華東師範大學

EAST CHINA NORMAL UNIVERSITY

POSTECH

POHANG UNIVERSITY OF SCIENCE AND TECHNOLOGY

2026

ECNU—POSTECH Joint Workshop on Mathematics

Conference Program

April 14 - 18, 2026

School of Mathematical Sciences

East China Normal University

Shanghai • China

2026 ECNU – POSTECH
Joint Workshop on Mathematics

School of Mathematical Sciences
East China Normal University
China

Department of Mathematics
Pohang University of Science and Technology
Korea

April 14 — 18, 2026, Shanghai, China

2026 ECNU – POSTECH
Joint Workshop on Mathematics

April 14 — 18, 2026

Introduction:

This workshop is the inaugural event of a series of academic collaborations initiated under the Memorandum of Understanding (MoU) signed between the School of Mathematical Sciences at East China Normal University (ECNU) and the Department of Mathematics at Pohang University of Science and Technology (POSTECH) in August 2025. The MoU aims to foster deep and extensive cooperation in scientific research, talent cultivation, and academic exchange.

This first workshop, hosted by ECNU, will have a special focus on Applied and Computational Mathematics.

The program will consist of plenary talks by distinguished experts from ECNU, POSTECH, and other leading institutions.

Conference Objectives:

The workshop aims to enhance academic exchange and cooperation between the mathematical communities of China and Korea, as well as with the broader international community. It will serve as a high-level platform for mathematicians and researchers to:

- Explore the frontiers of mathematics and its applications.
- Leverage the complementary strengths of both institutions.
- Discuss significant topics such as the development of the mathematical sciences and the cultivation of top-tier innovative talent.

Co-Chairs:

Hairong Yuan (Associate Dean, School of Mathematical Sciences, ECNU)

Jae-Hun Jung (Head, Department of Mathematics, POSTECH)

Committee Members:

ECNU	POSTECH
Xia Huang	Minseok Choi
Dong Ye	Jin Woo Jang
Longtu Yuan	Jae Ryong Kweon
Chunyi Zhao	
Haibiao Zheng	
Feng Zhou	

Hosted by:

School of Mathematical Sciences, East China Normal University (ECNU), China

Co-organized by:

Department of Mathematics, Pohang University of Science and Technology (POSTECH), Korea

Supported by:

Key Laboratory of Mathematics and Engineering Applications, Ministry of Education, P. R. China

Contacts:

Hairong Yuan (ECNU) Email: hryuan@math.ecnu.edu.cn; Phone: +86 - 13764387644

Gaoyang Li (ECNU) Email: 52280155014@stu.ecnu.edu.cn; Phone: +86 - 18516331850

Conference Schedule:

April 14: Conference Registration

April 15: Session 1; Poster Session; Session 2

April 16: Session 3; Open Discussion

April 17: Session 4; Session 5

April 18: Departure

Venue:

Lecture Hall 102, Math Building, ECNU Minhang Campus

华东师范大学闵行校区数学楼 102 报告厅

Accommodation:

Baolong Yiyue Hotel (Wujing Minhang Zizhu ECNU-SJTU Branch)

(No. 1, Lane 39, Shangyi Road, Wujing, Minhang District, Shanghai)

宝龙艺悦酒店 (吴泾闵行紫竹华师大交大店)

(上海市闵行区吴泾镇尚义路 39 弄 1 号)

Transportation (to Baolong Yiyue Hotel):

By Subway:

From Pudong International Airport, Hongqiao International Airport, or Hongqiao Railway Station, it is recommended to take the Airport Link Line to Jinghong Road Station, transfer to Metro Line 15, and exit from Exit 2 of Yongde Road Station.

From Shanghai Railway Station, it is recommended to take Metro Line 1 to Shanghai South Railway Station (or start directly from Shanghai South Railway Station), transfer to Metro Line 15, and exit from Exit 2 of Yongde Road Station.

After exiting the station, you can take a taxi to Baolong Yiyue Hotel (Wujing Minhang Zizhu ECNU-SJTU Branch), or walk about 1.1 kilometers to the hotel.

By Taxi:

