Forum on Applied and Computational Mathematics: From Problem to Insights

Agenda & Talk Information

March 28-30, 2025
Duke Kunshan University
Innovation Building（创新楼）2028
Zoom: 921 2574 5472 Pin: dkumath

Sponsors:

- **Zu Chongzhi Center for Mathematics and Computational Sciences, Duke Kunshan University**
- **Liu Bie Ju Centre for Mathematical Sciences City University of Hong Kong**
- **National Natural Science Foundation of China**

DUKE KUNSHAN
Zu Chongzhi Center for Mathematics and Computational Sciences

Liu Bie Ju Centre for Mathematical Sciences
香港城市大學 City University of Hong Kong

Mar. 28th 2025

Time	Chair	Speaker
8:15-8:30	Open Remark	Feng Tian
8:30-9:00	Huaxiong Huang	Roderick Wong A Short History of Asymptotics
9:00-9:30		Jun Zhang How things fall: from meteorites to snowflakes
9:30-10:00		Peter Gibson Results and open problems in acoustic imaging of layered media
10:00-10:30	Break &Photo	
10:30-11:00	Roderick Wong	Kaizhu Huang Interpreting and Generalizing Visual Classification with Logical Reasoning Regularization
11:00-11:30		Junjie Zhang The Impact of Climate Change on Rural Credit Risks
11:30-12:00		Jianbo Yue Quantitative Biology Approaches to Cell Signaling: Insights from MAPK Signaling in Oocyte Maturation and Endosomal Trafficking
12:00-13:30	Lunch Break	
13:30-14:00	Yayan Lu	Felipe Cucker The 17th problem of Smale
14:00-14:30		Qiang Zhang Investment and Consumption under Transaction Costs
14:30-15:00		Dong Wang Efficient methods for interface related optimization problems
15:00-15:30	Break	
15:30-16:00	Chunhua Ou	Dinghua Xu Two kinds of inverse problems in intelligent design industry
16:00-16:30		Minjie Luo On the asymptotics of some multivariable hypergeometric functions
16:30-17:00	Dinghua Xu	Yutian Li Asymptotic analysis and connection formulas for the first Painlevé equation
17:00-17:30		Yu Lin From Classroom to Real World: How Mathematical Tools Drive Modern Problem-Solving

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Time	Chair	Speaker
8:30-9:00	Rongliang Chen	Gergő Nemes Divergent Series: A Deal with the Devil?
9:00-9:30		Tiezheng Qian Dynamic flow structures in active viscoelastic liquids
9:30-10:00		Weiwei Sun Mathematical Modeling, computation and analysis for heat and sweat transport in porous textile materials
10:00-10:30	Break	
10:30-11:00	Tiezheng Qian	Lun Zhang Transient asymptotics of the modified Camassa-Holm equation
11:00-11:30		Dongmian Zou Exploring Effective Representations Using Hyperbolic Neural Networks
11:30-12:00		Rongliang Chen High-Performance Computing for Patient-Specific Biomechanics Simulations: Scalable Methods and Clinical Applications
12:00-13:30	Lunch	
13:30-14:00	Jonathan Wylie	Yayan Lu Bound states in the continuum in Schrodinger equations
14:00-14:30		Kui Li Local behavior, radial symmetry and classification of solutions to a class of weighted elliptic equations
14:30-15:00		Yuqiu Zhao Connection formulas and real solutions of the fourth Painlevé equation
15:00-15:30	Break	
15:30-16:00	Zhen Zhang	Dan Dai Eigenvalue distributions for random matrices
16:00-16:30		Jonathan Wylie Stability of drawing of micro-structured optical fibers
17:00-18:00	Scott MacEachern (VCAA)	Feng Shen (Public Lecture) Opportunities and Challenges in the New Era of Automobiles
18:30-20:30	Banquet	

