered Green function. Moreover, we develop the Nyström method for numerically solving the considered boundary value problems, based on the proposed integral equation formulations. We establish the convergence results of the Nyström method with the convergence rates depending on the smoothness of the rough boundary. It is worth noting that in establishing the well-posedness of the boundary value problems as well as the convergence results of the Nyström method, an essential role is played by the investigation of the asymptotic properties of the two-layered Green function for small and large arguments. Finally, numerical experiments are carried out to show the effectiveness of the Nyström method.

M10: New advances in data-driven numerical algorithms for inverse problems

(报告摘要按照报告顺序排序)

Convergent bivariate subdivision scheme with nonnegative mask

whose support is non-convex

程丽 丽水学院

Abstract: Bivariate subdivision schemes offer efficient ways of displaying curves and surfaces as well as methods to design particular shapes, to determine intersections of surfaces, to obtain level curves and surfaces. Additionally, they play also an important role in computer aided geometric design and the animation industry. We have characterized the convergence of bivariate subdivision scheme with nonnegative mask whose support is convex by means of the so-called connectivity of a square matrix, which is derived by a given mask. The convergence in this case can be checked in linear time with respect to the size of a square matrix. This talk will focus on the characterization of such schemes with non-convex supports.

Near-optimal bounds for generalized orthogonal Procrustes problem

via generalized power method

凌舒扬 上海纽约大学

Abstract: Given multiple point clouds, how to find the rigid transform (rotation, reflection, and shifting) such that these point clouds are well aligned? This problem, known as the generalized orthogonal Procrustes problem (GOPP), has found numerous applications in statistics, computer vision, and imaging science. While one commonly-used method is finding the least squares estimator, it is generally an NP-hard problem to obtain the least squares estimator exactly due to the notorious nonconvexity. In this work, we apply the semidefinite programming (SDP) relaxation and the generalized power method to solve this generalized orthogonal Procrustes problem. In particular, we assume the data are generated from a signal-plus-noise model: each observed point cloud is a noisy copy of the same unknown point cloud transformed by an unknown orthogonal matrix and also corrupted by additive Gaussian noise. We show that the generalized power method (equivalently alternating minimization algorithm) with spectral initialization converges to the unique global optimum to the SDP relaxation, provided that the signal-to-noise ratio is high. Moreover, this limiting point is exactly the least squares estimator and also the maximum likelihood estimator. In addition, we derive a block-wise estimation error for each orthogonal matrix and the underlying point cloud. Our theoretical bound is near-optimal in terms of the information-theoretic

limit (only loose by a factor of the dimension and a log factor). Our results significantly improve the state-of-the-art results on the tightness of the SDP relaxation for the generalized orthogonal Procrustes problem, an open problem posed by Bandeira, Khoo, and Singer in 2014.

Stochastic methods for seismic full waveform inversion

赵泽宇 北京大学

Abstract: Seismic full waveform inversion (FWI) was proposed to infer subsurface geological conditions using seismic data acquired at the surface or in a borehole. By comparing both kinematic and dynamic waveform information between observed and synthetic seismic data, FWI is able to retrieve accurate subsurface models with high-resolution. FWI is a PDEs governed highly non-linear inverse problem, which introduces ill-posedness and uncertainties. State of art FWI implementations often employ deterministic local optimization methods to solve the inverse problem, which can be problematic due to the inherent ill-posed nature of the non-linear inverse problem. We approach FWI from a stochastic point of view, at the same time incorporate ingredients from deterministic optimization methods. We propose to include the derivatives of the misfit function in the stochastic global optimization framework, we also introduce gradient based Markov chain Monte Carlo(GMCMC) method from a Bayesian inference point of view. Additionally, we investigate the FWI implementation using machine learning method where the optimization of the neural network is performed using stochastic gradients and random perturbations. We show that the new methods are much more robust than the traditional implementations, they all greatly relax the dependence of FWI on good starting models and low frequency components in observed data. In field data tests, we show that the methods can obtain good approximation to the true subsurface model using homogenous starting model and little prior information. The GMCMC method can be implemented to estimate the posterior distribution to quantify the uncertainties associated with the inverse problem.

The modifications and applications of Prony method based on the data-driven model

张冉 上海财经大学

Abstract: This talk focuses on the modifications, generalizations and applications of Prony method based on the data-driven model. In the first part, we consider a modification of Pronys method and give its interpretation as a maximum likelihood method. With the help of an explicitly derived Jacobian matrix, we review the Levenberg-Marquardt algorithm and a new iterated gradient method (IGRA). We compare this approach with the iterative quadratic maximum likelihood (IQML). We propose two further iteration schemes based on simultaneous minimization (SIMI) approach. In the

second part, a data-driven model based on a generalized Prony's method is introduced to simulate a physical problem. As a result, the nonuniform oscillations of the motion of a falling sphere in the non-Newtonian fluid is described by a jerk equation. This differential/algebraic equation is established by learning the experimental data of time vs velocity with Multiquadric (MQ) quasi-interpolation scheme, the generalized Prony method, and the regularization and variable selection method.

Bridging fairness gaps: A (conditional) distance covariance perspective in fairness learning

刘海霞 华中科技大学

Abstract: We bridge fairness gaps from a statistical perspective by selectively utilizing either conditional distance covariance or distance covariance statistics as measures to assess the independence between predictions and sensitive attributes. We enhance fairness by incorporating sample (conditional) distance covariance as a manageable penalty term into the machine learning process. Additionally, we optimize this constrained problem using the Lagrangian dual method, offering a better trade-off between accuracy and fairness. Theoretically, we provide a proof for the convergence between empirical and population (conditional) distance covariance, establishing necessary guarantees for batch computations. Through experiments conducted on a range of real-world datasets, we have demonstrated that our method effectively bridges the fairness gap in machine learning.

