VIASM
VIETNAM INSTITUTE FOR ADVANCED STUDY IN MATHEMATICS

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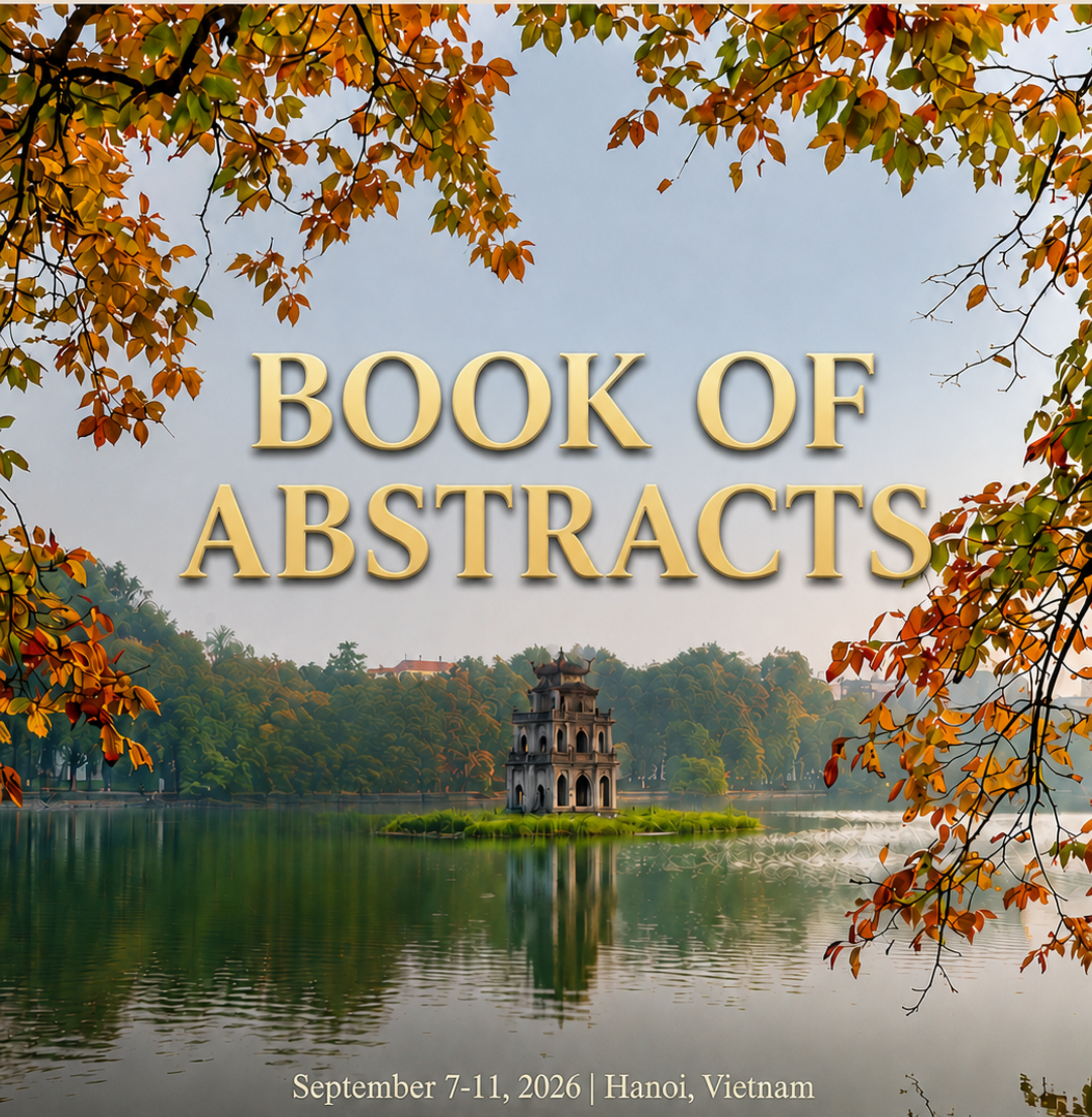
RITSUMEIKAN UNIVERSITY

# AUTUMN SCHOOL AND VIETNAM - JAPAN WORKSHOP ON APPLIED MATHEMATICS



# BOOK OF ABSTRACTS

September 7-11, 2026 | Hanoi, Vietnam

# Autumn School and Vietnam - Japan Workshop on Applied Mathematics

September 7–11, 2026

# Contents

# 1 Introduction

## Overview

The Autumn School and Vietnam - Japan Workshop on Applied Mathematics will be held from September 7 to September 11, 2026. This academic event gathers researchers, lecturers, and students to discuss and present recent advancements in Probability and Statistics, and Partial Differential Equations.

## Organizing Committee

- Vietnam Institute for Advanced Study in Mathematics (VIASM)
- Hanoi National University of Education (HNUE)
- Hanoi University of Science and Technology (HUST)
- Ritsumeikan University

**Contact:** Mr. Nguyen Quang Huy (nqhuy@viasm.edu.vn)

## Lecturers

- **Duong Anh Tuan**, Hanoi University of Science and Technology, Vietnam
- **Setsuro Fujiie**, Ritsumeikan University, Japan
- **Yushi Hamaguchi**, Kyoto University, Japan
- **Jorge Ignacio González Cázares**, National Autonomous University of Mexico