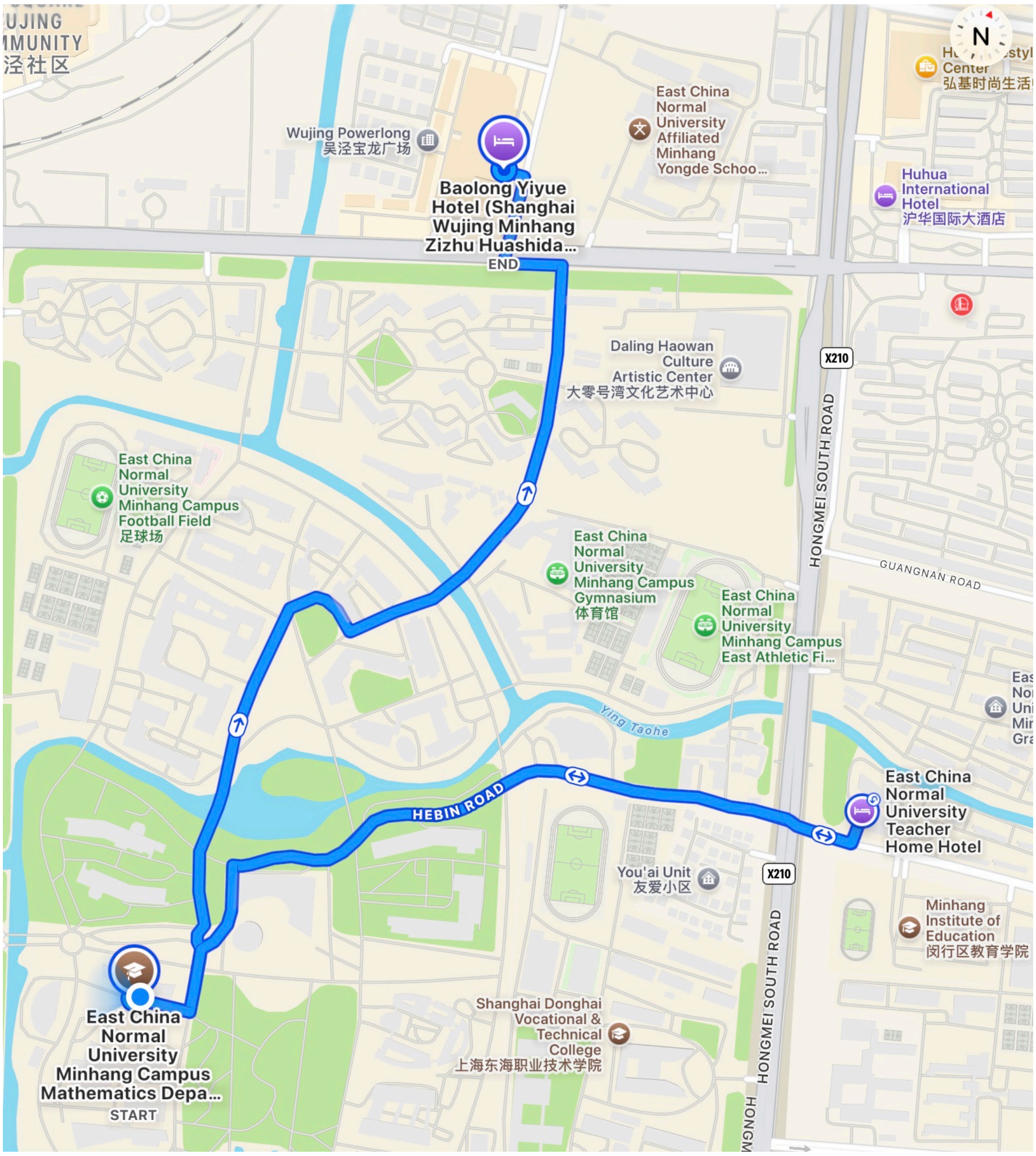
Please tell the taxi driver to go to the following address:

Baolong Yiyue Hotel (Wujing Minhang Zizhu ECNU-SJTU Branch)
No. 1, Lane 39, Shangyi Road, Wujing, Minhang District, Shanghai

宝龙艺悦酒店 (吴泾闵行紫竹华师大交大店)
上海市闵行区吴泾镇尚义路 39 弄 1 号

From Pudong International Airport, Hongqiao International Airport, Hongqiao Railway Station, Shanghai Railway Station, or Shanghai South Railway Station, you can take a taxi directly to the hotel.

The hotel is a 3-5 minute walk from the North Gate of the ECNU Minhang Campus, and a 15-20 minute walk from the Math Building.



Recommended Walking Route

Venue

Lecture Hall 102, Math Building, ECNU Minhang Campus.

华东师范大学闵行校区数学楼 102 报告厅.

Teacher Home Hotel, located 890 meters northeast of the Math Building.

教师之家, 位于数学楼东北侧 890 米处.

Part 1 Conference Program

Program at a Glance

Tuesday, April 14, 2026		
Conference Registration (Baolong Yiyue Hotel)		
17:30	Dinner (Baolong Yiyue Hotel)	
Wednesday, April 15, 2026		
Venue (Lecture Hall 102, Math Building, ECNU)		
Time	Presentation\Event	Chair
8:30 - 9:10	Opening Ceremony Changhong Lyu Bo Liu Jae-Hun Jung Group photo	Li Luo
Session 1		
9:10 - 10:00	Jae-Hun Jung	Hairong Yuan
10:00 - 10:50	Paolo Piersanti	Minseok Choi
10:50 - 11:10	Coffee Break	
11:10 - 12:00	Ling Guo	Dong Ye
12:00 - 14:00	Lunch (Baolong Yiyue Hotel)	
14:00 - 14:50	Poster Session	
Session 2		
14:50 - 15:40	Pengbo Xu	Haibiao Zheng
15:40 - 16:10	Coffee Break	
16:10 - 17:00	Minseok Choi	Feng Zhou
Special Session(Lecture Hall 401, Math Building, ECNU)		
16:00 - 17:00	Jae-Hun Jung: Meeting with Undergraduates	Meng Zhu
17:30 - 19:30	Dinner (Teacher Home Hotel)	

Program at a Glance (Continued)

Thursday, April 16, 2026		
Venue (Lecture Hall 102, Math Building, ECNU)		
Session 3		
Time	Presentation\Event	Chair
8:30 - 9:20	Yuning Liu	Longtu Yuan
9:20 - 10:10	Yanyan Zhang	Xia Huang
10:10 - 10:40	Coffee Break	
10:40 - 11:30	Jin Woo Jang	Dong Ye
12:00 - 14:00	Lunch (Baolong Yiyue Hotel)	
14:00 - 20:00	Open Discussion	
Friday, April 17, 2026		
Venue (Lecture Hall 102, Math Building, ECNU)		
Session 4		
Time	Presentation\Event	Chair
8:30 - 9:20	Jie Du	Jae-Hun Jung
9:20 - 10:10	Chuwen Ma	Dongil Shin
10:10 - 10:40	Coffee Break	
10:40 - 11:30	Haitao Wang	Jin Woo Jang
12:00 - 14:00	Lunch (Baolong Yiyue Hotel)	
Session 5		
14:00 - 14:50	Yu Cao	Shengfeng Zhu
14:50 - 15:40	Dongil Shin	Chunyi Zhao
15:40 - 16:10	Coffee Break	
16:10 - 17:00	Yeoneung Kim	Hairong Yuan
17:00 - 17:30	Closing Ceremony Jae-Hun Jung Zhi Jia	Hairong Yuan
Special Session for Talks to Undergraduates (Lecture Hall 401, Math Building, ECNU)		
13:00 - 13:50	Jae-Hun Jung	Meng Zhu
14:00 - 14:50	Jin Woo Jang	Meng Zhu
17:30	Dinner (Baolong Yiyue Hotel)	
Saturday, April 18, 2026		
Departure		

