Frontiers in Fluid and Kinetic Partial Differential Equations

Online Conference

December 3–6, 2025

Beijing Time (UTC +8)

Organizer: Quoc-Hung Nguyen, Institute of Mathematics, Academy of Mathematics and Systems Science (AMSS), Chinese Academy of Sciences (CAS)
Conference Website: nguyenquochung1241.wixsite.com/qhung

Overview

The *Frontiers in Fluid and Kinetic Partial Differential Equations* online conference brings together researchers to discuss recent advances in the mathematical analysis of problems governed by fluid and kinetic PDEs. These equations model a broad range of physical phenomena—from fluid motion and plasma dynamics to particle interactions and transport processes. The conference aims to strengthen connections between kinetic theory and fluid dynamics, fostering dialogue across these closely related areas. Topics of interest include the analysis of the Euler, Navier–Stokes, Boltzmann, and Vlasov equations; nonlinear stability; regularity theory; and related PDE models.

By connecting leading experts with early-career researchers in an accessible online format, the conference highlights new developments, encourages collaboration, and explores open problems at the current frontiers of fluid and kinetic PDE research.

CONFERENCE ACCESS

Zoom Meeting ID: 275 958 7492 — **Passcode:** PDE2025

Invited Speakers

Thomas Alazard
École Polytechnique, Paris

Dallas Albritton
University of Wisconsin–Madison

Jacob Bedrossian
UCLA

Léo Bigorgne
Université de Rennes 1

Elia Bruè
Bocconi University

Yu Deng
University of Chicago

Theodore D. Drivas
Stony Brook University

Renjun Duan
Chinese University of Hong Kong

Emmanuel Grenier
Beijing Institute of Technology

Taoufik Hmidi
NYU Abu Dhabi

Alexandru Ionescu
Princeton University

Pierre-Emmanuel Jabin
Pennsylvania State University

In-Jee Jeong
Seoul National University

Wei-Xi Li
Wuhan University

Benoit Pausader
Brown University

Sylvia Serfaty
Sorbonne University

Luis Silvestre
University of Chicago

Jiajun Tong
Peking University

Fei Wang
Shanghai Jiao Tong University

Chunjing Xie
Shanghai Jiao Tong University

Rongchan Zhu
Beijing Institute of Technology

Ruizhao Zi
Central China Normal University

Chair

Tobias Barker
University of Bath

Renjun Duan
Chinese University of Hong Kong

Te Li
AMSS, CAS

Quoc Hung Nguyen
AMSS, CAS

Scott Andrew Smith
AMSS, CAS

Yi Wang
AMSS, CAS

Yong Wang
AMSS, CAS

Zhenfu Wang
Peking Univeristy

Tong Yang
The Hong Kong Polytechnic University

Liutang Xue
Beijing Normal University

Xiangchan Zhu
AMSS, CAS

Ruizhao Zi
Central China Normal University

1 Schedule

Note: All times are displayed in **Beijing Time**.

Dec 3rd, 2025	Speaker & Title	Chair
08:15 – 08:30 am	**Ping Zhang** (President of AMSS) *Opening Remarks*	Quoc-Hung Nguyen
08:30 – 09:20 am	**Jacob Bedrossian** (UCLA) Title To Be Announced	Quoc-Hung Nguyen
09:30 – 10:20 am	**Luis Silvestre** (University of Chicago) Monotonicity of the Fisher information in kinetic equations	Tong Yang
10:30 – 11:20 am	**Emmanuel Grenier** (Beijing Institute of Technology) Bifurcations of viscous boundary layers in the half space	Yong Wang
	Lunch Break	
02:00 – 02:50 pm	**Renjun Duan** (CUHK) Kinetic shear flow via the nonlinear Boltzmann equation	Te Li
03:00 – 03:50 pm	**Taoufik Hmidi** (NYU Abu Dhabi) Desingularization of Periodic Orbits in Vortex Dynamics via KAM Theory	Liutang Xue
04:00 – 04:50 pm	**Léo Bigorgne** (Université de Rennes 1) Modified scattering for the small data solutions to the Vlasov-Maxwell system	Quoc-Hung Nguyen
05:00 – 08:00 pm	*Break*	–
08:00 – 08:50 pm	**Sylvia Serfaty** (Sorbonne University) Mean-Field Limits and Modulated Energy Methods	Quoc-Hung Nguyen
09:00 – 09:50 pm	**Alexandru Ionescu** (Princeton University) On the wave turbulence theory of 2D gravity water waves	Quoc-Hung Nguyen