## Speakers

***Invited Speakers - Section on Probability and Statistics:***

- **Masaaki Fukasawa**, Osaka University, Japan
- **Nino Kordzakhia**, Macquarie University, Australia
- **Alex Novikov**, University of Technology, Sydney, Australia
- **Alessio Rondelli**, University of Bologna, Italy
- **Ju-Yi Yen**, University of Cincinnati, USA
- **Nguyen Tien Dung**, VNU University of Sciences, Vietnam
- **Can Van Hao**, Institute of Mathematics, Vietnam
- **Hoang Viet Hung**, Industrial University of Ho Chi Minh City, Vietnam
- **Pham Viet Hung**, Institute of Mathematics, Vietnam
- **Phan Thi Huong**, Le Quy Don Technique University, Vietnam
- **Nguyen Tran Thuan**, UEH University, Vietnam

***Invited Speakers - Section on Partial Differential Equation:***

- **Takuya Mine**, Kyoto Institute of Technology, Japan
- **Hisashi Morioka**, Ehime University, Japan
- **Kenta Higuchi**, Gifu University, Japan
- **Nguyen Nhu Thang**, Hanoi National University of Education, Vietnam
- **Tran The Dung**, VNU University of Sciences, Vietnam
- **Dinh Nho Hao**, Institute of Mathematics, Vietnam
- **Nguyen Van Hoang**, FPT University, Vietnam
- **Tran Dinh Ke**, Hanoi National University of Education, Vietnam
- **Nguyen Tien Tai**, VNU University of Sciences, Vietnam
- **Nguyen Van Thin**, Thai Nguyen University, Vietnam
- **Nguyen Minh Tri**, Institute of Mathematics, Vietnam

**Contributed Speakers:**

- **Nakano Yuzaburo**, Yokohama National University, Japan
- **Syudo Hiroki**, Ritsumeikan University, Japan
- **Tamura Yuma**, Tokyo University of Sciences, Japan
- **Kambara Reika**, Ritsumeikan University, Japan
- **Yasuda Kazuhiro**, Hosei University, Japan
- **Ryoichi Suzuki**, Tokyo University of Science, Japan
- **Ito Masato**, Ritsumeikan University, Japan
- **Sota Hosokawa**, Ritsumeikan University, Japan
- **Xinmiao Zhang**, Ritsumeikan University, Japan
- **Yanyi Jiang**, Ritsumeikan University, Japan
- **Yuta Kawamura**, Ritsumeikan University, Japan
- **Vu Thi Hue**, Hanoi University of Science and Technology, Vietnam
- **Vu Thi Huong**, University of Transport and Communications, Vietnam

# 2 Schedule and Venue

## Venues

- **VIASM:** Vietnam Institute for Advanced Study in Mathematics, 161 Huynh Thuc Khang Street, Lang Ward, Hanoi (September 7-8, mornings of September 9-10, and September 11).
- **HUST:** Hanoi University of Science and Technology, 1 Dai Co Viet Street, Bach Mai Ward, Hanoi (Afternoon of Wednesday, September 9).
- **HNUE:** Hanoi National University of Education, 136 Xuan Thuy Street, Cau Giay Ward, Hanoi (Afternoon of Wednesday, September 9).

## Schedule

## Monday, September 7 (Venue: VIASM)

| Time | Speaker | Title |
|---|---|---|
| 08:30-10:00 | Setsuro Fujiie | An introduction to the scattering theory on the line and quantum walk |
| 10:00-10:15 | **Break** | |
| 10:15-11:45 | Jorge Ignacio González Cázares | Stochastic Optimization and its role in MCMC |
| 11:45-13:30 | **Lunch** | |
| 13:30-14:15 | Hisashi Morioka | Quantum walk representations of quantum circuits |
| 14:20-15:05 | Dinh Nho Hao | Determination of Surface Temperature from Interior Measurements |
| 15:05-15:25 | **Break** | |
| 15:25-16:10 | Takuya Mine | IDS for random point interactions |
| 16:15-17:00 | Alexander Novikov | The Martingale Approach to Boundary Crossing Problems for Stochastic Processes |
| 17:05-17:50 | Tran The Dung | A Unified Gradient-Flow Approach to Higher-Order Riemannian Spline Interpolation, with an Application to Quantum Splines |

## Tuesday, September 8 (Venue: VIASM)

| Time | Speaker | Title |
|---|---|---|
| 08:30-10:00 | Jorge Ignacio González Cázares | Stochastic Optimization and its role in MCMC |
| 10:00-10:15 | **Break** | |
| 10:15-11:45 | Setsuro Fujiie | An introduction to the scattering theory on the line and quantum walk |
| 11:45-13:30 | **Lunch** | |
| 13:30-14:15 | Can Van Hao | Subdiffusive concentration for the chemical distance in Bernoulli percolation |
| 14:20-15:05 | Nguyen Van Thin | A remark on the finite-time blow-up for the critical heat equation in $\mathbf{R}^N$ |
| 15:05-15:25 | **Break** | |
| 15:25-16:10 | Hoang Viet Hung | Boundary contacts for reflected random walks in the quarter plane |
| 16:15-17:00 | Kenta Higuchi | Fermi's golden rule and a complex translation method for resonances of quantum walks |
| 17:05-17:50 | Alessio Rondelli | Some approximation results about the reflected perturbed Brownian motion |

## Wednesday, September 9 (Morning Venue: VIASM)

| Time | Speaker | Title |
|---|---|---|
| 08:30-10:00 | Duong Anh Tuan | On the super-solutions of the Lane-Emden equation/system |
| 10:00-10:15 | **Break** | |
| 10:15-11:45 | Yushi Hamaguchi | Introduction to stochastic Volterra equations |
| 11:45-13:30 | **Lunch** | |

