可积系统学术研讨会

时间：2025 年 11 月 28 日

地点：复旦大学邯郸校区光华楼东主楼 1601

组织者：范恩贵、张仑、杨依灵、王兆钰、徐太阳

时间	报告题目	报告人	主持人
8:30-9:00	Application of tetragonal curves to semi-discrete Boussinesq equations	耿献国	张仑
9:00-9:30	The symmetric group and Frobenius manifolds	左达峰	
9:30-10:00	Dispersive revival and fractalization for dispersive evolution equations	康静	
10:00-10:20	茶歇		
10:20-10:50	A data-driven integrable BFGS algorithm (IBA-PDE) for discovering PDEs	李彪	田守富
10:50-11:20	Dark soliton gas of the defocusing NLS equation and its asymptotics	王灯山	
11:20-14:00	午餐（旦苑三楼）		
14:00-14:30	复杂背景波上的孤子	楼森岳	杨依灵
14:30-15:00	Integrable and nearly-integrable turbulence of nonlinear wave equations	闫振亚	
15:00-15:30	可积深度学习的进展-PE-RWP: 用于怪波模式和 Peregrine 波定位的多项式特征提取的深度学习框架	陈勇	王兆钰
15:30-16:00	On elliptic solitons	张大军	

报告题目和摘要

报告人： 耿献国 （郑州大学，教授）

题目：Application of tetragonal curves to semi-discrete Boussinesq equations

摘 要: The hierarchy of the semi-discrete Boussinesq equations associated with a discrete 4×4 matrix spectral problem has been derived by means of the zero-curvature and the Lenard recursion equations. The tetragonal curve is introduced by resorting to the characteristic polynomial of the Lax matrix for the semi-discrete Boussinesq hierarchy, upon which the Baker-Akhiezer functions, meromorphic functions, Abel differentials, and Riemann theta functions are constructed. Finally, we derive the Riemann theta function solutions to the semi-discrete Boussinesq hierarchy.

报告人： 左达峰 （中国科学技术大学，教授）

题目：The symmetric group and Frobenius manifolds

摘要: We present some constructions of Frobenius manifolds related to the symmetric groups, joint work with Silin Ma, Yixuan Ouyang, and Yemo Wu.

报告人：康静 （西北大学，教授）

题目：Dispersive revival and fractalization for dispersive evolution equations

摘要： In this talk, we investigate the dispersive revival and fractalization phenomena for dispersive evolution equations. Firstly, we study the periodic initial-boundary value problem of the bidirectional dispersive evolution equations and analyze the manifestation of a novel revival phenomenon for the corresponding solution at rational times. Next, we investigate the Talbot effect for the periodic initial-boundary value problem of the Manakov system.

报告人：李彪 （宁波大学，教授）

题目：A data-driven integrable BFGS algorithm (IBA-PDE) for discovering PDEs

摘要：Data-driven discovery of partial difference equations (PDEs) has become a hot topic, and scholars have proposed some excellent data-driven methods (PINNs,PDE-FIND,DLGA-PDE,SGA-PDE) and achieved good results in discovering PDEs. This paper proposes a new integrable BFGS algorithm (IBA-PDE) for PDE discovery, which solves two key problems: (1) To manage the complexity and redundancy of candidate PDE terms, it incorporates a weight balance condition tailored for partially integrable PDEs, along with a preliminary optimization strategy, we first solve the problem of narrowing down the range of PDEs candidates; (2) To accurately estimate unknown PDEs coefficients, the method employs the BFGS

optimization algorithm, enhancing the precision of the identification process. Through systematic numerical experiments, IBA-PDE demonstrates superior capability that not only rediscovers fundamental PDEs but also resolves previously intractable systems with unprecedented precision. Specifically, IBA-PDE discovered several complex integrable PDEs (fifth-order KdV, Kaup Kupershmidt, Sawada Kotera, complex modified KdV, Hirota, and (2+1) dimensional Kadomtsev Petviashvili (KP) equations) and two non integrable PDEs (Burgers KdV and Chafee Infante equations), all of which have mean square errors (MSEs) of 10−9 and coefficient errors of almost zero. Moreover, IBA-PDE use fewer experimental data compared to other data-driven methods throughout the entire process of discovering complete PDEs, whether in the stage of determining PDEs candidate terms or coefficient determination. For non-integrable systems, IBA-PDE employs an adaptive discovery mechanism that not only successfully resolves the Burgers-KdV equation but also autonomously identifies a new PDE that better matches the data of the Chafee-Infante equation reducing MSE from 10−11 to 10−14. Robustness analysis confirms the method's stability under noise conditions of 1%, 3% and 5%, maintaining the same MSE levels. IBA-PDE establishes a new paradigm for data-driven PDEs discovery, with transformative potential for discovering new PDEs or matching known PDEs from experimental data in fields such as physics, engineering,mechanics, chemistry and biology.

报告人：王灯山 （北京师范大学，教授）

题目：Dark soliton gas of the defocusing NLS equation and its asymptotics

摘要：In this talk, we report our recent work on dark soliton gas of the defocusing NLS equation and its asymptotics by Riemann-Hilbert formulation. It is demonstrated that the dark soliton gas is related to the one-phase Riemann-Theta function as $x\to-\infty$, and approaches to 1 as $x\to+\infty$. Additionally, the long-time asymptotic behavior of this soliton gas can be categorized into three distinct regions in the x-0-t plane, which from left to right are unmodulated one-phase wave, modulated one-phase wave and constant background wave. This is a joint work with Marco Bertola, Peng Yan and Dinghao Zhu.

报告人：楼森岳（宁波大学，教授）

题目：复杂背景波上的孤子

摘要：对于一个可积系统，存在形形式式的波解，从这些波解出发作达布变换即可得到以这些波为背景的孤立子。如何得到各种类型复杂背景波上的孤子是一个具有挑战性的课题。本报告以对称性为突破口研究这类问题。

报告人：闫振亚 （中原工学院/中科院数学院，研究员）

题目: Integrable and nearly-integrable turbulence of nonlinear wave equations

摘 要: In this talk, we discuss some properties of integrable and nearly-integrable turbulence and their relationship with rogue wave phenomena, with a specific focus on some nonlinear wave equations, such as the derivative nonlinear Schrödinger equation and the fractional nonlinear Schrödinger equation.

报告人：陈勇（华东师范大学，教授）

题目：可积深度学习的进展-PE-RWP: 用于怪波模式和 Peregrine 波定位的多项式特征提取的深度学习框架

摘要: 在本报告中，我们提出了一种基于深度学习的"怪波模式多项式提取器"（PE-RWP）。该方法取代了传统的高阶怪波解在大参数条件下的渐近分析，能够自动且准确地识别怪波模式中的多项式特征。PE-RWP 独特的双分支网络架构（包括一个用于确定参数值的回归分支和一个用于识别相应多项式类型的分类分支），使其能够有效地输出这种广义的多项式结构，并识别受任意缩放和旋转变换影响的怪波模式。此外，作为基于怪波模式数学理论的应用，我们利用 PE-RWP 输出的多项式族，通过深度学习方法实现 Peregrine 波的无监督定位。最后，通过广泛的实验评估，这两个问题——多项式提取和 Peregrine 波定位——都得到了有效解决，且准确性高。

报告人：张大军（上海大学，教授）

题目：On elliptic solitons

摘要：I will review elliptic potentials related to Schrödinger spectral problem. It is mainly about finite-gap potentials, Lame-Ince potential, Darboux-Treibich-Verdier potential, etc. A few related open problems will be mentioned as well.