Dec 4th, 2025	Speaker & Title	Chair
09:30 – 10:20 am	**Dallas Albritton** (University of Wisconsin–Madison) Self-similar solutions to the 2D Navier-Stokes equations	Tobias Barker
10:30 – 11:20 am	**Jiajun Tong** (Peking University) The Immersed Boundary Problem in 2-D: the Navier-Stokes Case	Liutang Xue
	Lunch Break	
02:00 – 02:50 pm	**Rongchan Zhu** (Beijing Institute of Technology) Φ^4_3 Theory from many-body quantum Gibbs states	Scott Smith
03:00 – 03:50 pm	**Thomas Alazard** (École Polytechnique, Paris) Nonlinear interpolation and the flow of quasilinear equations	Yi Wang
04:00 – 04:50 pm	**Elia Bruè** (Bocconi University) Lyapunov Exponents and Mixing in DiPerna-Lions Flow	Yi Wang
05:00 – 10:00 pm	*Break*	–
10:00 – 10:50 pm	**Theodore D. Drivas** (Stony Brook University) Some results on the long-time behavior of 2D fluids	Quoc-Hung Nguyen

Dec 5th, 2025	Speaker & Title	Chair
08:30 – 09:20 am	**Benoit Pausader** (Brown University) Stability of small BGK waves	Quoc-Hung Nguyen
09:30 – 10:20 am	**Pierre-Emmanuel Jabin** (Pennsylvania State University) A duality method for mean-field limits with singular interactions	Zhenfu Wang
10:30 – 11:20 am	**Chunjing Xie** (Shanghai Jiao Tong University) Rigidity for steady incompressible Euler system and its applications	Quoc-Hung Nguyen
	Lunch Break	
02:00 – 02:50 pm	**Ruizhao Zi** (Central China Normal University) Stability of Couette flow in Stokes-transport equations	Quoc-Hung Nguyen
03:00 – 03:50 pm	**Wei-Xi Li** (Wuhan University) On the radius of analyticity and Gevrey regularity for the Boltzmann equation	Renjun Duan
04:00 – 04:50 pm	*Free Discussion*	–

Dec 6th, 2025	Speaker & Title	Chair
08:30 – 09:20 am	**Yu Deng** (University of Chicago) Long time derivation of Boltzmann equation from hard sphere dynamics	Xiangchan Zhu
09:30 – 10:20 am	**Fei Wang** (Shanghai Jiao Tong University) Asymptotic Stability of Shear Flows Near Couette with Navier Boundary Condition	Ruizhao Zi
10:30 – 11:20 am	**In-Jee Jeong** (Seoul National University) Stability of multiple Lamb dipoles	Ruizhao Zi

Table 1: Time Zone Conversion Table (Base: Beijing Time)

Beijing	Paris	New York (EST)	Chicago (CST)	Los Angeles (PST)
08:00 AM	01:00 AM	07:00 PM prev	06:00 PM prev	04:00 PM prev
09:00 AM	02:00 AM	08:00 PM prev	07:00 PM prev	05:00 PM prev
10:00 AM	03:00 AM	09:00 PM prev	08:00 PM prev	06:00 PM prev
02:00 PM	07:00 AM	01:00 AM	12:00 AM	10:00 PM prev
03:00 PM	08:00 AM	02:00 AM	01:00 AM	11:00 PM prev
04:00 PM	09:00 AM	03:00 AM	02:00 AM	12:00 AM
08:00 PM	01:00 PM	07:00 AM	06:00 AM	04:00 AM
09:00 PM	02:00 PM	08:00 AM	07:00 AM	05:00 AM
10:00 PM	03:00 PM	09:00 AM	08:00 AM	06:00 AM

2 Abstracts

Speaker: Thomas Alazard (École Polytechnique, Paris)
Title: Nonlinear interpolation and the flow of quasilinear equations

Abstract: I will present an abstract result showing that, for a quasilinear evolution problem, the continuity of the data-to-solution map follows automatically from the estimates that are usually established in the proof of existence of solutions. This is joint work with N. Burq, M. Ifrim, D. Tataru, and C. Zuily.

