Robust Dividend Policy: Equivalence of Epstein-Zin and Maenhout Preferences

Kexin CHEN, Assistant Professor, PolyU

The classic optimal dividend problem aims to maximize the expected discounted dividend stream over the lifetime of a company. Since dividend payments are irreversible, this problem corresponds to a singular control problem with a risk-neutral utility function applied to the discounted dividend stream. In cases where the company's surplus process encounters model ambiguity under the Brownian filtration, we explore robust dividend payment strategies in worst-case scenarios. We establish a connection between ambiguity aversion in a robust singular control problem and risk aversion in Epstein-Zin preferences. To do so, we first formulate the dividend problem as a recursive utility function with the EZ aggregator within a singular control framework. We investigate the existence and uniqueness of the EZ dividend problem. By employing Backward Stochastic Differential Equation (BSDE) representations where singular controls are involved in the generators of BSDEs, we demonstrate that the EZ formulation is equivalent to the maximin problem involving risk-neutral utility on the discounted dividend stream, incorporating Meanhout's regularity that reflects investors' ambiguity aversion. Considering the equivalent Meanhout's preferences, we solve the robust dividend problem using a Hamilton-Jacobi-Bellman (HJB) approach combined with a variational inequality (VI). Our solution is obtained through a novel shooting method that simultaneously satisfies the VI and boundary conditions. This is a joint work with Kyunghyun Park and Hoi Ying Wong.

Density-equalizing map with applications

Gary CHOI, Vice-Chancellor Assistant Professor, CUHK

We present surface and volumetric mapping methods based on a natural principle of density diffusion. Specifically, we start with a prescribed density distribution in a surface or volumetric domain and then create shape deformations with different regions enlarged or shrunk based on the density gradient. Using the proposed methods, we can easily achieve different mapping effects with controllable area change. Applications to shape registration, morphing, remeshing, medical shape analysis, and data visualization will be presented.

Wasserstein Hamiltonian Flow and Its Structure Preserving Numerical Scheme

Jianbo CUI, Assistant Professor, PolyU

We study discretizations of Hamiltonian systems on the probability density manifold equipped with the L2-Wasserstein metric. For low dimensional problems, based on discrete optimal transport theory, several Wasserstein Hamiltonian flows (WHFs) on graph are derived. They can be viewed as spatial discretizations to the original systems. By regularizing the system using Fisher information, we propose a novel regularized symplectic scheme which could preserve several desirable longtime behaviors. Furthermore, we use the coupling idea and WHF to propose a supervised learning scheme for some high-dimensional problem. If time permits, we will talk about more details on solving high-dimensional Hamilton-Jacobi equation via the density coupling and supervised learning.

Hyper-Compression: Neural Network Compression via Hyper-function

Fenglei FAN, Research Assistant Professor, CUHK

Recently, the escalating demand for memory and computational resources by large models has presented formidable challenges for their deployment in resource-constrained environments. One prevalent way to serve large models is to develop effective model compression approaches that crop the size of large models while maintaining acceptable performance levels. Currently, the landscape of model compression methodologies predominantly revolves around four fundamental algorithms: pruning, quantization, knowledge distillation, and low-rank approximation whose basic frameworks have been established years ago. However, the compression efficacy of these methods is often capped or challenging to scale based on theoretical analysis. In this talk, we introduce a novel and general-purpose approach, referred to as hyper-compression, that redefines model compression as a problem of parameter representation. Specifically, we extend the concept of hypernets into what we term a ‘hyperfunction'. Then, the hyperfunction is designed based on ergodic theory (ET). This advanced formulation leads to a performant algorithm that offers several distinct advantages, succinctly summarized as PNAS: 1) Preferable compression ratio; 2) No post-hoc retraining; 3) Affordable inference time; and 4) Short compression time. Lastly, in light of the observed stagnation in hardware Moore's Law, we conjecture “Moore's Law of Model Compression", i.e., the efficiency of model compression could double annually in the near future to meet the needs of large model era. We believe that model compression based on hyperfunction can play an important role in “Moore's Law of Model Compression".