Tuesday, April 14

Conference Registration

Venue: Baolong Yiyue Hotel (Wujing Minhang Zizhu ECNU-SJTU Branch).

Hotel Address: No. 1, Lane 39, Shangyi Road, Wujing, Minhang District, Shanghai (Next to Powerlong Plaza).

Phone: +86 - 21 - 33880888.

17:30 Dinner: Baolong Yiyue Hotel

Wednesday, April 15, Morning

Chair Li Luo

8:30 — 9:10 Opening Ceremony; Changhong Lyu; Bo Liu; Jae-Hun Jung; Group photo

Session 1

Chair Hairong Yuan

9:10 — 10:00 Jae-Hun Jung: Topological Optimization for Machine Learning

Chair Minseok Choi

10:00 — 10:50 Paolo Piersanti: Grounded shallow ice sheets melting as an obstacle problem

10:50 — 11:10 Coffee Break

Chair Dong Ye

11:10 — 12:00 Ling Guo: Flow-based Bayesian filtering for high-dimensional nonlinear stochastic dynamical systems

12:00 — 14:00 Lunch: Baolong Yiyue Hotel

Wednesday, April 15, Afternoon

14:00 — 14:50 Poster Session: first floor of south-Math Building

Session 2

Chair Haibiao Zheng

14:50 — 15:40 Pengbo Xu: A High-Resolution Artificial Intelligence-Based Limited Area Weather Forecasting Model with Global-Local Coupling

15:40 — 16:10 Coffee Break

Chair Feng Zhou

16:10 — 17:00 Minseok Choi: Physics-Informed Laplace Neural Operator for Learning Differential Equations

Special Session

Chair Meng Zhu

16:00 — 17:00 Jae-Hun Jung: Meeting with Undergraduates

17:30 — 19:30 Dinner: Teacher Home Hotel

Thursday, April 16, Morning

Session 3

Chair Longtu Yuan

8:30 — 9:20 Yuning Liu: Curvature flow with forcing in a critical Sobolev space

Chair Xia Huang

9:20 — 10:10 Yanyan Zhang: Asymptotic Behavior of Rupture Solutions for 2D Elliptic MEMS Equations

10:10 — 10:40 Coffee Break

Chair Dong Ye

10:40 — 11:30 Jin Woo Jang: Long-Time Dynamics of the 3D Vlasov–Maxwell System with Boundaries

12:00 — 14:00 Lunch: Baolong Yiyue Hotel

Thursday, April 16, Afternoon

14:00 — 20:00 Open Discussion

Friday, April 17, Morning

Session 4

Chair Jae-Hun Jung

8:30 — 9:20 Jie Du: Well-balanced positivity-preserving high-order discontinuous Galerkin methods for Euler equations with gravitation

Chair Dongil Shin

9:20 — 10:10 Chuwen Ma: On Quantum Algorithms for Partial Differential Equations

10:10 — 10:40 Coffee Break

Chair Jin Woo Jang

10:40 — 11:30 Haitao Wang: Time-asymptotic expansion and fluid approximation of the 1D Boltzmann equation

12:00 — 14:00 Lunch: Baolong Yiyue Hotel

Friday, April 17, Afternoon

Session 5

Chair Shengfeng Zhu

14:00 — 14:50 Yu Cao: Simulating Lindblad Equations: Structure-Preserving Deterministic Schemes and Variance-Optimized Stochastic Unraveling

Chair Chunyi Zhao

14:50 — 15:40 Dongil Shin: Learning Effective Constitutive Operators from Microstructure: A Deep Material Network Approach

15:40 — 16:10 Coffee Break

Chair Hairong Yuan

16:10 — 17:00 Yeoneung Kim: A physics-informed, global-in-time neural particle method for the spatially homogeneous Landau equation

Chair Hairong Yuan

17:00 — 17:30 Closing Ceremony; Jae-Hun Jung; Zhi Jia

Special Session for Talks to Undergraduates

Chair Meng Zhu

13:00 — 13:50 Jae-Hun Jung: Topological Data Analysis and Machine Learning

Chair Meng Zhu

14:00 — 14:50 Jin Woo Jang: Kinetic Theory and Radiative Transfer: From Particles to Photons

17:30 Dinner: Baolong Yiyue Hotel

Saturday, April 18

Departure

Part 2 Titles and Abstracts

Topological Optimization for Machine Learning

Jae-Hun Jung
(POSTECH)

Recent advances in machine learning and artificial intelligence have highlighted the importance of incorporating structural information of data into learning frameworks. In particular, approaches such as structural learning emphasize that the geometric and topological properties of data play a crucial role in improving model performance and interpretability. It is essential to integrate geometric and topological features into the learning process to effectively utilize the "shape of data".