## Wednesday, September 9 (Afternoon Venue 1: HUST)

| Time | Speaker | Title |
|---|---|---|
| 13:30-14:15 | Nguyen Van Hoang | The L2-Caffarelli-Kohn-Nirenberg inequalities: The sharp constants and stability estimate |
| 14:20-15:05 | Yuta Kawamura | Propagation of Semiclassical Wave Front Sets for Non-Self-Adjoint Matrix-Valued Pseudo-Differential Operators |
| 15:05-15:25 | **Break** | |
| 15:25-16:10 | Nguyen Minh Tri | Recent results on embedding theorems for weighted Sobolev |
| 16:15-17:00 | Nguyen Nhu Thang | Sharp Long-Time Decay for Nonlocal Evolution Equations: Coupled Systems, Distributed-Order Dynamics, Delay, and Abstract Kernels |
| 17:05-17:50 | Nguyen Tien Tai | Two nonlinear instability problems of shear flows in fluid mechanics |

## Wednesday, September 9 (Afternoon Venue 2: HNUE)

| Time | Speaker | Title |
|---|---|---|
| 13:30-14:15 | Masaaki Fukasawa | Yet another asymptotic formula for implied volatility |
| 14:20-15:05 | Pham Viet Hung | Expected number of intersections between a Gaussian curve and an algebraic hypersurface |
| 15:05-15:25 | **Break** | |
| 15:25-16:10 | Nino Kordzakhia | On generalisation of Graversen-Peskir maximal inequality |
| 16:15-17:00 | Ju-Yi Yen | Phase-Rectified Signal Averaging: Nonlinear Phase Selection and Gaussian Fluctuations |
| 17:05-17:35 | Yasuda Kazuhiro | Pricing High-Dimensional Various American-Style Options via Reinforcement Learning |

## Thursday, September 10 (Venue: VIASM)

### Partial Differential Equation

| Time | Speaker | Title |
|---|---|---|
| 08:30-09:00 | Kambara Reika | Uniform convergence of the positive semi-definite modification of Malliavin-Mancino estimator for the spot volatility process |
| 09:00-09:30 | Sota Hosokawa | Spectral analysis of the magnetic Schrödinger operator on a strip |
| 09:30-10:00 | Syudo Hiroki | Algebraic Realizations of Quantum Walks |
| 10:00-10:15 | **Break** | |
| 10:15-10:45 | Xinmiao Zhang | The bipartite walk on an even-star |
| 10:45-11:15 | Ito Masato | Splitting of Low-lying eigenvalues for a wedge-shaped symmetric double well |
| 11:45-13:30 | **Lunch** | |
| Afternoon | **Excursion** | |

### Probability and Statistics

| Time | Speaker | Title |
|---|---|---|
| 08:30-09:00 | Vu Thi Hue | Strong convergence rate of Euler-Maruyama approximations in temporal-spatial Hölder-norms for Lévy-driven stochastic differential equations. |
| 09:00-09:30 | Vu Thi Huong | Stability and uniform convergence in time of stochastic fractional delay differential equations |
| 09:30-10:00 | Nakano Yuzaburo | An almost sure invariance principle for the Takagi-van der Waerden class functions |
| 10:00-10:15 | **Break** | |
| 10:15-10:45 | Tamura Yuma | Representation and Integration by Parts Formulas for Affine Processes |
| 10:45-11:15 | Ryoichi Suzuki | Explicit Locally Risk-Minimizing Hedging Strategies for Pure Jump Additive Models |
| 11:15-11:45 | Yanyi Jiang | Stochastic volatility model of quadratic Volterra Gaussian type |
| 11:45-13:30 | **Lunch** | |
| Afternoon | **Excursion** | |

## Friday, September 11 (Venue: VIASM)

| Time | Speaker | Title |
|---|---|---|
| 08:30-10:00 | Duong Anh Tuan | On the super-solutions of the Lane-Emden equation/system |
| 10:00-10:15 | **Break** | |
| 10:15-11:45 | Yushi Hamaguchi | Introduction to stochastic Volterra equations |
| 11:45-13:30 | **Lunch** | |
| 13:30-14:15 | Nguyen Tran Thuan | Jump-adapted discretization for stochastic integrals in weighted BMO |
| 14:20-15:05 | Tran Dinh Ke | Nonlocal parabolic-elliptic Keller-Segel systems |
| 15:05-15:25 | **Break** | |
| 15:25-16:10 | Phan Thi Huong | Asymptotic separation between solutions and fast $\theta$-Euler-Maruyama scheme for singular stochastic Volterra integral equations with jumps |
| 16:15-17:00 | Nguyen Tien Dung | Berry-Esseen bounds for ratio distributions via Malliavin-Stein method and applications |

# 3 Autumn School

## Stochastic Optimization and its role in MCMC

**Jorge Ignacio González Cázares** *National Autonomous University of Mexico*

**Abstract:** In this short course, we will review classical optimization algorithms and the advantages of modern stochastic optimization algorithms for big data and high dimensions. We will analyse the dynamics of these algorithms through the lens of MCMC, comparing them with popular gradient-based algorithms such as under- and overdamped Langevin diffusions and Hamiltonian MC. We will discuss their applications to machine learning and its connections to certain Bayesian estimation problems.

## Introduction to stochastic Volterra equations

**Yushi Hamaguchi** *Kyoto University, Japan*

**Abstract:** Stochastic Volterra equations (SVEs) have recently attracted significant attention across various scientific fields due to their exceptional ability to model memory effects and anomalous diffusion. However, the path-dependent nature of SVEs poses severe mathematical challenges: their solutions are generally neither Markov processes nor semimartingales, rendering standard tools of Itô's calculus and classical Markovian frameworks inapplicable. This mini-course provides a comprehensive introduction to SVEs, bridging applied motivations with modern probabilistic and analytic techniques. In the first lecture, we explore the appearance and significance of SVEs in applied mathematics. We will highlight prominent examples, including rough volatility models in mathematical finance and generalized Langevin equations in statistical physics. We will then discuss fundamental properties of SVEs, such as the existence and uniqueness of solutions, and review specific tractable classes including affine Volterra processes. The second lecture focuses on overcoming the non-Markovian property of SVEs by exploiting the underlying infinite-dimensional Markovian structure. We will introduce the framework of "Markovian lifts", demonstrating how an SVE can be embedded into an infinite-dimensional space to recover the Markov property and utilize the general theory of stochastic partial differential equations (SPDEs). Finally, we will investigate the ergodicity of these Markovian lifts and present our latest research results on their long-term behavior.