On the Optimality of Inference on the Mean Outcome under Optimal Treatment Regime

Xinzhou GUO, Assistant Professor, HKUST

When an optimal treatment regime (OTR) is considered, we need to address the question of how good the OTR is in a valid and efficient way. The classical statistical inference applied to the mean outcome under the OTR, assuming the OTR is the same as the estimated OTR, might be biased when the regularity assumption that the OTR is unique is violated. Although several methods have been proposed to allow nonregularity in inference on the mean outcome under the OTR, the optimality of such inference is unclear due to challenges in deriving semiparametric efficiency bounds under potential nonregularity. In this talk, we address the bias issue induced by potential nonregularity via adaptive smoothing over the estimated OTR and develop a valid inference procedure on the mean outcome under the OTR regardless of whether the regularity assumption is satisfied or not. We establish the optimality of the proposed method by deriving a lower bound of the asymptotic variance for the robust asymptotically linear unbiased estimator to the mean outcome under the OTR and showing that our proposed estimator achieves the variance lower bound. The considered class of the estimator is general and includes the efficient regular estimator and the current state-of-the-art approach allowing nonregularity, and the derived lower bound of the asymptotic variance can be viewed as an extension of the classical semiparametric theory for OTR to a more general scenario allowing nonregularity. The merit of the proposed method is demonstrated by re-analyzing the ACTG 175 trial.

A Unified Analysis of Likelihood-based Estimators in the Plackett-Luce Model

Ruijian HAN, Assistant Professor, PolyU

The Plackett–Luce model has been extensively used for rank aggregation in social choice theory. A central question in this model concerns estimating the utility vector that governs the model’s likelihood. In this paper, we investigate the asymptotic theory of utility vector estimation by maximizing different types of likelihood, such as full, marginal, and quasi-likelihood. Starting from interpreting the estimating equations of these estimators to gain some initial insights, we analyze their asymptotic behavior as the number of compared objects increases. In particular, we establish both the uniform consistency and asymptotic normality of these estimators and discuss the trade-off between statistical efficiency and computational complexity. For generality, our results are proven for deterministic graph sequences under appropriate graph topology conditions. These conditions are shown to be revealing and sharp when applied to common sampling scenarios, such as nonuniform random hypergraph models and hypergraph stochastic block models. Numerical results are provided to support our findings.

A Fast Algorithm for Symmetric Nonnegative Matrix Factorization

Liangshao HOU, Research Assistant Professor, Hong Kong Baptist University

We study the symmetric nonnegative matrix factorization (SNMF) which is a powerful tool in data mining for dimension reduction and clustering. The main contributions of the present work include: (i) a new descent direction for the rank-one SNMF is derived and a strategy for choosing the step size along this descent direction is established; (ii) a progressive hierarchical alternating least squares (PHALS) method for SNMF is developed, which is parameter-free and updates the variables column by column. Moreover, every column is updated by solving a rank-one SNMF subproblem; and (iii) the convergence to the Karush-Kuhn-Tucker (KKT) point set (or the stationary point set) is proved for PHALS. Several synthetical and real data sets are tested to demonstrate the effectiveness and efficiency of the proposed method. Our PHALS provides better performance in terms of the computational accuracy, the optimality gap, and the CPU time, compared with a number of state-of-the-art SNMF methods.

Nonlocal Conservation Laws for Traffic Flow Modeling

Kuang HUANG, Research Assistant Professor, CUHK

The emerging connected and automated vehicle technologies allow vehicles to perceive and process information in a wide spatial range, which motivates the modeling of traffic flows with nonlocal inter-vehicle interactions. For example, the literature has considered conservation laws with nonlocal integral terms. By conducting stability analysis of one such model, we obtain asymptotic stability of the uniform equilibrium flow under suitable assumptions on how the nonlocal information is utilized. The findings may serve to inform the development of future driving algorithms for connected vehicles. In this talk, I will also discuss a nonlocal conservation law for modeling traffic flows over urban transportation networks, where the nonlocality arises from a coarse-scale description of fine-scale traffic flow dynamics, and an associated inverse problem of calibrating inflow rates.

The Geometry of Grassmannians Fibrations
Qingyuan JIANG, Assistant Professor, HKUST

Algebraic geometry studies "spaces" defined by algebraic equations. These spaces are crucial in many areas of mathematics and physics, presenting complex and fascinating structures. A fundamental method in algebraic geometry is to explore these spaces through their "invariants"—simpler algebraic structures like vector spaces or groups that encapsulate essential information about the spaces. Two main questions arise: What effective geometric operations can we perform on these spaces, and how do these operations influence their invariants?