In this talk, we present a framework for combining topological structures into machine learning using topological loss functions. These losses are constructed using persistent homology and are implemented through representations such as persistence diagrams and persistence images. We illustrate several applications of this approach. First, we consider classification problems based on Fourier-transformed data, where multiparameter persistent homology is employed to identify an optimal filtration space for improved classification. Second, we discuss multimodal learning, where topological optimization is applied to align image and text embedding spaces within a Contrastive Language-Image Pretraining (CLIP) framework. Finally, we present a method for minimizing Gibbs oscillations in nonsmooth solutions of partial differential equations by adding topological constraints into physics-informed neural networks (PINNs). These examples demonstrate that topological optimization provides a flexible and powerful tool for embedding structural information into machine learning models.

This is joint work with Junwon You (KAIST) and Keunsu Kim (Kyushu University).

Grounded shallow ice sheets melting as an obstacle problem

Paolo Piersanti
(The Chinese University of Hong Kong, Shenzhen)

In this talk, which is based on joint work with with Roger Temam (Indiana University), we will study a model describing the evolution of the thickness of a grounded shallow ice sheet. Since the thickness of the ice sheet is constrained to be nonnegative, the problem under consideration is an obstacle problem.

A rigorous modelling exercise shows that this model, which is time-dependent, is governed by a set of variational inequalities that involve non-linearities in the time derivative and in the elliptic term. In order to establish the existence of solutions for the time-dependent model we recovered formally upon completion of the aforementioned modelling exercise, we first depart from a penalized relaxation, and we show —by resorting to a discretization in time - that the corresponding relaxed problem admits at least one solution.

Second, by means of Dubinskii's lemma and other new results and new inequalities, we extract compactness for the family of solutions of the relaxed problems and we show that this family of solutions converges to a solution of a doubly nonlinear parabolic variational inequality akin to the one that was recovered formally.

Flow-based Bayesian filtering for high-dimensional nonlinear stochastic dynamical systems

Ling Guo
(Shanghai Normal University)

Bayesian filtering for high-dimensional nonlinear stochastic dynamical systems is a fundamental yet challenging problem in many fields of science and engineering. Existing methods face significant obstacles: Gaussian-based filters struggle with non-Gaussian distributions, while sequential Monte Carlo methods are computationally intensive and prone to particle degeneracy in high dimensions. Although generative models in machine learning have made significant progress in modeling high-dimensional non-Gaussian distributions, their inefficiency in online updating limits their applicability to filtering problems. In this talk, we will present a flow-based Bayesian filter (FBF) that integrates normalizing flows to construct a novel latent linear state-space model with Gaussian filtering distributions. This framework facilitates efficient density estimation and sampling using invertible transformations provided by normalizing flows, and it enables the construction of filters in a data-driven manner, without requiring prior knowledge of system dynamics or observation models. Numerical experiments demonstrate the superior accuracy and efficiency of the FBF method.

A High-Resolution Artificial Intelligence-Based Limited Area Weather Forecasting Model with Global-Local Coupling

Pengbo Xu
(East China Normal University)

Artificial Intelligence (AI) has significantly advanced global weather forecasting, yet high-resolution, data-driven limited area models remain underexplored. This report presents a novel AI-based limited area weather forecasting model with a spatial resolution of 3 km and a temporal resolution of 1 hour. The model employs a parallel global-local architecture to effectively capture multiscale meteorological features. It is trained using high-resolution regional analysis data and incorporates forecasts from global AI models as lateral boundary conditions during prediction, resulting in substantially faster performance compared to traditional dynamical forecast models.

Experimental results over two selected regions demonstrate that the proposed model outperforms dynamical models in surface wind speed forecasting, while showing relatively lower performance in surface temperature and pressure predictions. The study further indicates that improving lateral boundary conditions can enhance temperature and pressure forecasting skills to levels comparable with dynamical models. Additionally, key challenges related to lateral boundary conditions—such as determining optimal boundary widths and integrating multi-resolution predictions—are investigated, providing insights for future improvements in high-resolution regional AI forecasting systems.

Physics-Informed Laplace Neural Operator for Learning Differential Equations

Minseok Choi
(POSTECH)

Differential equations are fundamental for modelling complex scientific and engineering processes. Operator learning offers a powerful framework for approximating the mapping from parametric inputs such as initial/boundary conditions or forcings to the corresponding solutions. However, purely data-driven operator learning methods such as the Laplace Neural Operator (LNO) typically require large training datasets and exhibit limited extrapolation capabilities. We propose the Physics-Informed Laplace Neural Operator (PILNO), which embeds the governing physical laws directly within the learning process. This physics-informed approach reduces data dependency, enabling effective learning in small-data regimes and enhancing generalization to out-of-distribution inputs where purely data-driven LNOs often fail. By leveraging both data (when available) and physics, PILNO offers a more robust and data-efficient pathway to learning solution operators. We demonstrate advantages of PILNO across diverse parametric differential equation problems, highlighting its improved data efficiency and extrapolation performance.

Curvature flow with forcing in a critical Sobolev space

Yuning Liu
(New York University Shanghai)

Given a closed 1-rectifiable set $\Gamma_0 \subset \mathbb{R}^2$ of finite one-dimensional Hausdorff measure and a vector field u in a dimensionally critical Sobolev space, we construct a non-trivial flow of curves with the velocity given by $\kappa + u$, starting from Γ_0. The motion law is satisfied in the sense of Brakke and the flow exists through singularities. This is joint work with Y. Tonegawa.

Asymptotic Behavior of Rupture Solutions for 2D Elliptic MEMS Equations

Yanyan Zhang
(East China Normal University)

We study solutions of the singular elliptic equation

$$\Delta u = \lambda |x|^{\alpha} u^{-p}, \quad u > 0,\ x \in \mathbb{R}^2 \setminus \{0\}, \quad u(0) = 0,$$

which models electrostatic MEMS devices. Here $\lambda > 0$, $p > 0$, and $\alpha > -2$.