# An introduction to the scattering theory on the line and quantum walk

**Setsuro Fujiie** *Ritsumeikan University, Japan*

**Abstract:** In view of the variety of the background of the participants, I would like to talk about a topic concerning some of the topics of the talks in the afternoon sessions: Schroedinger equation and quantum walk. The scattering matrix and transmission/reflection probability for a quantum particle on the real line is defined in an elementary way in the 1 dimensional setting. We will see by simple computations the following facts about the scattering by one or many potential barriers:
1) In the case of single barrier, the transmission propbability is almost 0 for an energy below the barrier top just like the classical mechanics, whereas, in the double barrier case, it may become 1 for certain energies below the barrier-top. This quantum effect is called 'resonant tunneling' and used in the semi-conductor.
2) We will also see that the scattering matrix has a Feynmann-type expression, namely it is written as the sum of the complex probability amplitudes, each of which is associated with a path of quantum walk.
3) We compute the semiclassical asymptotics of the barrier-top scattering to find the close relation with the Hadamard walk, a typical example of the quantum walk.

# On the super-solutions of the Lane-Emden equation/system: Local and non-local cases

**Duong Anh Tuan** *Hanoi University of Science and Technology, Vietnam*

**Abstract:** In this course, we shall review the existence and non-existence results for super-positive solutions of the Lane-Emden equation/system in both local and non-local cases.

# 4 Workshop

## Probability and Statistics

# Yet another asymptotic formula for implied volatility

**Masaaki Fukasawa** *Osaka University, Japan*

**Abstract:** For a general perturbation of the Black-Scholes model, we show that the Black-Scholes implied variance is approximately the conditional expectation of the cumulative variance given that the underlying asset price at the maturity is the strike price.

# On generalisation of Graversen-Peskir maximal inequality.

**Nino Kordzakhia** *Macquarie University, Australia*

**Abstract:** The classical maximal inequality, established by Kolmogorov for the maximum of the sum of independent identically distributed random variables, has been extended by Graversen and Peskir to the Ornstein-Uhlenbeck process. Their result, obtained for the Brownian-driven Ornstein-Uhlenbeck process, provided two-sided bounds for the running maximum in terms of the logarithmic growth of the random time horizon. In this talk, we broaden the scope of the Graversen-Peskir framework by establishing maximal moment and exponential inequalities for generalised Ornstein-Uhlenbeck processes with jumps. Our setting allows both positive and negative jumps and accommodates a wide class of Lévy driving process under natural assumptions on their tail behaviour. The key innovation lies in constructing and analysing an appropriate martingale (or supermartingale) associated with the process obtained from the Lévy cumulant and its Legendre transform combining it with Lenglart's domination principle. This approach complements the diffusion-specific techniques, and yields inequalities of the same functional type as the Graversen-Peskir bounds, now expressed in terms of moderate functions. We will also discuss the sharpness of the bounds.

# The Martingale Approach to Boundary Crossing Problems for Stochastic Processes

**Alex Novikov** *University of Technology, Sydney, Australia*

**Abstract:** The problem of evaluating boundary crossing probabilities for stochastic processes arises in numerous applications across statistics, finance, physics, and related disciplines. Historically, foundational methods for computing these probabilities relied on the direct and backward Kolmogorov equations for diffusion processes. This talk presents an alternative framework grounded in martingale and stochastic analysis techniques. This approach offers significantly greater generality, as it applies to processes with jumps across both continuous- and discrete-time settings. Specifically, we will discuss exact and asymptotic results for boundary crossing probabilities associated with Lévy processes—including alpha-stable processes—as well as generalized Ornstein–Uhlenbeck processes. Finally, we provide an overview of recent developments in numerical methods, highlighting a hybrid approach that combines numerical computations over an initial time interval with asymptotic approximations for large time horizons.

## Some approximation results about the reflected perturbed Brownian motion

**Alessio Rondelli** *University of Bologna, Italy*

**Abstract:** We investigate reflected Brownian motion perturbed by its running maximum. We first establish quantitative probabilistic estimates for its excursions, including Gaussian bounds for barrier crossing probabilities and exponential tail estimates for the number of alternating excursions between the reflecting boundary and the running maximum. These estimates motivate an approximation in which, over each time step, only one of the two singular mechanisms (reflection or maximum perturbation) is retained. We show that the approximation is exact outside exponentially rare activation events. Exploiting the discrete dynamics, we obtain an explicit representation of the first variation as a product of elementary matrices indexed by the sequence of barrier visits. This yields a probabilistic formula for derivatives of the associated semigroup and provides a new perspective on sensitivity analysis for perturbed reflected Brownian motions.