Speaker: Dallas Albritton (University of Wisconsin–Madison)
Title: Self-similar solutions to the 2D Navier-Stokes equations

Abstract: In 2014, Jia and Sverak constructed self-similar solutions evolving from arbitrarily large scaling-invariant initial data in 3D and conjectured that they go unstable at high Reynolds numbers and thereby generate non-unique solutions. In 2D, Leray-Hopf solutions are unique, but this picture may still hold in the infinite-energy class. We construct self-similar solutions evolving from arbitrarily large scaling-invariant initial data in 2D and present numerical evidence of non-uniqueness. Joint work with Julien Guillod (Sorbonne Universite and ENS), Mikhail Korobkov, and Xiao Ren (Fudan University).

Speaker: Jacob Bedrossian (University of California, Los Angeles)
Title: [Title To Be Announced]

Abstract: [Abstract To Be Announced]

Speaker: Léo Bigorgne (Université de Rennes 1)
Title: Modified scattering for the small data solutions to the Vlasov-Maxwell system

Abstract: We will be interested in the solutions to the Vlasov–Maxwell system arising from sufficiently regular initial data, with a small distribution function. In particular, we will compare their asymptotic behavior with that of the solutions to the linearised system. While the electromagnetic field can be approximated by a linear solution, the distribution function exhibits a modified scattering dynamic: due to the long–range effects of the Lorentz force, it converges along linear characteristics corrected by a logarithmic term. A key step in defining these modified characteristics is to identify an effective Lorentz force that governs the asymptotic behavior of the force field.

Speaker: Elia Bruè (Bocconi University)
Title: Lyapunov Exponents and Mixing in DiPerna-Lions Flows

Abstract: In 2003, Bressan proposed a conjecture on the mixing efficiency of incompressible flows, which remains open. This talk surveys progress toward resolving Bressan's mixing conjecture and presents a new result confirming its asymptotic validity for time-periodic velocity fields. We accomplish this by adapting dynamical systems tools to the non-smooth framework of DiPerna-Lions flows. Furthermore, we discuss links to bounds on metric entropy and extensions of the Ruelle inequality.

Speaker: Yu Deng (University of Chicago)
Title: Long time derivation of Boltzmann equation from hard sphere dynamics

Abstract: We present recent works with Zaher Hani and Xiao Ma, in which we derive the Boltzmann equation from the hard sphere dynamics in the Boltzmann-Grad limit, for the full time range in which the (strong) solution to the Boltzmann equation exists. This is done in the Euclidean setting in any dimension $d \geq 2$, and in the periodic setting in dimensions $d \in \{2, 3\}$. As a corollary, we also derive the corresponding fluid equations from the the hard sphere dynamics. This executes the original program, proposed in Hilbert's Sixth Problem in 1900, pertaining to the derivation of hydrodynamic equations from colliding particle systems, via the Boltzmann equation as the intermediate step.

Speaker: Theodore D. Drivas (Stony Brook University)
Title: Some results on the long-time behavior of 2D fluids

Abstract: We will discuss some results concerning the long-time behavior of solutions to the two-dimensional incompressible Euler and Navier-Stokes equations. One at zero viscosity and long times, the other at long time and subsequently zero viscosity.

Speaker: Renjun Duan (Chinese University of Hong Kong)
Title: Kinetic shear flow via the nonlinear Boltzmann equation

Abstract: In the first part of the talk, we survey recent results on the nonlinear Boltzmann equation for kinetic shear flow. We discuss the issue in two cases either on the finite interval with finite energy or on the infinite interval with infinite energy at infinite time. In the second part, we focus on a recent study of the diffusive limit of the time evolutionary Boltzmann equation in the half space $\mathbb{T}^2 \times \mathbb{R}^+$ for a small Knudsen number $\varepsilon > 0$. For boundary conditions in the normal direction, it involves diffuse reflection moving with a tangent velocity proportional to ε on the wall, whereas the far field is described by a global Maxwellian with zero bulk velocity. The incompressible Navier-Stokes equations, as the corresponding formal fluid dynamic limit, admit a specific time-dependent shearing solution known as the Rayleigh profile, which accounts for the effect of the tangentially moving boundary on the flow at rest in the far field. Using the Hilbert expansion method, for well-prepared initial data we construct the Boltzmann solution around the Rayleigh profile without initial singularity over any finite time interval.