Firstly, we classify all possible singularities at the origin. For certain parameters (α, p) the solution exhibits only an isotropic singularity; otherwise anisotropic singularities may appear. The analysis relies on a self-similar transformation, phase-plane methods and Lojasiewicz-Simon method. We also reveal a critical role of p: especially the special case $p = 3$ where a continuum of solutions exists.

Secondly, we investigate global solutions on $\mathbb{R}^2 \setminus \{0\}$, establishing their asymptotic behavior near zero and at infinity. Using energy monotonicity, we derive necessary conditions linking the limiting profiles, yielding a frequency ordering principle. The external pressure F is also considered, particularly in the subcritical case $\alpha < 2p$.

This is joint work with Yujin Guo, Feng Zhou and Qing Li.

Long-Time Dynamics of the 3D Vlasov–Maxwell System with Boundaries

Jin Woo Jang
(POSTECH)

In this talk, we consider the Vlasov – Maxwell system, a fundamental collisionless kinetic model for plasmas, posed in a three-dimensional half-space with boundaries. We begin with a brief warm-up by revisiting the one-dimensional Vlasov – Poisson system in the absence of magnetic fields, focusing on Penrose′s classical 1960 spectral criterion for linear stability and instability. We then turn to the full Vlasov–Maxwell system and discuss the major analytical difficulties introduced by electromagnetic coupling, boundary effects, and nonlinear interactions. In particular, we highlight the role of an effective gravitational force directed toward the boundary and its interplay with boundary temperature conditions. This viewpoint naturally leads us to formulate a conjectural linear instability criterion associated with boundary-induced confinement effects. Within this framework, we construct global-in-time classical solutions to the nonlinear Vlasov – Maxwell system beyond the vacuum scattering regime. Our approach combines the construction of stationary boundary equilibria with a proof of their asymptotic stability in the L^∞ setting under small perturbations. This work provides a new framework for analyzing long-time plasma dynamics in bounded domains with interacting magnetic fields. To our knowledge, it yields the first construction of asymptotically stable non-vacuum steady states for the full three-dimensional nonlinear Vlasov–Maxwell system. This is joint work with Chanwoo Kim.

Well-balanced positivity-preserving high-order discontinuous Galerkin methods for Euler equations with gravitation

Jie Du
(East China Normal University)

We develop high order discontinuous Galerkin (DG) methods with Lax-Friedrich fluxes for Euler equations under gravitational fields. Such problems may yield steady-state solutions and the density and pressure are positive. There were plenty of previous works developing either well-balanced (WB) schemes to preserve the steady states or positivity-preserving (PP) schemes to get positive density and pressure. However, it is rather difficult to construct WB PP schemes with Lax-Friedrich fluxes, due to the penalty term in the flux. In fact, for general PP DG methods, the penalty coefficient must be sufficiently large, while the WB scheme requires that to be zero. This contradiction can hardly be fixed following the original design of the PP technique. In this talk, we reformulate the source term such that it balances with the flux term when the steady state has been reached. To obtain positive numerical density and pressure, we choose a special penalty coefficient in the Lax-Friedrich flux, which is zero at the steady state. The technique works for general steady-state solutions with zero velocities. Numerical experiments are given to show the performance of the proposed methods.

On Quantum Algorithms for Partial Differential Equations

Chuwen Ma
(East China Normal University)

In this talk, we will discuss recent developments in quantum algorithms for partial differential equations (PDEs). A central difficulty is that many PDEs of practical interest generate non-unitary evolution, while quantum computation is naturally formulated in terms of unitary dynamics. To address this issue, we will introduce the Schrödingerization framework, which provides a systematic way to reformulate general linear PDE systems into Schrödinger-type systems with unitary evolution in a higher-dimensional space, making them suitable for quantum computation. We will present recent advances including complexity improvements via smooth extensions of the initial data and preconditioning techniques, as well as applications to representative PDE models such as Maxwell equations with source terms and physical boundary conditions, and certain ill-posed evolution problems including inverse heat conduction and backward wave propagation.

Time-asymptotic expansion and fluid approximation of the 1D Boltzmann equation

Haitao Wang
(Shanghai Jiao Tong University)

We investigate the quantitative pointwise behavior of solutions to the one-dimensional (1D) Boltzmann equation for hard potentials and Maxwellian molecules. Our study pursues two main objectives. First, we characterize the time-asymptotic hierarchical structure of solutions. Second, we establish the asymptotic equivalence between solutions of the 1D Boltzmann equation and the 1D compressible Navier-Stokes equations. Unlike prior works in the multi-dimensional case, where comparison of linear solutions suffices, our approach extracts the leading nonlinear fluid waves from the 1D Boltzmann equation and directly compares them with solutions of the nonlinear Navier-Stokes system.

Simulating Lindblad Equations: Structure-Preserving Deterministic Schemes and Variance-Optimized Stochastic Unraveling

Yu Cao
(Shanghai Jiao Tong University)

Simulating open quantum systems governed by the Lindblad equation requires balancing physical fidelity with the steep memory costs of evolving density matrices. First, we introduce a family of structure-preserving deterministic numerical schemes capable of achieving arbitrary high-order accuracy. By strictly preserving the quantum state's physical nature, these schemes eliminate non-physical artifacts common in traditional integrators. Consequently, they serve as reliable backbones for further developing randomized and quantum algorithms. Second, to overcome the memory limitations of density matrix evolution, we investigate stochastic unraveling techniques. While unraveling reduces memory cost by simulating state vectors, it inherently introduces stochastic uncertainty. We provide a complete parametric characterization of unraveling schemes driven by Brownian motion and Poisson processes in a minimal setting. From this framework, we analytically derive dynamically optimal quantum state diffusion (DO-QSD) and dynamically optimal quantum jump processes (DO-QJP) to minimize the short-time growth of observable variance. Supported by numerical examples, these two approaches provides an optimized toolkit for simulation of open quantum systems.