## Phase-Rectified Signal Averaging: Nonlinear Phase Selection and Gaussian Fluctuations

**Ju-Yi Yen** *University of Cincinnati, USA*

**Abstract:** We investigate the mathematical structure of phase-rectified signal averaging (PRSA), a nonlinear signal-processing procedure originally introduced in biomedical applications. PRSA constructs averages over local windows selected through a threshold condition on signal increments, producing a nonlinear coupling between selection and averaging. We analyze PRSA in two complementary settings. For deterministic quasi-periodic signals consisting of two incommensurable oscillatory components, we show that the hinge-selection mechanism induces a nontrivial phase-space bias. Using Weyl-Kronecker equidistribution on the torus, the PRSA limit can be represented as a conditional phase average over a selected region of phase space. This leads to explicit formulas showing that PRSA transforms amplitudes and removes phase information through nonlinear phase selection. We then study PRSA for stationary Gaussian processes. In this setting, the PRSA statistic becomes a nonlinear ratio functional with strong dependence induced by overlapping windows and random selection. Using covariance estimates for Gaussian functionals, Gaussian regularization, and cumulant methods, we establish laws of large numbers and central limit theorems for the PRSA profile.

## Berry-Esseen bounds for ratio distributions via Malliavin-Stein method and applications

**Nguyen Tien Dung** *VNU University of Sciences, Vietnam*

**Abstract:** In this talk, we introduce a general method to bound the Kolmogorov distance in the central limit theorem for the ratio distributions. We then apply these bound to parameter estimations in stochastic differential equations.

## Subdiffusive concentration for the chemical distance in Bernoulli percolation.

**Can Van Hao** *Institute of Mathematics, Vietnam*

**Abstract:** Considering supercritical Bernoulli percolation on the integer lattice, Garet and Marchand proved a diffusive concentration for the graph distance. We aim to refine this result by establishing a concentration inequality on a subdiffusive scale. Our approach is inspired by similar work in first-passage percolation by Damron, Hanson, and Sosoe, combined with new tools to address the infinite weight of the model. Based on joint work with Nguyen Van Quyet.

## Boundary contacts for reflected random walks in the quarter plane

**Hoang Viet Hung** *Industrial University of Ho Chi Minh City, Vietnam*

**Abstract:** Reflected random walks in the quarter plane arise naturally in probability theory, queueing systems, statistical physics, and combinatorics. In this talk, I will discuss the local time spent on the reflection boundaries. When the drift lies within the cone, the local time converges, without normalization, to a nontrivial random variable as the walk length tends to infinity. I will present recent results on these limiting variables in two different settings: in the first, the reflections on the horizontal and vertical boundaries are assumed to be similar, leading to a recursive structure for the probability mass functions that can be analyzed using a coupling approach; in the second, we consider more general reflection rules but singular random walks, for which we derive an explicit closed-form expression for the limiting distribution using the compensation approach. Some perspectives and simple examples on both singular and non-singular models will also be discussed, time permitting. This is joint work with Kilian Rachel.

## Expected number of intersections between a Gaussian curve and an algebraic hypersurface

**Pham Viet Hung** *Institute of Mathematics, Vietnam*

**Abstract:** In this talk, we will give a brief introduction to the history of the Kac-Rice formula and discuss a recent application to derive the expectation of the number of intersections between a Gaussian curve and an algebraic hypersurface. We will revisit some special cases such as chi-square processes or polynomial matrix processes.

# Asymptotic separation between solutions and fast $\theta$-Euler-Maruyama scheme for singular stochastic Volterra integral equations with jumps

**Phan Thi Huong** *Le Quy Don Technical University, Vietnam*

**Abstract:** This paper investigates both qualitative and quantitative aspects of a class of singular stochastic Volterra integral equations with jumps. On the qualitative aspect, we establish fundamental results on the existence and uniqueness of solutions, together with their continuous dependence on initial data and on the singularity degrees of the kernel functions. We then examine the temporal Hölder continuity of solutions and derive the optimal asymptotic separation rate between distinct solutions. On the quantitative aspect, we develop and analyze several discretization schemes, including the $\theta$-Euler–Maruyama method and its accelerated variant, the fast $\theta$-Euler–Maruyama scheme. We investigate their strong convergence properties, convergence rates, and computational complexities. Furthermore, in the case without jumps, we analyze the strong convergence under the supremum norm by employing the Garsia–Rodemich–Rumsey inequality. The theoretical results are supported by numerical simulations, which demonstrate the effectiveness and accuracy of the proposed methods.

# Jump-adapted discretization for stochastic integrals in weighted BMO

**Nguyen Tran Thuan** *UEH University, Vietnam*

**Abstract:** This talk discusses discrete-time approximation of stochastic integrals driven by semimartingales with jumps via the weighted bounded mean oscillation (BMO) approach. This approach yields $L^p$-estimates, $2 < p < \infty$, for the approximation error that depends on the weight. Moreover, these estimates remain unchanged under a change of the underlying measure. Taking advantage of these features, we propose a new approximation scheme that adjusts the classical Riemann approximation by tracking the jumps of the driving semimartingale. We discuss a way to optimize the approximation and illustrate the sharpness of the obtained convergence rates.

## Partial Differential Equation

# IDS for random point interactions

**Takuya Mine** *Kyoto Institute of Technology, Japan*

**Abstract:** We study the asymptotics of the integrated density of states (IDS) for the Schrödinger operators on the Euclidean space $\mathbf{R}^3$ with point interactions supported on some random point configurations. Especially, we show that the decay rate of IDS $N(\lambda)$ as $\lambda \to -\infty$ is slower than that for the random scalar potential supported near the same random point configurations. We also show the numerical result about the IDS for several random point interactions. This talk is based on the joint work with Masahiro Kaminaga (Tohoku Gakuin Univ.), Fumihiko Nakano (Tohoku Univ.) and Tomoyuki Shirai (Kyushu Univ.).

# Quantum walk representations of quantum circuits

**Hisashi Morioka** *Ehime University, Japan*

**Abstract:** Quantum circuits consist of qubits and quantum gates. In order to represent quantum circuits, one usually adopt the quantum circuit diagrams. On the other hand, we would like to propose quantum walk representations of quantum circuits via an orthonormal basis of the tensor product of some Hilbert spaces. We can see that quantum walks on balanced directed graphs (cf. K. Higuchi, preprint. arXiv:2504.15584) appear in our context. This is a joint work with Keita Mohara (Ehime University).