Speaker: Emmanuel Grenier (Beijing Institute of Technology)
Title: Bifurcations of viscous boundary layers in the half space

Abstract: It is well-established that shear flows are linearly unstable provided the viscosity is small enough, when the horizontal Fourier wave number lies in some interval, between the so-called lower and upper marginally stable curves. In this article, we prove that, under a natural spectral assumption, shear flows undergo a Hopf bifurcation near their upper marginally stable curve. In particular, close to this curve, there exists space periodic traveling waves solutions of the full incompressible Navier-Stokes equations. For the linearized operator, the occurrence of an essential spectrum containing the entire negative real axis causes certain difficulties which much be overcome. Moreover, if this Hopf bifurcation is super-critical, these time and space periodic solutions are linearly and nonlinearly asymptotically stable. This is a joint work with D. Bian and G. Iooss.

Speaker: Taoufik Hmidi (New York University Abu Dhabi)
Title: Desingularization of Periodic Orbits in Vortex Dynamics via KAM Theory

Abstract: In this talk, I will present recent advances in the study of vortex dynamics for the two-dimensional Euler equations. I will discuss results on the desingularization of time-periodic point vortex configurations, both in rigid and non-rigid frameworks. The focus will be on the rigorous construction of a leapfrogging motion associated with Love's four-vortex configuration, obtained through a combination of KAM theory and the Nash–Moser iterative scheme.

Speaker: Alexandru Ionescu (Princeton University)
Title: On the wave turbulence theory of 2D gravity water waves

Abstract: I will talk about some recent work on the problem of establishing a wave turbulence theory for water waves systems. This is a classical problem in Mathematical Physics, going back to pioneering work of Hasselmann. To address it we propose a new mechanism, based on a combination of two main ingredients: (1) deterministic energy estimates for all solutions that are small in L^∞-based norms, and (2) probabilistic arguments aimed at understanding propagation of randomness on long time intervals. This is joint work with Yu Deng and Fabio Pusateri.

Speaker: Pierre-Emmanuel Jabin (Pennsylvania State University)
Title: A duality method for mean-field limits with singular interactions

Abstract: We introduce a new approach to derive mean-field limits for first- and second-order particle systems with singular interactions. It is based on a duality approach combined with the analysis of linearized dual correlations, and it allows to cover for the first time arbitrary square-integrable interaction forces at possibly vanishing temperature. The approach also provides convergence rates, and some statistical form of Central Limit Theorem at the limit. This corresponds to joint works with D. Bresch, M. Duerinckx, and N. Khoury.

Speaker: In-Jee Jeong (Seoul National University)
Title: Stability of multiple Lamb dipoles

Abstract: Classical variational approach of maximizing the kinetic energy under constraints provides nonlinear stability of the maximizing vortex configuration in various settings, but this approach fails to handle the situations where the vorticity is concentrated at multiple points in the fluid domain. This is simply because such configurations are not even local kinetic energy maximizers, even when we restrict the admissible class using all known coercive conserved quantities. We present results on nonlinear stability of superpositions of several Lamb dipoles, obtained by combining classical variational principle with dynamical bootstrapping schemes. This is based on several joint works with Ken Abe, Kyudong Choi, and Yao Yao.

Speaker: Wei-Xi Li (Wuhan University)
Title: On the radius of analyticity and Gevrey regularity for the Boltzmann equation

Abstract: This talk studies the non-cutoff Boltzmann equation for hard potentials in a perturbative setting. We first establish a sharp short-time estimate on the radius of analyticity and Gevrey regularity of mild solutions. Furthermore, we obtain a global-in-time radius estimate in Gevrey space. The proof combines hypoelliptic estimates with the macro-micro decomposition.

Speaker: Benoit Pausader (Brown University)
Title: Stability of small BGK waves

Abstract: The BGK waves are the steady states for the 1d Vlasov-Poisson system. We consider their linear stability and derive a simple criterion. This is joint work with D. Bian, E. Grenier and W. Huang.