Learning Effective Constitutive Operators from Microstructure: A Deep Material Network Approach

Dongil Shin
(POSTECH)

Deep Material Networks (DMNs) provide a physics-informed machine learning framework for modeling the relationship between complex microstructures and their effective macroscopic behavior. By combining hierarchical network architectures with mechanics-based building blocks, DMNs enable efficient and interpretable learning of constitutive responses from high-fidelity simulations. In this talk, we introduce the core formulation of DMNs, along with their training and prediction strategies. We also highlight their ability to generalize under unseen loading conditions, distinguishing them from conventional black-box approaches. Recent developments further demonstrate the potential of DMNs as a scalable and reliable tool for multiscale material modeling.

A physics-informed, global-in-time neural particle method for the spatially homogeneous Landau equation

Yeoneung Kim
(Seoul National University of Science and Technology)

We propose a physics-informed neural particle method (PINN-PM) for the spatially homogeneous Landau equation. The method adopts a Lagrangian interacting-particle formulation and jointly parameterizes the time-dependent score and the characteristic flow map with neural networks. Instead of advancing particles through explicit time stepping, the Landau dynamics is enforced via a continuous-time residual defined along particle trajectories, yielding a mesh-free solver that can be queried at arbitrary times. We establish a deterministic, global-in-time stability analysis in an L_v^2 framework. The deviation between learned and exact characteristics is controlled by three interpretable sources: the score approximation error, the particle approximation error, and the physics residual of the neural flow. This trajectory estimate is then lifted to Wasserstein stability and density reconstruction error via kernel density estimation, resulting in a complete error propagation chain from particle dynamics to macroscopic quantities. At the oracle level, the score error is characterized through the implicit score matching functional via Hyvärinen′s identity. In practice, the empirical ISM objective provides a computable surrogate for monitoring score accuracy during training. Numerical experiments on analytical benchmarks, including the two- and three-dimensional BKW solutions, as well as reference-free configurations, demonstrate stable transport, preservation of macroscopic invariants, and competitive or improved accuracy compared with time-stepping particle methods while using significantly fewer particles.

Part 3 Special Session for Talks to Undergraduates

Topological Data Analysis and Machine Learning

Jae-Hun Jung
(POSTECH)

Modern data analysis increasingly deals with complex, high-dimensional, and structured data arising from various applications. Traditional methods often rely on local features, which can fail to capture the global structure of data. In contrast, topology provides tools to study the intrinsic shape of data, studying patterns that are robust under noise and deformation. In this lecture, we explain topological data analysis (TDA), focusing on persistent homology as a key method for extracting multi-scale topological features such as connected components, loops, and higher-dimensional structures. We explain how persistence homology summarize these features and discuss their stability and interpretability. We then explain how these topological information can be integrated into machine learning framework. Applications include analyzing the geometric structure of image data, understanding feature representations in neural networks, and capturing semantic organization in large language models. The goal of this lecture is to provide an accessible introduction to the role of topological methods in data analysis and in machine learning framework.

Kinetic Theory and Radiative Transfer: From Particles to Photons

Jin Woo Jang
(POSTECH)

Kinetic theory provides a microscopic description of the behavior of gas molecules, with the Boltzmann equation at its core. This equation not only explains the dynamics of gases in high-temperature and low-pressure regimes, but also serves as a fundamental framework for modeling a wide range of physical phenomena. In this talk, we introduce the basic concepts of kinetic theory and outline the derivation of the Boltzmann equation, illustrating how it captures the collective behavior of particles from underlying microscopic interactions. We then extend this perspective to the realm of radiative transfer, where the interaction between light and matter plays a crucial role. In particular, we explain how Boltzmann-type equations arise in modeling the propagation of radiation, and compare the characteristics of systems in thermodynamic equilibrium and non-equilibrium settings. Through this unified viewpoint, the talk highlights how seemingly different entities—particles and light—can be described within a common mathematical framework, demonstrating the power of mathematics in explaining and predicting complex natural phenomena.

Part 4 Poster Session

Name	Institution	Title
Jong-in Kim	POSTECH	Asymptotic behavior of large-amplitude solutions to the Boltzmann equation with soft interactions in $L^p_v L^\infty_x$ spaces
Kwanghyuk Park	POSTECH	Conservative approximation-based feedforward neural network for WENO schemes
Seungwan Han	POSTECH	A scaled TW-PINN: A physics-informed neural network for traveling wave solutions of reaction-diffusion equations with general coefficients
Sungbin Park	POSTECH	Exponential-Type Ill-Posedness Problem of the BGK and Boltzmann Models
Ting Xiao	ECNU	Supersonic Euler flow through a two-dimensional finite straight nozzle
Zhengrong Xie	ECNU	From Well-Posed Integral Invariant Model to Optimal Error Estimates for CSLDG Algorithm