反问题方法在非微扰物理问题中的应用

熊傲昇 兰州大学

摘要: 非微扰问题是物理学中一个重要难题。我们最近原创性地提出一种计算非微扰物理量的新方法：反问题方法。它从量子场论的色散关系出发，通过高能区的微扰计算反解低能非微扰物理量，基于严谨的数学理论和逻辑，不引入任何人为假设，是一种精度可以系统性提高的理论方法。我们近期把它应用到求解粒子的衰变常数上，计算结果很好，而且展示了该方法能计算激发态的比较优势，具有很好的应用前景。

淄博文旅简介

1、关于淄博

淄博市，简称“淄”，齐国故都，山东省辖地级市，Ⅱ型大城市，国务院批复确定的山东区域性中心城市、现代工业城市，重要的石油化工基地。淄博地处中国华东地区、山东省中部，南接临沂，北接东营、滨州，东接潍坊，西接济南，位于黄河三角洲高效生态经济区、山东半岛蓝色经济区两大国家战略经济区与济南都市圈交汇处，是山东半岛城市群核心城市之一。截至2023年，全市下辖5个区，3个县和3个功能区，总面积5965平方千米，建成区面积341.9平方千米。2022年末，淄博市常住人口470.59万人。

淄博市的临淄区是国家历史文化名城，历史悠久，淄博的临淄是古代齐国的首都，为齐文化的发祥地、世界足球起源地，有“东方古罗马”之称，“淄博烧烤”已经成为淄博的新名片，烧烤节于每年五一前后举办。淄博这个地名形成于20世纪20年代初期，原为淄川、博山两地的合称。淄博是全国文明城市之一。淄博是山水结合的组团式城市（组群式城市），有博山国家级风景名胜区；也是资源型城市和全国老工业基地，全国首批产业转型升级示范区，设有山东省区域性股权交易市场（齐鲁股权交易中心）。淄博高新技术产业开发区，属山东半岛国家自主创新示范区；淄博市张店区为国家大众创业万众创新示范基地。

2、淄博旅游

淄博陶瓷博物馆：

位于淄博市中心文化广场。主体建筑面积5万平方米，展览面积2万平方米，是一座科技类陶瓷业专题博物馆，隶属于淄博市经济贸易委员会。

2011年，淄博市陶瓷博物馆经国家批准向全社会开放，馆地分上五层，地下一层，馆内设25个展厅，分为《陶瓷展陈》《琉璃展陈》和《陶琉文化体验互动》、《文创产品销售》四部分等基本陈列。淄博市陶瓷博物馆展示了新石器时代早期后李文化至明、清、民国等各朝代陶瓷文物；西周至元、明、清、民国等各朝代琉璃文物；当代淄博、景德镇、宜兴、唐山、龙泉、德化、佛山等大师级陶瓷艺术精品和北京、上海、台湾、衡水等大师级琉璃艺术精品和美国、英国、加拿大、韩国、日本等20多个国家和地区的现代陶瓷、琉璃艺术品。

2018年，淄博市陶瓷博物馆跨入国家三级博物馆行列。是全国科普教育基地、国家4A级旅游景点。

周村古商城：

位于山东省淄博市周村区新建中路1号。周村古商城于2004年开放为景区，占地总面积0.61平方千米。

周村古商城其历史最早可以追溯至明永乐八年（1410年）兴建的古商业街。周村古商城历经数百年风雨仍保留完好，素有“旱码头”“金周村”“丝绸之乡”“天下第一村”的美誉，被中国古建筑保护委员会的专家誉为“中国活着的古商业建筑博物馆群”。周村古商城内分布着千佛寺庙群、三益堂印刷展馆、谦祥益、瑞蚨祥、历史文化展览馆、丝绸文化体验馆、英美烟草公司展览馆、状元府、票证博物馆、票号展览馆、杨家大院、大染坊、魁星阁庙群、淄博艺术博物馆等10多处具有较强的知识性和趣味性的景点。

周村古商城现为省级重点文物保护单位，国家AAAA级旅游景区。

齐文化博物馆：

位于山东省淄博市临淄区临淄大道308号，是一座集文物收藏、展陈、保护、研究、教育、休闲功能于一体的综合性博物馆，由原齐国故城遗址博物馆（齐国历史博物馆）迁建，于2016年9月12日开馆。

齐文化博物馆建筑面积3.5万平方米，展厅分为四个部分，分别是基本陈列展厅、特色陈列展厅、专题陈列展厅和临时展厅。拥有文物3万余件，上展文物4100余件（套）。

2018年9月25日，齐文化博物馆被公布为中国国家二级博物馆。2020年12月，被评定为第四批国家一级博物馆。

潭溪山旅游风景区：

国家AAAA级旅游区，国家森林公园，省级地质公园，国家水利风景区，山东省重点风景名胜区。潭溪山位于山东省中部，泰沂山脉交汇之地，青州市与淄博市两市交汇处，隶属于淄博市。可游览面积9平方公里，有自然景观100余处，最高峰海拔867米，是一处集风景揽胜、休闲度假、餐饮娱乐、拓展训练为一体的综合性旅游度假区。潭溪山不仅山色秀美，还具有深厚的历史文化资源。据史载，明昭阳太子曾在此避难读书，昭阳洞由此得名。唐赛儿曾在此屯兵起义，并留有点将台、三教祠、古碑、古庙等历史遗迹。