In this talk, we will delve into the theory of "Grassmannians of complexes," which simplifies and extends many standard operations in geometry into a cohesive framework. This theory also provides formulas for important invariants such as Chow groups, K-theory, and derived categories. Our theory is built on the framework of Derived Algebraic Geometry (DAG), introduced by Toën, Vezzosi, Lurie, and others in the early 2000s, which extends classical algebraic geometry by integrating concepts and ideas from homotopy theory.

Phase transition for the bottom singular vector of rectangular random matrices
Jaehun Lee, Postdoc, CityU

In this talk, we consider the rectangular random matrix $X = (x_{ij}) \in \mathbb{R}^{N\times n}$ whose entries are iid with tail $\mathrm{P}(|x_{ij}| > t) \sim t^{-\alpha}$ for some $\alpha > 0$. We consider the regime $\frac{N(n)}{n} \to a > 1$ as n tends to infinity. Our main interest lies in the right singular vector corresponding to the smallest singular value, which we will refer to as the "bottom singular vector", denoted by u. We prove the following phase transition regarding the localization length of u: when $\alpha < 2$ the localization length is $O(\frac{N}{log\ n})$; when $\alpha > 2$ the localization length is of order n. Similar results hold for all right singular vectors around the smallest singular value. The variational definition of the bottom singular vector suggests that the mechanism for this localization-delocalization transition when α goes across 2 is intrinsically different from the one for the top singular vector when α goes across 4. This is the joint work with Zhigang Bao and Xiaocong Xu.

Compactness in geometry and application
Man Chun LEE Assistant Professor, CUHK

Compactness of functions play an important role in understanding regularity and singularity in mathematics. In this talk, we will discuss some geometric compactness and their application in problems in geometry.

Mathematical Modelling Applied in Scheduling Cluster Tools in Semiconductor Manufacturing Fabs
Xin Stephen LI, research assistant professor, EdUHK

Cluster tools have been widely used in the semiconductor industry. In previous work, singe-arm and dual-arm cluster tools are dealt with separately. When considering residency time constraints, algorithms for scheduling robot moving sequences are mainly developed based on backward and swap strategies, respectively. How about the performance of other robot moving sequences is still an open problem. The present work addresses general conditions by considering all feasible robot moving sequences—beyond backward- and swap-based strategies. Based on detailed analysis of all available robot operations in a cluster tool, mixed-integer programming formulations are developed. Subsequently, both illustrative examples and randomly generated instances are tested to validate the efficiency of the proposed approach. Results of one example show improvement comparing to previous work. Another two examples—not scheduled previously—are scheduled well by the proposed approach. Meanwhile, the flexibility of operations obtained by the proposed model is demonstrated by an example with six processing modules and 12 stages in a dual-arm cluster tool. Additionally, more randomly generated instances are tested more to validate the proposed approach and analyse computation time.

Linear-quadratic Mean Field Control with Non-convex Data
Mengzhen LI, Postdoc, CityU

In this manuscript, we study a class of linear-quadratic (LQ) mean field control problems with a common noise and their corresponding N-particle systems. The mean field control problems considered are not standard LQ mean field control problems in the sense that their dependence on the mean field terms can be non-convex. The key idea to solve our LQ mean field control problem is to utilize the common noise. We first prove the global well-posedness of the corresponding Hamilton-Jacobi equations via the non-degeneracy of the common noise. In contrast to the LQ mean field games master equations, the Hamilton-Jacobi equations for the LQ mean field control problems are inherently infinite-dimensional partial differential equations (PDEs) and cannot be reduced to finite-dimensional ones. However, their well-posedness is equivalent to the well-posedness of two finite-dimensional PDEs. We then globally solve the Hamilton-Jacobi equations for N-particle systems. As byproducts, we derive the optimal quantitative convergence results from the N-particle systems to the mean field control problem and the propagation of chaos property for the related optimal trajectories. This paper extends the results in [M. Li, C. Mou, Z. Wu and C. Zhou, Trans. Amer. Math. Soc., 376(06) (2023), pp. 4105–4143] to the LQ mean field control problems.