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Mar. 30th 2025

Time	Chair	Speaker
8:30-9:00	Shixin Xu	Zhen Zhang A novel phase-field model for N-phase problems
9:00-9:30		Xiaobo Gong Investigations on the mechanisms of fluid-membrane interaction of red blood cells and novel practices
9:30-10:00		Zhe Huang Study on the speed selection of spreading speeds for monotone systems
10:00-10:30	Break	
10:30-11:00	Shixin Xu	Jun Wang On Julia limiting directions of meromorphic functions
11:00-11:30		Weiyuan Qiu Asymptotic behaviors of Hausdorff dimensions of radial Julia sets of exponential and cosine functions
11:30-12:00		Zhitao Wen Difference analogue of “abc” theorem
	Close Remark	Roderick Wong Yayan Lu Huaxiong Huang
12:00-14:00	Lunch Break	
14:00-17:30	Discussion	

Title: High-Performance Computing for Patient-Specific Biomechanics Simulations: Scalable Methods and Clinical Applications
Speaker: Rongliang Chen
Affiliation: Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences
Abstract: The increasing demand for personalized healthcare solutions has brought biomechanical simulations to the forefront of medical diagnostics and treatment planning. Fast and accurate simulations are critical for clinical applications, where timely decision-making can significantly impact treatment outcomes. Biomechanical models, however, are inherently complex, involving multiphysics such as fluid-structure interaction (FSI) and structure-electrical interaction. These models are highly nonlinear, and the corresponding discretized systems are often large and ill-conditioned, posing significant challenges for numerical solution techniques. In this talk, we present some parallel scalable domain decomposition methods for patient-specific biomechanics simulations. These methods enable the efficient and accurate solution of large-scale computational models that capture the complex dynamics of biological systems. By significantly improving computational efficiency and scalability, our approach makes these simulations feasible for real-world clinical applications in personalized medicine. We will also discuss applications of this methodology in cardiovascular simulations, where patient-specific data are used to predict surgical outcomes and optimize treatment strategies, demonstrating the potential for improving patient care.

Title: The 17th problem of Smale
Speaker: Felipe Cucker
Affiliation: City University of Hong Kong
Abstract: At the turn of the century the International Mathematical Union edited a book with the panorama of mathematics, both in terms of achievements and of problems to solve. The book included three lists of problems for the mathematicians of the 21st century, written by Vaughan Jones, Steve Smale, and Shing-Tung Yau. In the talk I will explain what the 17th problem in the list of Smale is and some of the main results leading to its solution. If time allows it, I can describe further results and open problems.

Title: Eigenvalue distributions for random matrices
Speaker: Dan Dai
Affiliation: City University of Hong Kong
Abstract: In this talk, we will provide a brief introduction to random matrices, focusing on eigenvalue distributions. We will review some celebrated results in the literature and briefly discuss applications of random matrices.

Title: Results and open problems in acoustic imaging of layered media
Speaker: Peter Gibson
Affiliation: York University, Canada
Abstract: We discuss some mathematical aspects of acoustic wave propagation in layered media and their relation to practical technology for nondestructive testing and imaging. Some known results will be presented, as will a number of open questions. In particular, we discuss two types of acoustic experimental data, phaseless reflection data and transmission data, and the mathematical problem associated with their use in acoustic testing of physical structure.

Title: Investigations on the mechanisms of fluid-membrane interaction of red blood cells and novel practices
Speaker: Xiaobo Gong
Affiliation: Shanghai Jiaotong University
Abstract: As one of the most common cells inside our body, red blood cells (RBCs) play crucial roles in maintaining the living environments, not only for oxygen transportation but also for rolling adhesion of nucleated cells in immunological processes, and cardiovascular disease induced by the stiffening of RBCs etc. In this talk, we introduced our continuous work on modeling RBCs from single cell to cell-cell interactions. It is interesting to show that RBC deformation suggests a high-throughput for measurement of mechanical properties of RBC which indicates a novel method for diagnosis of diabetes using biophysical markers of RBCs. We also find that manipulating the secondary flow stably in a 3-dimensional microfluidics, whole blood is purified from dispersed particles efficiently (Research & Presentations are supported by National Science Foundation China Nos. 12072198 and 12432014)