Name	Institution	Title
Peng Chen	ECNU	Low-Rank and Deep Plug-and-Play Priors for Missing Traffic Data Imputation
Wenhan Zhang	ECNU	FEM–MsFEM Hybrid Methods for Stationary and Non-Stationary Stokes–Darcy Models
Ke Liu	ECNU	Radon measure-valued solutions of compressible Euler equations and concentration boundary layers in unsteady inviscid flows passing solid obstacles
Minghong Han	ECNU	Uniqueness of transonic shock solutions in general approximate nozzles for steady potential flow
Shuxin Ge	ECNU	Radial Positive Solution Branches and Singular Solutions of MEMS-type and Lane-Emden Equations with Steklov Boundary Conditions
Yuhang Zhou	ECNU	Blowup of C^1 Solution to an Inviscid Two-Phase Flow Model with Damping
Yunxiao Li	ECNU	Asymptotic Behavior of Rupture Solutions for the Elliptic MEMS Equation with Hénon and External Pressure

Name	Institution	Title
Wan Li	ECNU	Convergence analysis of approximate shape gradients for shape optimization in parabolic problems
Mingbo Zhou	ECNU	Shape Optimization of Stokes-Darcy Coupled System in Free-Flow and Porous Media

Part 5 Partial List of Participants

No.	Name	Institution
1	Jae-Hun Jung	Head, Department of Mathematics, POSTECH
2	Dongil Shin	POSTECH
3	Jin Woo Jang	POSTECH
4	Minseok Choi	POSTECH
5	Yeoneung Kim	Seoul National University of Science and Technology
6	Jong-in Kim	POSTECH
7	Kwanghyuk Park	POSTECH
8	Seungwan Han	POSTECH
9	Sungbin Park	POSTECH
10	Ling Guo	Shanghai Normal University
11	Paolo Piersanti	The Chinese University of Hong Kong, Shenzhen
12	Yuning Liu	New York University Shanghai
13	Haitao Wang	Shanghai Jiao Tong University
14	Yu Cao	Shanghai Jiao Tong University
15	Chuwen Ma	East China Normal University
16	Jie Du	East China Normal University
17	Pengbo Xu	East China Normal University
18	Yanyan Zhang	East China Normal University
19	Changhong Lyu	Assistant President of ECNU Dean of the Undergraduate School, ECNU
20	Zhi Jia	Head, School of Mathematical Sciences, ECNU

No.	Name	Institution
21	Bo Liu	Dean, School of Mathematical Sciences, ECNU
22	Li Luo	Associate Dean, School of Mathematical Sciences, ECNU
23	Tao Cheng	Associate Dean, School of Mathematical Sciences, ECNU
24	Hairong Yuan	Associate Dean, School of Mathematical Sciences, ECNU
25	Ping Bi	East China Normal University
26	Haohui Dai	East China Normal University
27	Ruoxia Du	East China Normal University
28	Yuanyuan Feng	East China Normal University
29	Wei Fu	East China Normal University
30	Xianlong Fu	East China Normal University
31	Xin Gao	East China Normal University
32	Xueping Guo	East China Normal University
33	Jialin He	East China Normal University
34	Xiaoqing He	East China Normal University
35	Xia Huang	East China Normal University
36	Fang Li	East China Normal University
37	Yuqi Li	East China Normal University
38	Yuqing Li	East China Normal University
39	Xingbo Liu	East China Normal University
40	Yinping Liu	East China Normal University
41	Mingkang Ni	East China Normal University
42	Jianyu Pan	East China Normal University
43	Xiaoyan Tang	East China Normal University
44	Liping Wang	East China Normal University
45	Zili Xu	East China Normal University
46	Zhuhong Yang	East China Normal University
47	Danping Yang	East China Normal University
48	Dong Ye	East China Normal University

No.	Name	Institution
49	Qingjie Ye	East China Normal University
50	Longtu Yuan	East China Normal University
51	Xingzhi Zhan	East China Normal University
52	Jing Zhang	East China Normal University
53	Xiangyun Zhang	East China Normal University
54	Chunyi Zhao	East China Normal University
55	Haibiao Zheng	East China Normal University
56	Feng Zhou	East China Normal University
57	Shengfeng Zhu	East China Normal University
58	Ting Xiao	East China Normal University
59	Zhengrong Xie	East China Normal University
60	Peng Chen	East China Normal University
61	Wenhan Zhang	East China Normal University
62	Ke Liu	East China Normal University
63	Minghong Han	East China Normal University
64	Shuxin Ge	East China Normal University
65	Yuhang Zhou	East China Normal University
66	Yunxiao Li	East China Normal University
67	Li Hang	East China Normal University
68	Wan Li	East China Normal University
69	Mingbo Zhou	East China Normal University
70	Gaoyang Li	East China Normal University
71	Shanwen Xu	East China Normal University
72	Xuqiong Zeng	East China Normal University
73	Yunfeng Lu	East China Normal University
74	Yuxin Chen	East China Normal University