Full compressible Euler equations in a physical vacuum

Sicheng LIU, postdoc, University of Macau

This presentation addresses vacuum free-boundary problems for the non-isentropic compressible Euler equations, focusing on the behavior of gases in the vicinity of vacuum boundaries, where the density approaches zero. The concept of a physical vacuum, with boundaries moving over time with finite non-zero accelerations, is of close relevance to the study of gaseous stars and shallow water waves. The talk primarily concentrates on the Hadamard-style local well-posedness of physical vacuum problems within suitable weighted Sobolev spaces. It will cover aspects such as existence, uniqueness, continuous dependence on initial data, a priori energy estimates, and continuation criteria. These results apply to low-regularity solutions, for which the velocity fields of free boundaries are only Lipschitz continuous.

This is the first well-posedness result for the full compressible Euler equations in a physical vacuum with space dimensions larger than one. The approach is in the framework of Eulerian coordinates.

Inverse problems in population models

Wing Kwan Catharine LO, Postdoc, CityU

I will discuss several recent works focusing on inverse problems in population ecological models, such as Lotka-Volterra models, chemotaxis models, and aggregation models. These works delve into the unique identifiability of multiple parameters in these models, including interaction terms, compression, prey attack, crowding, carrying capacity, diffusion coefficients, environmental factors such as gravitational potential and the oxygen carrying-capacity. These studies contribute unique insights and novel methodologies to advance the understanding of inverse problems for complex systems across diverse scientific disciplines.

Nonlinear preconditioning algorithms with learning capability

Li Luo, Assistant Professor, University of Macau

Nonlinear preconditioning algorithms have been applied successfully for solving some difficult nonlinear partial differential equations by identifying and balancing the nonlinearities in the system. One of the challenging tasks when applying the methods is to identify the unbalanced nonlinearities. We study some learning-based strategies that identify the bad behavior of a Newton solver from the slow residual subspace of a training problem. Numerical experiments show that the learning-based algorithms are more robust and efficient compared with existing nonlinear solvers.

High order free cumulants and quantitative laws

Daniel Munoz George, Postdoc, CityU

In this talk, we will explore the higher-order cumulants of some random matrix models and discuss the concept of higher-order free cumulants, which was introduced in a series of papers culminating in [1]. In the first half of the talk, we will present some results on the Gaussian and Wigner models, showing that, as with the expectation of traces, higher-order cumulants can be simply expressed in terms of certain quantities called free cumulants.

In the second half of the talk, we will explore how further analysis of higher-order cumulants can lead us to derive quantitative laws for the Central Limit Theorem (CLT). Specifically, by allowing the parameter of the r^{th}−cumulant to be arbitrary, we obtain upper bounds for these cumulants. With these bounds, along with results from [2], we can derive a CLT with a Cramér-type correction, a Berry-Esseen bound for the CLT, and a concentration inequality.

The first part of the talk is based on joint work with James Mingo (see [3]), while the second part is based on ongoing work with Zhigang Bao.

References
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[2] H. Döring, S. Jansen, K. Schubert, The method of cumulants for the normal approximation, Probab. Surv., 19 (2022), 185-270.
[3] D. Munoz, J. A. Mingo, submitted, Asymptotic limit of cumulants and higher order free cumulants of Complex Wigner matrices, (2024), preprint arXiv:2407.17608

Bulk Deviation Lower Bounds for the Simple Random Walk

Maximilian Nitzschner, Assistant Professor, HKUST

This talk deals with the probability of certain bulk deviation-type events depending on the occupation-time field of a simple random walk on Z^d when $d \geq 3$. As one pertinent application, we obtain an exact leading cost for the probability of the (unlikely) event that a simple random walk covers a volume-like fraction of a macroscopic body, upon combination with upper bound previously obtained by Sznitman. Based on joint work with A. Chiarini (University of Padova).

Constrained Nonnegative Matrix Factorization (NMF) and Beyond

Junjun PAN, Research Assistant Professor, Hong Kong Baptist University

Nonnegative matrix factorization (NMF) is a linear dimensionality technique for nonnegative data with applications such as image analysis, text mining, audio source separation, and hyperspectral unmixing. Although NMF is generally NP-hard to solve, it can be computed efficiently under specific constraints, such as orthogonality or separability. In this talk, we will first introduce separable NMF models and their applications on text mining. Next, we will present a novel low-rank quaternion linear mixing model for polarized signals, derived by incorporating separability into quaternion matrix factorization. Finally, we will discuss tensor models with orthogonal nonnegative constraints for clustering, demonstrating their effectiveness in tasks such as hyperspectral unmixing and video analysis.