Title: Interpreting and Generalizing Visual Classification with Logical Reasoning Regularization
Speaker: Kaizhu Huang
Affiliation: Duke Kunshan University
Abstract: Machine learning models can excel in classification but may struggle to generalize to unseen data, such as classifying images from unseen domains or discovering novel categories from data. In this talk, we explore the relationship between logical reasoning and deep learning generalization in the context of visual classification. A logical regularization termed L-Reg is derived which bridges a logical analysis framework to image classification. Our work unveils the interpretability brought by L-Reg, as it enables the model to extract the salient features, such as faces to persons, for classification.

Theoretical analysis and experiments demonstrate that L-Reg enhances generalization across various scenarios, including multi-domain generalization and generalized category discovery. In complex real-world scenarios where images span unknown classes and unseen domains, L-Reg consistently improves generalization, highlighting its practical efficacy.

Title: Study on the speed selection of spreading speeds for monotone systems
Speaker: Zhe Huang
Affiliation: Guangdong University of Finance
Abstract: In this talk, I will introduce the spreading speed determinacy to an abstract time-periodic monotone semiflow, which is of monostable type with weak compactness and admits boundary equilibria in the phase space. The problem is challenging due to the existence of single spreading speed or multiple spreading speeds (fastest and slowest spreading speeds). We first study under what condition single spreading speed exists and establish necessary and sufficient conditions for linear and nonlinear selections of the spreading speed as well as the minimal wave speed of traveling wavefronts. In the case of multiple spreading speeds, the determinacy of each speed is further investigated based on the connection of wavefronts to the boundary equilibria. To illustrate our results, we apply them to four time-periodic models: a delayed diffusive equation, a stream population model with a benthic zone, a nonlocal dispersal Lotka-Volterra model, and a reducible cooperative system.

Title: Local behavior, radial symmetry and classification of solutions to a class of weighted elliptic equations
Speaker: Kui Li
Affiliation: Zhengzhou University
Abstract: We study positive solutions with an isolated singularity to a class of weighted elliptic equations in $B_1\backslash\{0\}$ and in $R^N\backslash\{0\}$. In $B_1\backslash\{0\}$, we first present some results on the asymptotic behavior for positive solutions at the singular point. Then in $R^N\backslash\{0\}$, we prove radially symmetric properties for positive singular solutions, and give classification for them.

Title: Asymptotic analysis and connection formulas for the first Painlevé equation
Speaker: Yutian Li
Affiliation: Chinese University of Hong Kong, Shenzhen
Abstract: We consider a connection problem of the first Painlevé equation (PI), trying to connect the local behavior (Laurent series) near poles and the asymptotic behavior as the variable tends to the negative infinity for real PI functions. We get a classification of the real PI functions in terms of p, the location of a pole and H, the free parameter in the Laurent series. Some limiting-form connection formulas of PI functions are obtained for large H. Specifically, for the real tritronquée solution, the large- n asymptotic formulas of p_n and H_n
are obtained, where p_n is the n-th pole on the real line in the ascending order and H_n is the associated free parameter.
Our approach is based on the complex WKB method (also known as the method of uniform asymptotics) introduced by Bassom et al. in their study on the connection problem of the second Painlevé transcendent [*Arch. Ration. Mech. Anal.*, 143 (1998), pp. 241--271].
Our asymptotic and numerical results partially answer Clarkson's open question on the connection problem of the first Painlevé transcendent.

Title: From Classroom to Real World: How Mathematical Tools Drive Modern Problem-Solving
Speaker: Yu Lin
Affiliation: South China University of Technology
Abstract: This talk explores how fundamental mathematical concepts from undergraduate courses—such as calculus, linear algebra, and probability theory—are key tools in solving contemporary challenges. We will demonstrate how these theoretical foundations are transformed into practical problem-solving instruments across various fields. By examining real-world applications, we highlight how core mathematical principles continue to drive innovation and shape solutions in an increasingly complex world.

