2025 HKU Workshop on PDEs and Analysis
November 29, 2025 @ RRS 210, HKU

09:00 - 09:40	**Chengbo Wang**
09:40 - 10:20	**Dongbing Zha**
10:20-10:40	**Tea Break**
10:40-11:20	**Kai Yang**
11:20-12:00	**Hai Zhang**
12:00-14:30	**Lunch**
14:30-15:10	**Guixiang Xu**
15:10-15:50	**Xinyu Cheng**
15:50-16:10	**Tea Break**
16:10-16:50	**Hao-Ning Wu**
16:50-17:30	**Wen-Yi Tian**
18:00-20:00	**Dinner**

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Titles and Abstracts

Xinyu Cheng Fudan University

Parameter-stable low-regularity method in fluid models: analytic and numerical results

Among the study of fluid PDEs, parameter stability including vanishing viscosity/damping limits is a very interesting research topic; indeed, it is deeply related to boundary layers, perturbation theory, and many other areas. However, parameter stability is not always captured in numerical simulations. On the other hand, solutions with low regularity play an important role in the study of fluid PDEs and are deeply connected to the well-known Onsager conjecture. Therefore, computing such low-regularity solutions while preserving parameter stability is of great significance. In this talk, we will discuss some recent progress in parameter-stable methods for low-regularity problems arising from fluid models, supported by both analytical and numerical results.

Wen-Yi Tian Tianjin University

Numerical analysis for an optimal control problem governed by forward fractional Feynman-Kac equation

An optimal control problem governed by the forward fractional Feynman-Kac equation is considered, which describes functional distributions of anomalous diffusion and encounters significant challenges arise from the time-space coupled nonlocal operator and its non-commutativity with the Laplacian. First, we investigate the well-posedness of the continuous optimal control problem, derive the first-order optimality conditions and establish the regularity estimates of the solution. Then, the Riemann-Liouville fractional substantial derivative in the equation is approximated by using the backward Euler convolution quadrature formula, and a temporal semi-discrete scheme is proposed for the optimal control problem. Moreover, we rigorously analyze the $\ell^2\big(L^2(\Omega)\big)$ and $\ell^\infty\big(L^2(\Omega)\big)$ error estimates of the proposed semi-discrete scheme, which exhibits almost optimal convergence of $O(\tau \ln \tau)$, relying only on the regularity assumptions on the data and without extra assumptions on the solution of the optimality system. Finally, we perform the numerical experiments by using the inexact alternating direction method of multipliers (ADMM) algorithm and the piecewise linear finite element method. The numerical results demonstrate the validity of our numerical scheme and verify the theoretical convergence order.

Chengbo Wang Zhejiang Normal University
Generalized Strauss conjecture for semilinear wave equations

In this talk, we will recast the Strauss conjecture in the context of general nonlinearity, instead of the classical power type nonlinearity. It is based on the joint work with Xiaoran Zhang.

Hao-Ning Wu University of Georgia
Control Design for Fluid Mixing Based on Least Action Principle

We investigate the mixing dynamics of a passive scalar field advected by a divergence-free velocity field with the free-slip boundary condition. This mixing process is governed by a purely transport equation. Drawing inspiration from the least action principle and optimal transport theory, we introduce a control design aimed at achieving a specified level of mixing in the passive scalar field. In our design, the velocity field (the "control") is assumed to be generated by a finite set of divergence-free flows, with the cellular flow serving as a representative example. We derive the first-order necessary conditions for optimality and implement the optimization algorithm using augmented Lagrangian methods. The associated partial differential equations are numerically solved using spline methods. Numerical experiments demonstrating the mixing results are presented.

Guixiang Xu Beijing Normal University
Global well-posedness of the defocusing, NLW outside of the ball with radial data

We consider the defocusing, cubic nonlinear wave equation with zero Dirichlet boundary value in the exterior $\Omega = R^3 \setminus \bar{B}$ $(0,1)$. We make use of the distorted Fourier transform in [LiSZ:NLS, LiXZ:NLS, Taylor:PDE:II] to establish the dispersive estimate and the global-in-time (endpoint) Strichartz estimate of the linear wave equation outside of the ball with radial data. As an application, we combine the Fourier truncation method as those in [Bourgain98:FTM, GallPlan03:NLW, KenigPV00:NLW] with the energy method to show global well-posedness of radial solution to the defoucusing, cubic nonlinear wave equation outside of a ball in the Sobolev space $\left(\dot{H}_D^s(\Omega) \cap L^4(\Omega)\right) \times \dot{H}_D^{s-1}(\Omega)$ for $s > 3/4$. It is a joint work with Pengxuan Yang.

Kai Yang Southeast University
Dynamics of NLS with inverse square potential

We consider the Cauchy problem of the energy subcritical and critical NLS with inverse square potential. We classify the behaviour of solutions when the energy is less than or equal to the energy of the ground state in the energy critical case. In the energy subcritical case, we obtain similar results at the ground state threshold level, and the uniqueness of the ground

state solution is also obtained via the shooting method. These are joint works with Chongchun Zeng and Xiaoyi Zhang.

Dongbing Zha Donghua University
Global existence, scattering and rigidity for nonlinear elastic waves

In this talk, we will show that how the Helmholtz decomposition, combined with various energy type estimates, can be used to study the long time behavior for 3-D nonlinear elastic waves. First, we will provide a new and streamlined proof for the global existence result in the case of some null condition is satisfied, first proved by Agemi and Sideris independently. Then, we will show the asymptotic behavior of the global classical solution: the scattering property and rigidity property are satisfied.

Hai Zhang HKUST
Mathematical theory of interface/edge modes in topological photonics and phononics

Topological photonics and phononics are rapid developing fields that apply the principles of topological insulators from condensed matter physics into periodic optical and acoustic media. A central challenge in these systems is to understand how in-gap interface modes emerge at the boundary between two bulk media in distinct topological phases. Such modes are inherently topologically protected and remain robust under a broad class of perturbations. In this talk, we review recent progress in elucidating the mechanisms that give rise to in-gap interface modes across various topological photonic and phononic structures.