Speaker: Sylvia Serfaty (Sorbonne University)
Title: Mean-Field Limits and Modulated Energy Methods

Abstract: A central theme in this body of work is the rigorous derivation of mean-field limits for systems of particles with singular interactions—notably Coulomb and Riesz types. These systems are governed by gradient flows, conservative flows, and may include stochastic (noisy) effects. The modulated energy method is introduced as a tool to quantify convergence from a discrete particle system to a continuum PDE limit. At the heart of this approach lies a commutator-type functional inequality, which has seen significant recent progress. Global-in-time convergence is also addressed.

Speaker: Luis Silvestre (University of Chicago)
Title: Monotonicity of the Fisher information in kinetic equations

Abstract: We discuss recent results showing that the standard Fisher information is monotone in time for the space homogeneous Boltzmann and Landau equations. This new Lyapunov functional allows us to establish the existence of global smooth solutions in all cases that remained open. To prove this monotonicity, we introduce a novel doubling-variables technique and reduce the problem to an inequality in the family of the log-Sobolev inequalities.

Speaker: Jiajun Tong (Peking University)
Title: The Immersed Boundary Problem in 2-D: the Navier-Stokes Case

Abstract: We will report recent progress on the 2-D immersed boundary problem with the Navier-Stokes equation, which models coupled motion of a 1-D closed elastic string and ambient fluid in the entire plane. This is based on joint works with Dongyi Wei.

Speaker: Fei Wang (Shanghai Jiao Tong University)
Title: Asymptotic Stability of Shear Flows Near Couette with Navier Boundary Conditions

Abstract: We consider the 2D, incompressible Navier-Stokes equations near the Couette flow, $\omega^{(NS)} = 1 + \epsilon\omega$, set on the channel $\mathbb{T} \times [-1, 1]$, supplemented with Navier boundary conditions on the perturbation, $\omega|_{y=\pm 1} = 0$. We are simultaneously interested in two asymptotic regimes that are classical in hydrodynamic stability: the long time, $t \to \infty$, stability of background shear flows, and the inviscid limit, $\nu \to 0$ in the presence of boundaries. Given small ($\epsilon \ll 1$, but independent of ν) Gevrey 2- datum, $\omega_0^{(\nu)}(x, y)$, that is supported away from the boundaries $y = \pm 1$. This is the first nonlinear asymptotic stability result of its type, which combines three important physical phenomena at the nonlinear level: inviscid damping, enhanced dissipation, and long-time inviscid limit in the presence of boundaries.

Speaker: Chunjing Xie (Shanghai Jiao Tong University)
Title: Rigidity for steady incompressible Euler system and its applications

Abstract: When the steady flows are away from stagnation, the associated Euler equations can be locally reduced to a semilinear equation. On the other hand, stagnation of flows is not only an interesting phenomenon in fluid mechanics, but also plays a significant role in understanding many important properties of fluid equations. It also induces many challenging problems in analysis. First, we discuss the scenario when the Euler equations can be reduced to a single semilinear equation in terms of stream function. Second, we give a classification of incompressible Euler flows via the set of flow angles. Finally, the applications for vanishing viscosity limit of fluid via these classifications will be addressed.

Speaker: Rongchan Zhu (Beijing Institute of Technology)
Title: Φ_3^4 Theory from many-body quantum Gibbs states

Abstract: We derive the Φ_3^4 measure on the torus as a rigorous limit of the quantum Gibbs state of an interacting Bose gas, where the limiting classical measure describes the critical behavior of the Bose gas just above the Bose–Einstein phase transition. Since the quantum problem is typically formulated using a nonlocal interaction potential, a key challenge is to approximate the local Φ_3^4 theory by a Hartree measure with a nonlocal interaction. This requires uniform estimates on the Hartree measure, which are achieved using techniques from recent development on stochastic quantization and paracontrolled calculus. The connection to the quantum problem is then established by applying the variational approach and deriving a quantitative convergence of the quantum correlation functions to those of the Hartree classical field.

Speaker: Ruizhao Zi (Central China Normal University)
Title: Stability of Couette flow in Stokes-transport equations

Abstract: In this talk, I will present some recent stability results on 2D and 3D Stokes-transport equations around the Couette with non-homogeneous density background. This is based on joint works with Daniel Sinambela and Weiren Zhao.

Acknowledgments

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