Title: Bound states in the continuum in Schrodinger equations
Speaker: Yayan Lu
Affiliation: City University of Hong Kong
Abstract: In 1929, von Neumann and Wigner constructed a bound state for a one-dimensional Schrodinger equation with an energy in the radiation spectrum. It corresponds to an eigenvalue in the continuous spectrum, and thus, is called a bound state in the continuum (BIC). However, in von Neumann and Wigner's Schrodinger equation, the potential is oscillatory as x tends to infinity. In this talk, we analyze BICs for a system of two one-dimensional Schrodinger equations with a potential that is constant for sufficiently large x.

Title: On the asymptotics of some multivariable hypergeometric functions
Speaker: Minjie Luo
Affiliation: Donghua University
Abstract: In a series of papers published between 1954 and 1957, S. Saran systematically studied the hypergeometric functions of three variables. In this talk, we present the latest results on the asymptotics of Saran's F_K function and its related functions. A brief introduction to the history and applications of these multivariable hypergeometric functions is also provided to offer inspiration and insights for research.

Title: Divergent Series: A Deal with the Devil?
Speaker: Gergő Nemes
Affiliation: Harbin Institute of Technology
Abstract: Rainbows are a natural phenomenon that have fascinated scientists for centuries, and mathematics plays a key role in explaining their intricate details. This talk explores how divergent series—once called the "invention of the devil" by Abel—refine our understanding of supernumerary rainbows. We begin with Young's theory and Airy's refinement, leading to Stokes' divergent asymptotic series for the dark bands between rainbows. Surprisingly, these divergent series provide remarkably accurate results with just a few terms, far outperforming traditional convergent power series. We will also briefly touch on the modern theory of resurgence, which sheds new light on these series. Through this journey, we will see how seemingly ill-behaved mathematical methods can yield deep and practical insights.

Title: Dynamic flow structures in active viscoelastic liquids
Speaker: Tiezheng Qian
Affiliation: Hong Kong University of Science and Technology
Abstract: Active fluids encompass a wide range of non-equilibrium fluids, in which the self-propulsion or rotation of their units can give rise to large-scale spontaneous flows. Despite the diversity of active fluids, they are commonly viscoelastic. Therefore, we develop a hydrodynamic model of isotropic active liquids by accounting for their viscoelasticity. Specifically, we incorporate an active stress term into a general viscoelastic liquid model to study the spontaneous flow states and their transitions in two-dimensional channel, annulus, and disk geometries. We have discovered rich spontaneous flow states in a channel as a function of activity and Weissenberg number, including unidirectional flow, travelling wave, and vortex-roll states. The Weissenberg number acts against activity by suppressing the spontaneous flow. In an annulus confinement, we find that a net flow can be generated only if the aspect ratio of the annulus is not too large nor too small, consistent with the experiments of microtubule-based active fluids. In a disk geometry, we observe a periodic chirality-switching of a single vortex flow, resembling the bacteria-based active fluid experiments. As such, our active viscoelastic model offers a unified framework to elucidate diverse active liquids, uncover their connections, and highlight the universality of dynamic active-flow patterns. — This work is supported by Hong Kong RGC and completed through a collaboration with Zhe Feng and Rui Zhang (to appear in JFM Rapids).

Title: Asymptotic behaviors of Hausdorff dimensions of radial Julia sets of exponential and cosine functions
Speaker: Weiyuan Qiu
Affiliation: Fudan University
Abstract: We obtained a four-term asymptotic formula of the Hausdorff dimension of the radial Julia set $J_r(f_\lambda)$ for the exponential function $f_\lambda(z) = \lambda e^z$ as $\lambda \to 0$ which improves upon the results given by Karpińska and by Bergweiler-Ding. Moreover, we have also explored the asymptotic behaviors of the Hausdorff dimension of the radial Julia set of cosine function $f_{a,b}(z) = ae^z + be^{-z}$as $a, b \to 0$ in various ways.