# Fermi's golden rule and a complex translation method for resonances of quantum walks

**Kenta Higuchi** *Gifu University, Japan*

**Abstract:** Quantum resonances describe metastable states with finite lifetimes. A typical source of such resonances in the Schrödinger setting is a bound state weakly coupled to scattering states. In this case, the corresponding energies are no longer $L^2$-eigenvalues in the usual sense, but appear as poles of the analytically continued resolvent. The imaginary part of a resonance energy determines the decay rate of the state, and Fermi's golden rule gives the leading term of this decay rate. In this talk, we study an analogous problem for quantum walks. We analyze the behavior of eigenvalues under weak perturbations, showing that they may either turn into resonances or persist as eigenvalues. We also estimate their displacement from the unperturbed eigenvalues in terms of the small coupling parameter. Our analysis uses a complex translation method based on the adjoint operator.

## Sharp Long-Time Decay for Nonlocal Evolution Equations: Coupled Systems, Distributed-Order Dynamics, Delay, and Abstract Kernels

**Nguyen Nhu Thang** *Hanoi National University of Education, Vietnam*

**Abstract:** For a two-component subdiffusion system, Li, Liu, and Wada found that the decay rate is sublinear when the driving fractional order is below one, but superlinear, strictly faster than any power, when it equals one. They conjectured this for any number of components. We prove it with a new time-domain method, avoiding residue calculus. The method also covers a Caputo equation with distributed-order memory and delay, where decay switches between power-law and logarithmic regimes; delayed time-fractional equations on unbounded strip domains, where a spectral gap stops blow-up but not exponential decay; and completely positive kernels on Besov–Morrey spaces, recovering every rate above from one Tauberian argument and adding a small-data theory for critical nonlinearities. In each case, stability needs the dissipation rate to exceed the coupling strength.

## A Unified Gradient-Flow Approach to Higher-Order Riemannian Spline Interpolation, with an Application to Quantum Splines

**Tran The Dung** *VNU University of Sciences, Vietnam*

**Abstract:** This talk presents a unified gradient -flow method for variational spline interpolation and least - squares fitting on smooth Riemannian manifolds, naturally encompassing spline problems on Lie groups. The method leads to a family of $2k$th -order parabolic systems, for which we establish global existence of solutions and show that their asymptotic limits solve the corresponding variational spline interpolation problems. As a special case of this framework corresponding to $k = 2$, we establish the first rigorous existence theory for the quantum splines introduced by Brody, Holm, and Meier (2012). By adapting the method to the boundary conditions arising in quantum control, we construct a well -posed fourth -order parabolic system whose asymptotic limits realize the desired quantum splines.

## Determination of Surface Temperature from Interior Measurements

**Dinh Nho Hao** *Institute of Mathematics, Vietnam*

**Abstract:** In several engineering applications, the surface temperature of a material cannot be measured directly and must instead be determined from measurements taken inside the material. Examples of such situations arise in quenching studies, internal combustion engines, nuclear reactors, hypersonic flight vehicles, solid rocket nozzles, and other applications. In this talk, we consider an inverse heat transfer problem for one-dimensional parabolic equations and time-fractional parabolic equations with variable coefficients in a quarter-plane. Since these problems are severely ill-posed, we first establish Hölder-type stability estimates and then develop a regularization method based on mollification to obtain stable approximate solutions. Finally, we present numerical results to illustrate the effectiveness of the proposed method.

## The L2-Caffarelli-Kohn-Nirenberg inequalities: The sharp constants and stability estimate

**Nguyen Van Hoang** *FPT University, Vietnam*

**Abstract:** The Caffarelli-Kohn-Nirenberg inequalities are the first order interpolation inequalities that have many applications in Analysis and PDEs. In this talk, we present the recent results on the sharp constant and the stability estimate for a family of L2-Caffarelli-Kohn-Nirenberg inequalities for the scalar functions and vector fields. The talk is based on the joint works with Xuan Anh Do, Lam Hoang Nguyen, Guozhen Lu and Anh Tuan Duong.

## Nonlocal parabolic-elliptic Keller-Segel systems with nonlinear growth and signal production

**Tran Dinh Ke** *Hanoi National University of Education, Vietnam*

**Abstract:** We study the nonlocal parabolic-elliptic Keller-Segel system in the entire space, incorporating nonlinearities for both cell kinetics and chemical signal production. Our aim is to establish a global solvability result with small data and prove the Hölder regularity for the obtained mild solution.

## Two nonlinear instability problems of shear flows in fluid mechanics: Rayleigh-Taylor and Kelvin-Hemholtz

**Nguyen Tien Tai** *VNU University of Sciences, Vietnam*

**Abstract:** In this talk, we study the nonlinear instability of the incompressible Euler equations around a shear flow in a horizontal strip with rigid boundaries. The equilibrium state is given by a density profile depending only on the vertical variable and by a horizontal background velocity. We discuss both the Rayleigh-Taylor regime, corresponding to zero background velocity, and the Kelvin-Helmholtz regime, corresponding to monotone shear velocity. Following Grenier's framework, we construct high-order approximate solutions growing along the most unstable eigenmode to prove nonlinear instability of the shear equilibrium in the sense of energy.

## A remark on the finite-time blow-up for the critical heat equation in $\mathbf{R}^N$

**Nguyen Van Thin** *Thai Nguyen University, Vietnam*

**Abstract:** In this talk, we first establish a finite-time blow-up result for the Cauchy problem associated with a semilinear parabolic equation, involving a nonlinear term, with critical polynomial growth at infinity, under arbitrary positive initial energy. We then derive both lower and upper bounds for the maximal existence time. These results complement and improve the ones presented in Ishiwata et.al [Adv. Differential Equations (2025), no. 3-4, 141-176].