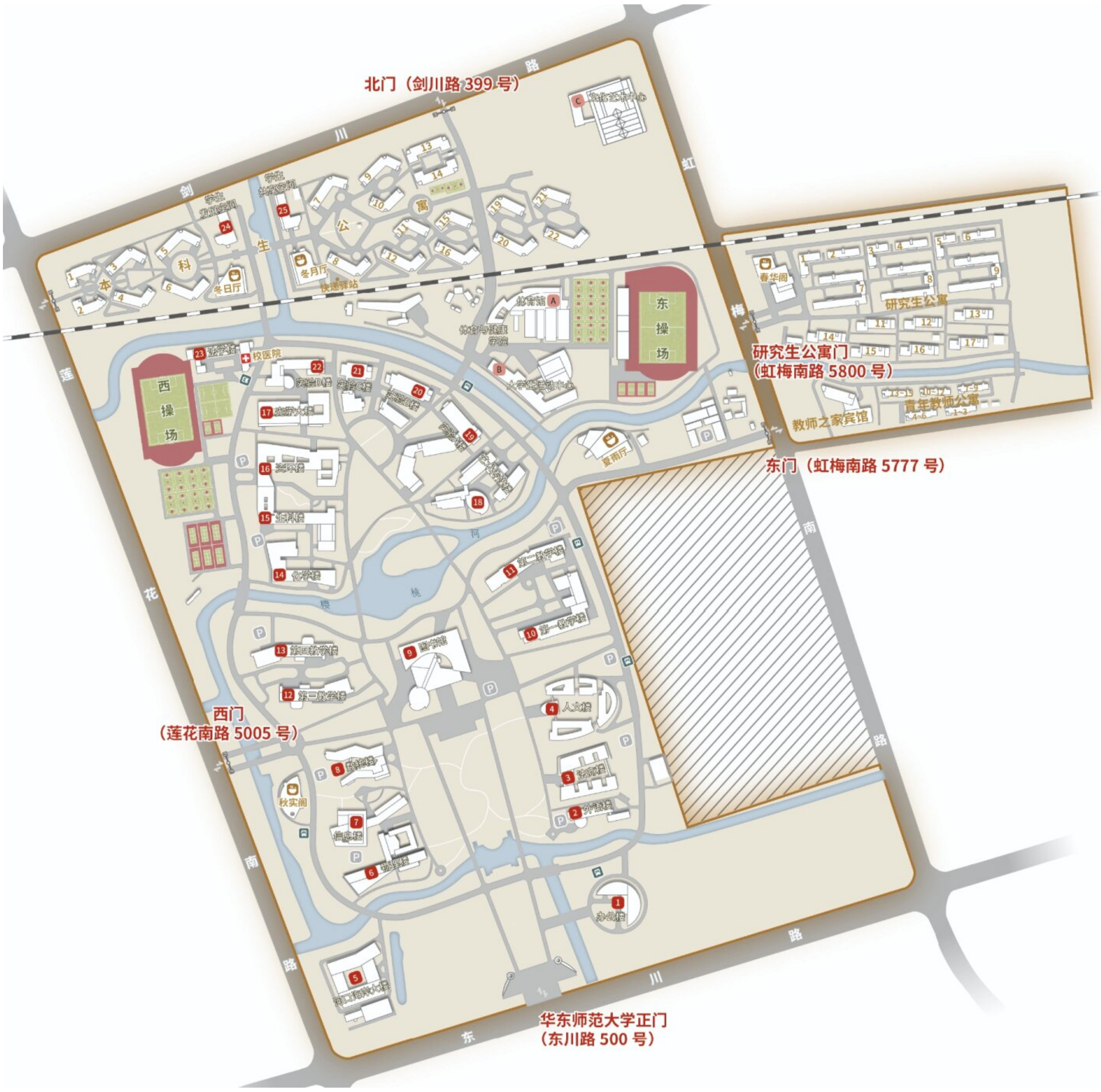
Part 6 Introduction to the School of Mathematical Sciences

The School of Mathematical Sciences at East China Normal University is a major national hub for mathematical research, talent cultivation, and the preparation of secondary school mathematics teachers. In the latest round of disciplinary evaluations by the Ministry of Education, the School received an excellent rating, and its research output ranks in the top 0.5% globally according to ESI rankings.

The School comprises three departments: Pure Mathematics, Applied Mathematics, and Mathematics Education. It offers a full range of specializations and possesses strong research capabilities. Its research platforms include the Ministry of Education Key Laboratory of Mathematics and Engineering Applications, the Shanghai Key Laboratory of Pure Mathematics and Practice, and several specialized mathematics research centers.

The discipline has a rich historical legacy. In particular, since the 1980s, under the guidance of mathematicians and educators such as Cao Xihua, Xiao Gang, and Zhang Dianzhou, East China Normal University became a pioneer in algebraic group and algebraic geometry research in China, as well as a leading institution in mathematics education research.

The School has an outstanding reputation in talent cultivation. It has been recognized as a national base for scientific research and talent training, a national characteristic program, and a national first-class un-



ECNU Minhang Campus Map

dergraduate program. The School also offers a special program for students in basic sciences and has been selected for the Ministry of Education's "Pilot Program 2.0 for Top-Notch Talent Training". It has cultivated a large number of mathematicians, scientists, educators, entrepreneurs, and technology professionals, making it a successful model for cultivating diverse, interdisciplinary talent in mathematics.

Part 7 Introduction to the Key Laboratory of Mathematics and Engineering Applications, Ministry of Education

---

The Key Laboratory of Mathematics and Engineering Applications, Ministry of Education, focuses on theoretical and applied research addressing the mathematical needs in smart transportation engineering and coastal and ecological engineering. Being problem-oriented and aiming for practical implementation, the laboratory conducts problem-driven mathematical research and applications, deeply investigating the underlying mathematical theories for broader applications. Leveraging Shanghai's locational advantages, the laboratory serves the regional construction and development needs of both the nation and the Shanghai area.

The laboratory integrates university-level research platforms at East China Normal University, such as the Algebra Research Center, the Center for Partial Differential Equations, the Center for Geometric Analysis, and the Center for Applied Mathematics and Interdisciplinary Studies. It consolidates key development directions, precisely aligns with national strategies, and enhances the capability for collaborative innovation across industry, academia, and research, as well as the capacity to undertake major national and local projects. In basic research, it focuses on frontier fundamental problems with application prospects, using pure mathematics to provide disruptive technologies for mathematical applications. In applied mathematics, it conducts problem-driven research to provide mathematical support for national and regional innovative development.

Value Creating University

POSTECH