Title: Opportunities and Challenges in the New Era of Automobiles
Speaker: Feng Shen
Affiliation: Nio Inc.
Abstract: Drawing on over 20 years of experience in the automotive sector, Dr. Shen Feng will share his insights into the industry's transformative journey. He will examine the seismic shifts in automotive technology, from the transition to electric powertrains to the integration of intelligent systems. Dr. Shen will also highlight the evolving supply chain landscape, emphasizing the need for sustainability and the emergence of new players. Central to his talk is the profound impact of smart electric vehicles on human mobility, illustrating how these innovations are revolutionizing the driving experience and reshaping urban environments. By offering a glimpse into the future, Dr. Shen aims to highlight both the immense opportunities for growth and the challenges that lie ahead in this dynamic new era of automobiles.

Title: Mathematical Modeling, computation and analysis for heat and sweat transport in porous textile materials

Speaker: Weiwei Sun
Affiliation: United International College

Abstract: Mass and heat transfer in fibrous porous media can be found in numerous industrial and engineering applications such as textile, paper and pulp, building materials and more recently in the electrodes of proton exchange membrane fuel cells. In these applications, modeling becomes increasingly important as it provides an efficient and cost effective way for evaluating new designs or testing new materials. In this talk, we present our recent work on heat and sweat transport in fibrous clothing assemblies. We formulate this problem as multi-component and multi-phase flows in fibrous porous media with phase change and fiber absorption, which is described by a system of nonlinear parabolic PDEs. We present our numerical simulations on several practical cases, including human-sweat, firefighter-jacket and 3D clothing assemblies. Qualitative comparison between the numerical results and the experimental measurements are also given. Mathematical analysis for some simplified models are also presented.

Title: Efficient methods for interface related optimization problems

Speaker: Dong Wang
Affiliation: The Chinese University of Hong Kong, Shenzhen

Abstract: In this talk, we will talk about the recent advances in designing the efficient numerical methods for interface related optimization problems raised from structure design, topology optimization, and image segmentation. We will mainly talk about how mechanism constraints are imposed into the methods to obtain better results. We will use an example in image segmentation with topology preservation constraint to illustrate the basic ideas and extend it to topology optimization problems and optimal partition problems. If time permits, we will also talk about the integration between deep neural networks and interface related problems.

Title: On Julia limiting directions of meromorphic functions

Speaker: Jun Wang
Affiliation: Fudan University

Abstract: Let be a meromorphic function in the complex plane. A value $\theta \in [0, 2\pi)$ is called a Julia limiting direction of f if there is an unbounded sequence $\{z_n\}$ in the Julia set $J(f)$ satisfying $\lim_{n\to\infty} \arg z_n = \theta (\mathrm{mod}\ 2\pi)$.We denote by $L(f)$ the set of all Julia limiting directions of f. Our main result is that, for any non-empty compact set $E \subseteq [0, 2\pi)$ and $\rho \in [0, \infty]$, there are an entire function f of infinite lower order and a transcendental meromorphic function g of order ρ such that $L(f) = L(g) = E$. In addition, we have also constructed some transcendental entire functions whose lower order is $\rho \in (1/2, \infty)$ and whose $L(f)$ coincides with a certain kind of compact set. To prove our results, we have established a criterion for a direction θ to be a Julia limiting direction of a function by utilizing the growth rate of the function in the direction θ. The criterion may be of independent interest.

Title: Difference analogue of "abc" theorem
Speaker: Zhitao Wen
Affiliation: Shantou University
Abstract: In this talk, we give difference analogue of "abc" theorem by a new definition on difference radical for polynomials. We also generalize this result for transcendental entire functions of order less than 1, which can be seen difference abc theorem for entire functions of order less than 1.

Title: A Short History of Asymptotics
Speaker: Roderick Wong
Affiliation: City University of Hong Kong
Abstract: Asymptotics is a topic in Mathematical Analysis. Its aim is to investigate the behavior of functions as one of their variables tends to infinity or tends to zero. These functions can be solutions of differential equations or representations of integrals. Its application is very broad, including Statistics, Computer Science, Physics, Chemistry and Biology.
In this lecture, I will mention a few examples to illustrate its usefulness.