Algorithms to compute Jacquet modules for general linear group

Basudev Pattanayak, postdoc, HKU

Let G be a general linear group over a non-archimedean local field. In this talk, we discuss some algorithms to compute certain Jacquet modules in the form ‘derivatives’ of irreducible smooth representations of G. These derivatives are crucial for understanding quotient branching laws, particularly in identifying generalized GGP relevant pairs in G. This talk is based on an ongoing work with Kei Yuen Chan.

Reduced order model enhanced preconditioner for parametric radiative transfer equation
Zhichao PENG, Assistant Professor, HKUST

Radiative transfer equation (RTE) models particles propagating through and interacting with a background medium. Applications, such as uncertainty quantification, medical imaging, and shape optimization, require solving RTE many times for various parameters.

Classical Diffusion Synthetic Acceleration (DSA) preconditioner for RTE utilizes the diffusion limit of a kinetic correction equation. However, it may become less effective, if the correction equation is not well approximated by the diffusion limit. Moreover, it does not exploit low-rank structures of the solution manifold with repsect to parameters.

To address these issues, we utilize data-driven reduced order models (ROMs) to design a hybrid preconditioner. This new preconditioner directly starts from the original kinetic description and leverages low-rank structures with respect to parameters.

On symmetry breaking for the Navier-Stokes equations
Jin TAN, Research Assistant Professor, CUHK

In this talk, I will talk about symmetry breaking and symmetry preservation for the 3D Navier-Stokes equations with initially zero third component. Specifically, I will demonstrate Isotropic Norm Inflation starting from zero third component and show certain symmetry preserving solutions with a shear flow structure. An explicit solutions for the 3D Euler equations that inviscidly damp to the Kolmogorov flow will also be exhibited. This talk is based on a joint work with Tobias Barker (University of Bath) and Christophe Prange (Cergy Paris Université).

Adaptivity of Diffusion Models to Manifold Structures
Rong TANG, Assistant Professor, HKUST

Empirical studies have demonstrated the effectiveness of (score-based) diffusion models in generating high-dimensional data, such as texts and images, which typically exhibit a kw-dimensional manifold nature. These empirical successes raise the theoretical question of whether score-based diffusion models can optimally adapt to low-dimensional manifold structures. While recent work has validated the minimax optimality of diffusion models when the target distribution admits a smooth density with respect to the Lebesgue measure of the ambient data space, these findings do not fully account for the ability of diffusion models in avoiding the curse of dimensionality when estimating high-dimensional distributions. This work considers a common class of diffusion model: forward-backward diffusion. We show that the model can adapt to the intrinsic manifold structure by showing that the convergence rate of the inducing distribution estimator depends only on the intrinsic dimension of the data. Moreover, our considered estimator does not require knowing or explicitly estimating the manifold. We also demonstrate that the forward-backward diffusion can achieve the minimax optimal rate under the Wasserstein metric when the target distribution possesses a smooth density with respect to the volume measure of the low-dimensional manifold.

Tightness of the Sparse Moment-SOS Hierarchy
Xindong TANG, Assistant Professor, Hong Kong Baptist University

We study the sparse Moment-SOS hierarchy of relaxations for solving sparse polynomial optimization problems. We show that this sparse hierarchy is tight if and only if the objective can be written as a sum of sparse nonnegative polynomials, each of which belongs to the sum of the ideal and quadratic module generated by the corresponding sparse constraints. Based on this characterization, we give several sufficient conditions for the sparse Moment-SOS hierarchy to be tight. In particular, we show that this sparse hierarchy is tight under some assumptions such as convexity, optimality conditions or finiteness of constraining sets.

Annealed heat kernel for random walk on loop-erased random walk
Satoini Wanatanbe, Postdoc, CityU

Random walks on random graphs are associated with diffusion phenomena in disordered media. This talk focuses on the simple random walks on loop-erased random walks (LERW). We will discuss the sub-Gaussian estimate for the annealed off-diagonal heat kernel of the simple random walk on high-dimensional LERWs. In the course of the proof, we will demonstrate the Gaussian-type local central limit theorem of high-dimensional LERWs.

Isogenies of CM elliptic curves of a fixed degree
Jiacheng XIA, Postdoc, HKU

Given two elliptic curves over a number field, Francois Charles showed that there are infinitely many places where the reductions of these two curves are geometrically isogenous, which has consequences for the existence of supersingular primes. I will talk about some progress on an analogous refined problem for a given pair of CM elliptic curves: for a fixed number m, how many places are there where the reductions of the CM elliptic curves are m-isogenous?