## Recent results on embedding theorems for weighted Sobolev

**Nguyen Minh Tri** *Institute of Mathematics, Vietnam*

**Abstract:** In this talk we will present some new results, obtained spaces and applications jointly with G. T. Hieu and D. A. Tuan, concerning embedding of weighted Sobolev spaces into weighted Lebesgue spaces and applications to the study of boundary value problems for semilinear elliptic degenerate differential equations of the Grushin type.

# 5 Contributed Speakers

## An almost sure invariance principle for the Takagi-van der Waerden class functions

**Nakano Yuzaburo** *Yokohama National University, Japan*

**Abstract:** The Takagi-van der Waerden functions are a well-known class of continuous but nowhere differentiable functions. In this paper, we study their weighted versions, the Takagi-van der Waerden class functions, from a probabilistic point of view. We prove that the local modulus of continuity of the functions is described by a standard Brownian motion under some regularity assumptions on the weights, as an application of a strong approximation for elephant random walks remembering the very recent past with variable step length.

## Algebraic Realizations of Quantum Walks

**Syudo Hiroki** *Ritsumeikan University, Japan*

**Abstract:** Fermion Fock spaces, boson Fock spaces, free Fock spaces, and mono-Atonic Fock spaces are special cases of interacting Fock spaces, where the measure-theoretic realizations of the sum of their corresponding creation and annihilation operators are random variables of the Bernoulli distribution, standard Gaussian distribution, Wigner's semicircle law, and arcsine distribution types, respectively. Therefore, we investigated the algebraic realizations of quantum walks with random variables of the limit distribution type and their corresponding Fock spaces.

## Representation and Integration by Parts Formulas for Affine Processes

**Tamura Yuma** *Tokyo University of Sciences, Japan*

**Abstract:** Many quantities in stochastic modeling are expressed as expectations of functions of stochastic processes. A typical example is the *delta* of an option, which is the derivative $\partial_x \mathbb{E}[f(X_T^x)]$ with respect to the initial value $x$ of the underlying process. Such sensitivities are important in mathematical finance, but they are also natural objects in stochastic analysis. In this talk, we discuss representation formulas and integration by parts formulas for one-dimensional diffusion-type affine processes on $\mathbb{R}_{\geq 0}$ of the form $dX_t^x = \sqrt{\alpha X_t^x}\, dW_t + (\beta X_t^x + b)\, dt$, with $X_0^x = x$, where $\alpha > 0$, $\beta \in \mathbb{R}$, and $b \geq 0$. This class includes the Cox-Ingersoll-Ross model, which is a basic interest-rate model. For this class of processes, we obtain formulas that express $\partial_x \mathbb{E}[f(X_t^x)]$ and $\mathbb{E}[f(X_t^x)]$ in terms of expectations of $f$ evaluated at affine processes with shifted parameters. In particular, the formulas imply an identity of the form $\partial_x \mathbb{E}[f(X_t^x)] = e^{\beta t} \mathbb{E}[f(X_t^{1,x})]$, where $X^{1,x}$ is an affine process obtained by a suitable shift of the parameters. This identity may help stabilize numerical computations of the delta. Finally, I will present recent progress on the CIR model. This talk is based on joint work with Professor Arturo Kohatsu-Higa (Ritsumeikan University), Alessio Rondelli (University of Bologna), and Yinan Zhu (Ritsumeikan University).

# Uniform convergence of the positive semi-definite modification of Malliavin-Mancino estimator for the spot volatility process

**Kambara Reika** *Ritsumeikan University, Japan*

**Abstract:** This talk establishes the uniform convergence in probability and the associated convergence rates for a positive semi-definite modification of the Malliavin-Mancino Fourier estimator (the PDF estimator) using high-frequency, non-synchronized data. Building on its previously established L2-consistency, we derive the explicit convergence rates for both the general non-synchronized setting and the synchronous, equally spaced case. These findings provide a theoretical guarantee for the method, ensuring that the estimated volatility path closely approximates the true path, which is a crucial property for applications in financial econometrics and risk management.

# Pricing High-Dimensional Various American-Style Options via Reinforcement Learning

**Yasuda Kazuhiro** *Hosei University, Japan*

**Abstract:** Accurate pricing and optimal exercise strategy determination for multi-dimensional options with path-dependent features, such as American-Style options, present significant computational challenges. This study proposes the application of a reinforcement learning approach specifically, Randomized Fitted Policy Iteration (RFPI) which combines policy iteration with the efficient, highdimensional function approximation capabilities of Randomized Neural Networks. Unlike traditional Least Squares Monte Carlo, which often yields fragmented boundaries due to local regression errors, RFPI learns smooth, globally consistent exercise boundaries. We perform extensive numerical experiments applying this approach to the pricing of multi-asset (high-dimensional) American options and American-Asian options under standard stochastic models. In addition, we conduct a detailed comparative analysis between the pricing dynamics of these path-dependent options and simple high-dimensional American-Style options. By investigating these differences, we discuss the impact of the averaging feature on the optimal exercise boundaries and overall pricing behavior. The results demonstrate that the RFPI approach robustly handles the combined challenges of high dimensionality and path dependency, providing an effective and computationally efficient framework for complex multi-asset derivatives. This is a joint work with Ryota Iizuka.