Title: Stability of drawing of micro-structured optical fibres
Speaker: Jonathan Wylie
Affiliation: City University of Hong Kong
Abstract: We consider the stability of the drawing of a long and thin viscous thread with an arbitrary number of internal holes of arbitrary shape. Flows of this type are fundamental in the fabrication of micro-structured optical fibres that have the revolutionized the transmission of data and are extremely important in modern sensing. The thread evolves due to a complicated interaction between axial drawing, inertia, surface tension, thermal and pressurization effects. Despite the complicated geometry of the boundaries, we use asymptotic techniques to determine a particularly convenient formulation of the equations of motion that is well-suited to stability calculations. We use this formulation to show how the presence of internal holes affects the stability of the drawing process and address a longstanding question from the literature. We also consider the interactions between external cooling, surface tension and inner hole pressurization and show that these effects combine in a complicated way to produce counterintuitive behaviour. We carefully explore these effects and explain the underlying mechanisms.

Title: Two kinds of inverse problems in intelligent design industry
Speaker: Dinghua Xu
Affiliation: Shanghai University of Finance and Economics
Abstract: The talk will present inverse problems approaches for textile material parameter design in textile engineering and catalyst preparation process modelling in chemical industry.

Title: Quantitative Biology Approaches to Cell Signaling: Insights from MAPK Signaling in Oocyte Maturation and Endosomal Trafficking

Speaker: Jianbo Yue
Affiliation: Duke Kunshan University

Abstract: Cell signaling governs essential biological processes, and a quantitative approach is critical for dissecting its complex regulatory mechanisms. In this presentation, I will illustrate how quantitative biology can be applied to study cell signaling using MAPK signaling in oocyte maturation as an example. By integrating computational modeling and biochemical analysis, we can gain deeper insights into the dynamic regulation of signaling networks. Additionally, I will introduce my research on endosomal trafficking and its role in signal transduction, highlighting how endosomal transport dynamics influence cellular responses. Understanding these mechanisms through quantitative methods can provide novel perspectives on cellular communication and potential therapeutic targets.

Title: How things fall: from meteorites to snowflakes

Speaker: Jun Zhang
Affiliation: NYU Shanghai and New York University

Abstract: Studying how solid objects fall through a fluid, whether water or air, has long been an active branch of research in fluid dynamics. Gaining a deeper understanding of these processes enhances our knowledge on the interaction between falling objects with their surrounding fluids. In this talk, I will discuss the behavior of solid bodies as they fall, from heavy cones to fluffy snowflakes. The distinct dynamic behaviors found in our experiments help explain several fascinating natural phenomena, including the descent of meteorites and their unique shapes, as well as the optical effects produced collectively by snow crystals.

Title: The Impact of Climate Change on Rural Credit Risks

Speaker: Junjie Zhang
Affiliation: Duke Kunshan University

Abstract: This study examines the climate vulnerability of rural credit markets in China. Utilizing granular records of agricultural production loans, we quantify the adverse effects of extreme weather events on credit quality. Our findings reveal significant climate-risk transmission channels: Each additional extreme cold day/year post-loan issuance elevates the probability of default (PD) by 0.08-0.28 percentage points, while extreme heat and heavy precipitation days increase PD by 0.02-0.022 and 0.015-0.022 percentage points respectively. Projections suggest unmitigated climate warming could amplify baseline default probabilities by 0.6-1.6 percentage points per year through intensified weather shocks. Notably, we identify adaptive responses in credit pricing strategies. RCCs systematically reduce loan spreads by 2-4 basis points per additional extreme heat day and 0.5-1 basis points per precipitation day observed during pre-issuance periods. Using IV methods, we find that a low pricing strategy substantially mitigates climate impacts - a 10 basis point spread reduction offsets around 50% of default risk from daily temperature extremes. These results highlight the critical interaction between climate resilience and financial market adaptations.

