香港數學學會
The Hong Kong Mathematical Society
(Founded in 1979)

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The Hong Kong Mathematical Society
c/o Department of Mathematics
The University of Hong Kong
Pokfulam, Hong Kong

THE HONG KONG MATHEMATICAL SOCIETY
ANNUAL GENERAL MEETING 2025

17 May 2025 (Saturday)
9:00 am – 4:30 pm
City University of Hong Kong

Schedule of Events

Time: 9:00 am-11:30 am
Venue: HKIAS Lecture Theater (AE-040), CityU HK

9:00 am – 10:00 am	HKMS Distinguished Lecture by Prof. Zhihong Xia Northwestern/Big Bay University Chair: Prof. Xuhua He
10:00 am -- 10:30 am	Tea/Coffee break with refreshment
10:30 am -- 10:50 am	Award Presentation Ceremony
10:50 am -- 11:10 am	Financial report by Prof. Xin Zhang (Treasurer)
11:10 am -- 11:30 am	HKMS constitution amendment vote

Time: 12:00 noon - 14:00
Venue: City Chinese Restaurant, 8/F, Bank of China (Hong Kong) Complex

12:00 --14:00	Lunch

Time: 14:00 - 16:15
Venue: HKIAS Lecture Theater (AE-040), CityU HK

14:00 -- 14:45	Plenary talk 1 Chair: Prof. Hongyu Liu
14:45 -- 15:30	Plenary talk 2 Chair: Prof. Hongyu Liu
15:30 -- 16:15	Plenary talk 3 Chair: Prof. Hongyu Liu

Title and Abstract

Distinguished lecture

Time: 9:00am-10:00am
Title: AI and Mathematics: Efficient Machine Learning algorithms inspired by Complex Analysis, Dynamics and Whitney Embedding
Speaker: Zhihong Xia, Northwestern/Big Bay University

Abstract:

At its core, AI and machine learning algorithms represent our mathematical communication with computers. Current algorithms are the product of iterative trial and error. In our work, we propose novel machine learning algorithms derived from and inspired by pure mathematics.

First, our machine learning algorithm based on complex analysis are highly efficient in solving both mathematical and physical problems, surpassing existing Physical Informed Neural Networks (PINNs), for solving Partial Differential Equations (PDEs) and other scientific computations, achieving improvements in both speed and accuracy often by several orders of magnitude. It also shows strong performance in tasks like image recognition and other AI applications. Currently, we are testing our algorithms on Transformers and Large Language Models (LLMs). Initial results are promising. For example, on one task with MiniMind large language model, our algorithm, with only 0.1 billion (0.1B) parameters, achieves results comparable to the current model with 8 billion (8B) parameters—a huge efficiency improvement. However, it remains uncertain whether our algorithm can scale further. To put this in perspective, ChatGPT-4 operates with 8 models, each containing over 200 billion parameters.

Inspired by dynamical systems theory and Whitney embedding, we also created machine learning algorithms for time series predictions. To understand the essence of AI, we pose a simple question: Given a Sun-Earth-Jupiter three-body system, where we observe the position of Jupiter from Earth every night, and assume we know nothing about Newtonian mechanics, calculus, or universal gravitation, can a machine predict the future motion of Jupiter? The surprising answer is yes—provided there is enough data. We show that, more generally, for any dynamical system on a manifold, enough sequential data from a single, generic observable can fully recover the original system.

Plenary Talks:

Time: 14:00 – 14:45
Speaker: Wing Tat Leung, City U
Title: Multi-continuum approaches for multiscale problems

Abstract: This talk presents a perspective on multi-continuum approaches for multiscale problems in high-contrast heterogeneous media. We begin with a multicontinuum framework derived via constrained cell problems, which model coarse-scale interactions among multiple continua defined by local spectral decompositions. Oversampling techniques are employed to reduce boundary effects, enhancing accuracy even without clear scale separation. We will introduce the Constraint Energy Minimizing Generalized Multiscale Finite Element Method (CEM-GMsFEM), which constructs multiscale basis functions through energy minimization constrained by an auxiliary space capturing key high-contrast features.

This ensures convergence rates independent of contrast and proportional to the coarse mesh size when suitable oversampling is applied. Numerical results demonstrate the efficiency and robustness of the approach across various challenging test cases. These methods offer a powerful and flexible framework for upscaling in complex multiscale systems, bridging homogenization theory and multiscale finite element methods.

Time: 14:45 – 15:30
Speaker: Moritz Reintjes, City U
Title: The essential regularity of singular connection

Abstract: The question whether a singularity is removable by coordinate transformation has been of central importance in General Relativity since Schwarzschild's discovery of black hole solution in 1916. However, beyond ad-hoc coordinate constructions, General Relativity lacked a unifying theory for identifying when singularities are removable, and it lacked a general procedure for removing them. The speaker, in collaboration with B. Temple, discovered a system of elliptic partial differential equations, the RT-equations, which provides a definitive theory for identifying and removing singularities. That is, based on the RT-equations, we developed a necessary and sufficient condition for when a singularity in an affine connection (the basic object of a geometry) is removable by coordinate transformation, together with a computable procedure for removing the singularity by regularizing the connection all the way up to its essential (highest possible) regularity. Our theory applies to cusp and shock wave singularities in the Lorentzian metrics of General Relativity—but not yet singularities at black hole horizons. More generally, the RT-equations apply to singular connections on vector bundles of Yang-Mills gauge theories, and imply that connections with L^p curvature can always be regularized to one derivative above L^p; based on this, we gave the first extension of Uhlenbeck compactness from Riemannian to Lorentzian geometry.

Time: 15:30 – 16:15
Speaker: Hai Zhang, HKUST
Title: Symmetry and Topology Meet Light: Interface/Edge Spectra in Photonic Structures

Abstract: The discovery of topological insulators in condensed matter physics has opened new avenues for generating interface and edge modes in photonic and phononic media. These modes, confined near the interface between two distinct structures or along the boundary of a single structure, offer robust ways to guide and control light. Their origin lies in the symmetries and nontrivial topology of the underlying wave operators. In this talk, we report on recent advances toward rigorously establishing the existence of interface and edge spectra in a variety of topological photonic and phononic structures.

CityU HK campus map

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LG/F, Academic Exchange Building
City University of Hong Kong
83 Tat Chee Avenue
Kowloon Tong, Hong Kong

City Chinese Restaurant, 8/F, Bank of China (Hong Kong) Complex