## Explicit Locally Risk-Minimizing Hedging Strategies for Pure Jump Additive Models

**Ryoichi Suzuki** *Tokyo University of Science, Japan*

**Abstract:** In incomplete markets with jumps, perfect replication is usually impossible, and local risk-minimization provides a natural quadratic hedging criterion. This talk presents a Malliavin calculus method for deriving explicit, locally risk-minimizing strategies in financial models driven by pure-jump additive processes. The key ingredients are martingale representation formulas. We first recall the Clark-Ocone-Haussmann formula and then introduce its Taylor-type extension, the Malliavin-Mancino-Taylor formula. Our main results establish MMT-type formulas for L1- and L2-pure jump additive processes, together with corresponding formulas under a change of measure.

## Splitting of Low-lying eigenvalues for a wedge-shaped symmetric double well

**Ito Masato** *Ritsumeikan University, Japan*

**Abstract:** We discuss the eigenvalue problem of the Schrödinger operator with a symmetric double well potential with the wedge-shaped bottom. The symmetric double well potential causes so-called eigenvalue splitting that is the distance between the nearest eigenvalues is exponentially small as a semiclassical parameter tends to zero. We give the asymptotic expansion of the eigenvalue splitting for the two smallest eigenvalues with explicit leading term. In particular, we show that the polynomial order of the leading term except exponential decay factor is characterized by the shape of the bottom.

## Spectral analysis of the magnetic Schrödinger operator on a strip

**Sota Hosokawa** *Ritsumeikan University, Japan*

**Abstract:** We study the Schrödinger operator with a constant magnetic field on a strip domain under Dirichlet boundary conditions. We investigate the trace formula for the operator perturbed by a smooth positive electric potential with a coupling constant. We derive the asymptotic behavior of the trace formula in the large coupling constant limit by reducing the problem to a related one in a slowly varying regime.

# THE BIPARTITE WALK ON AN EVEN-STAR

**Xinmiao Zhang** *Ritsumeikan University, Japan*

**Abstract:** We calculate the characteristic polynomials of the time evolution matrices of the bipartite walks on an even-star as a generalization of a star graph and an even cycle graph. We also calculate the characteristic polynomials of the time evolution matrices of a bipartite walk on a double star, a $2k$ ($k \geq 3$)-star and a 4-star, and present their spectra. Furthermore, we present a relation between the transition probability matrix $\mathbf{T}$ and the specified matrix $\mathbf{F} = \hat{\mathbf{P}}_0^T \hat{\mathbf{P}}_1 \hat{\mathbf{P}}_1^T \hat{\mathbf{P}}_0$ appearing in the characteristic polynomial of the time evolution matrix of a bipartite walk on a bipartite graph. As its application, we calculate the spectra of $\mathbf{F}$ for a double star, a $2k$ ($k \geq 3$)-star and a 4-star, and so present the spectra of $\mathbf{T}$ for them.

# Stochastic volatility model of quadratic Volterra Gaussian type

**Yanyi Jiang** *Ritsumeikan University, Japan*

**Abstract:** We study several asymptotic expansions of the laws of the quadratic Wiener functional. We show that the formulas are also applicable to the joint law of the price and the volatility of a class of rough volatility models where the law is characterized by a fractional Riccati equation.

# Propagation of Semiclassical Wave Front Sets for Non-Self-Adjoint Matrix-Valued Pseudo-Differential Operators

**Yuta Kawamura** *Ritsumeikan University, Japan*

**Abstract:** We study the propagation of semiclassical wavefront sets for solutions to systems of pseudodifferential equations with non-Hermitian matrix-valued symbols. Under a generalized microhyperbolicity condition and the nonnegativity of the imaginary part of the principal symbol, we prove propagation of semiclassical wavefront sets and establish a corresponding propagation estimate. The proof combines a positive commutator argument with the construction of exponentially growing escape functions. Our results generalize previous propagation theorems obtained for scalar operators and several classes of matrix-valued systems. The classical maximal inequality, established by Kolmogorov for the maximum of the sum of independent identically distributed random variables, has been extended by Graversen and Peskir to the Ornstein–Uhlenbeck process. Their result, obtained for the Brownian-driven Ornstein–Uhlenbeck process, provided two-sided bounds for the running maximum in terms of the logarithmic growth of the random time horizon.

# Strong convergence rate of Euler-Maruyama approximations in temporal-spatial Hölder-norms for Lévy-driven stochastic differential equations.

**Vu Thi Hue** *Hanoi University of Science and Technology, Vietnam*

**Abstract:** We study the error between the exact solution and its Euler-Maruyama approximation in temporal-spatial Hölder-norms for Lévy-driven stochastic differential equations. This problem poses significant difficulties for traditional methods due to the presence of jumps. In this paper, we establish novel estimates to evaluate the error under both spatial and temporal variations.

# Stability and uniform convergence in time of stochastic fractional delay differential equations

**Vu Thi Huong** *University of Transport and Communications, Vietnam*

**Abstract:** This paper investigates the strong convergence of numerical schemes for stochastic fractional differential delay equations (SFDDEs) over an infinite horizon ($t \geq 0$). While approximate solutions for existing results on [0, T] rely on Mittag-Leffler (ML) functions that diverge as T $\to \infty$, we establish a time-independent error bound, ensuring uniform convergence for long-term simulations. By meticulously constructing a weighted norm and leveraging the stability conditions of the linear components, we effectively dominate the singular integrals and non-Markovian memory effects. We rigorously prove that the 0-Mittag-Leffler Euler-Maruyama (MLEM) scheme is uniformly moment bounded, stable, and maintains a global-in-time convergence rate without requiring an infinitesimal step size as time progresses. Furthermore, we demonstrate that the exact solution of the SFDDEs is itself stable around its equilibrium point. Numerical experiments validate that our approach remains robust and computationally efficient over extended temporal domains, providing a significant improvement over existing finite-horizon methods.