We establish an explicit lower bound for the first time by using some Gross--Zagier type results and a novel explicit upper bound for the growth of Fourier coefficients of a general cusp form. The latter relies on a recent Deligne bound result in terms of the Petersson norm, and some extra care to bound the Petersson norm explicitly in terms of the first few Fourier coefficients up to the Sturm bound, generalizing a few cases in the literature for level 2 and 3 to arbitrary prime power levels. This is a joint work in progress with Yingkun Li and Tian Wang.

Randomized methods for computing optimal transport and convergence analysis
Yue XIE, Research Assistant Professor, HKU

In this talk, I will introduce the random block coordinate descent (RBCD) methods to directly solve the linear programming (LP) problem motivated by optimal transport (OT). Our approach restricts the potentially large-scale LP to small LP subproblems constructed via randomly chosen working sets. We equip the vanilla version of RBCD with almost sure convergence and a linear convergence rate. To further improve the efficiency, we explore the special structure of constraints in OT and refine the random working set selection. We conduct numerical experiments demonstrating that the accelerated RBCD compares well with other solvers and offers the advantage of saving memory.

A cross-validation approach for distribution free two sample testing
Shunan YAO, Assistant Professor, Hong Kong Baptist University

Two-sample testing is a cornerstone of modern statistics. In the realm of multi-dimensional two-sample testing, traditional methods often rely on distributional assumptions, e.g., Hotelling's T-test, or use a subset of the data to convert multi-dimensional data to one-dimension, thereby not utilizing the full dataset for the actual test. In our work, we introduce a novel cross-validation style rank-sum test to two-sample testing that can use the full dataset for testing. Specifically, we (a) show that our method achieves super-uniformity in finite samples under the null hypothesis, (b) establish the asymptotic properties of the test statistic, and (c) introduce a computationally more efficient rank-sum test that has asymptotically optimal power.

Some Recent Studies on Learning Theory of Distribution Regression
Zhan YU, Research Assistant Professor, Hong Kong Baptist University

In this talk, we introduce the theory of two-stage distribution regression (DR) which aims at regressing from probability distributions to real-valued outputs. Firstly, we briefly introduce kernel-regularized least squares DR and discuss several existing works circling around it. Then, we provide a new robust kernel-based DR scheme and introduce its learning theory. To improve existing results, we also consider a weak moment condition on output variable. Under such a condition, we further introduce a distributed learning scheme for DR and discuss its learning theory. On the other hand, in a totally different way, we briefly introduce a learning theory of distribution regression with neural networks. We show that some satisfactory learning rates can be derived in our neural-network-based hypothesis space.

HOT: An Efficient Halpern Accelerating Algorithm for Optimal Transport Problems
Yancheng YUAN, Assistant Professor, PolyU

This talk introduces an efficient HOT algorithm for solving the optimal transport (OT) problems with finite supports. We particularly focus on an efficient implementation of the HOT algorithm for the case where the supports are in R^2 with ground distances calculated by L_2^2-norm. Specifically, we design a Halpern accelerating algorithm to solve the equivalent reduced model of the discrete OT problem. Moreover, we derive a novel procedure to solve the involved linear systems in the HOT algorithm in linear time complexity. Consequently, we can obtain an ϵ-approximate solution to the optimal transport problem with M supports in $O(M^{1.5}/\epsilon)$ flops, which significantly improves the best-known computational complexity. We further propose an efficient procedure to recover an optimal transport plan for the original OT problem based on a solution to the reduced model, thereby overcoming the limitations of the reduced OT model in applications that require the transport map. We implement the HOT algorithm in PyTorch and extensive numerical results show the superior performance of the HOT algorithm compared to existing state-of-the-art algorithms for solving the OT problems.

Recent studies on compressible boundary layers

Zhu ZHANG, Assistant Professor, PolyU

Even though there are extensive studies on the stability/instability of different hydrodynamic patterns in various physical settings, particularly in the high Reynolds number limit of laminar flows for the incompressible Navier-Stokes equations, there are much fewer mathematical results in the compressible setting. This talk will present a new approach to studying the compressible Navier-Stokes equations in the subsonic and high Reynolds number regimes. Some applications of this approach will also be discussed.