Title: Transient asymptotics of the modified Camassa-Holm equation

Speaker: Lun Zhang
Affiliation: Fudan University

Abstract: In this talk, we are concerned with long time asymptotics of the modified Camassa-Holm equation in three transition zones under a nonzero background. The first transition zone lies between the soliton region and the first oscillatory region, the second one lies between the second oscillatory region and the fast decay region, and possibly, the third one, namely, the collisionless shock region, that bridges the first transition region and the first oscillatory region. Under a low regularity condition on the initial data, we obtain Painlevé-type asymptotic formulas in the first two transition regions, while the transient asymptotics in the third region involves the Jacobi theta function. We establish our results by performing a $\bar{\partial}$ nonlinear steepest descent analysis to the associated Riemann-Hilbert problem. Joint work with Taiyang Xu and Yiling Yang.

Title: Investment and Consumption under Transaction Costs

Speaker: Qiang Zhang
Affiliation: Institute of Mathematical Research, Beijing Normal University & UIC

Abstract: Selections of the optimal investment strategy and the optimal consumption strategy to meet various investors' risk attitudes are very important issues in modern finance. Several important optimal strategies have been carried out under the assumption of no transaction costs. Such an assumption is not realistic. The transaction costs are unavoidable in the execution of selected strategies and must be included in the strategy design process. Transaction costs can occur in the form of proportional cost and fixed cost. Mathematically, determination of the optional investment and consumption strategies with transaction costs requires solving a nonlinear partial differential equation, known as Hamilton-Jacobi-Bellman equation, in high dimensions with four free-boundaries. This makes the problem not only practically important but also mathematically difficult. In this talk we represent our solution to this difficult problem. We obtained the analytical expressions for the optimal asset allocation strategy, for the optimal consumption strategy and for the four free boundaries associated with fixed and proportional transaction costs. In financial industry, fund managers need to adjust the holding of financial instruments in their funds to reduce the risks and to enhance the performance of their funds. In doing so, one must take into account the transaction costs. Therefore, the findings in our results not only have importance in theoretical understanding, but also provide practical guidance for fund managers in financial industry.

Title: A novel phase-field model for N-phase problems

Speaker: Zhen Zhang
Affiliation: Southern University of Science and Technology

Abstract: We propose a novel phase-field model for N-phase problems by using a dichotomic representation. Derived from Onsager's variational principle, the proposed model enjoys mechanic, energetic, algebraic and dynamic consistencies and is shown to asymptotically converge to its sharp interface limit. An operator-splitting based numerical method is developed to simulate the model with both second-order accuracy and energy stability. Various numerical results are presented to validate theoretical derivation and show interesting phenomena.

Title: Connection formulas and real solutions of the fourth Painlevé equation

Speaker: Yuqiu Zhao
Affiliation: Sun Yat-sen University

Abstract: Connection formulas furnish a central piece in understanding local and global behaviour. We take as an example the fourth Painlevé equation, to demonstrate methods leading to such formulas. The main focus will be on a combination of the idea of monodromy data, with the Riemann-Hilbert method.
This talk is based on joint papers with Jun XIA and Shuai-Xia XU.

Title: Exploring Effective Representations Using Hyperbolic Neural Networks

Speaker: Dongmian Zou
Affiliation: Duke Kunshan University

Abstract: Hyperbolic Neural Networks (HNNs) have recently found successful in representing hierarchical and complex data. However, unlike other domains, the exploration of hyperbolic neural operations and the development of effective hyperbolic representations remains limited. We delve into developing HNN architectures and addressing the stability and robustness issues. In this talk, we discuss some of our recent findings in the following aspects: first, we investigate representation learning through hyperbolic convolutions with provable properties; second, we enhance representations with Gromov-Wasserstein regularization; third, we improve stability and robustness by designing hyperbolic operations and regularization techniques. Finally, we demonstrate the practical applications of these advancements in tasks such as few-shot image classification, graph classification, and anomaly detection.