应用数学研究所青年学者研讨会（2023）

2023 年 2 月 16 日（周四）9:00-17:30，南楼 N202

主办：中国科学院数学与系统科学研究院应用数学研究所

时　间	报告人	报告题目
9:00--9:10	开幕式	
9:10--9:30	G. Véchambre	Lambda-Wright-Fisher processes with general selection and opposing environmental effects: fixation and coexistence
9:30--9:50	李　瞳	图论中的染色与极值问题
9:50--10:10	孟世旭	Wave propagation and inverse problems
10:10--10:30	盛　赢	Synthesizing external aggregated information in the presence of population heterogeneity
10:30--10:40	茶　歇	
10:40--11:00	石　权	The derivative martingale in a branching Lévy process
11:00---11:20	王长军	Best cost-sharing rule design for selfish bin packing
11:20--11:40	夏　旭	离散薛定谔算子的一些谱问题
11:40	午餐（盒饭）	
14:00--14:20	杨　钊	Convergence of point and essential spectra in the homoclinic limit
14:20--14:40	袁　谦	守恒律方程的周期扰动问题
14:40--15:00	张　悦	量子信息理论中态的非经典性刻画
15:00--15:20	赵国焕	Non-local operators with low-order singular kernels
15:20--15:40	郑　好	Introduction on quantum hydrodynamic models
15:40--15:50	茶　歇	
15:50--17:30	座谈会	
17:30	晚餐（物科餐厅）	

报告信息

G. Véchambre（概率统计研究室）

简　介：2022 年入职中国科学院数学与系统科学研究院应用数学研究所。In 2016, he received a PhD in Mathematics from Université d'Orléans in France. His research field is probability and his main research direction are population models (including Wright-Fisher SDEs), Lévy processes and related processes. Research results have been published in the Annales de l'Institut Henri Poincaré, Journal of Theoretical Probability and other journals. Some recent results are currently in press in The Annals of Applied Probability.

题　目： Lambda-Wright-Fisher processes with general selection and opposing environmental effects: fixation and coexistence

摘　要：Wright-Fisher diffusions offer popular models in population genetics. They can be used to model the frequency of a gene in a large constant size population. In a recent join work with F. Cordero (Bielefeld University) and S. Hummel (UC Berkeley) we consider a class of Lambda-Wright-Fisher diffusions with a general form of selection and environmental effects. We reveal a rich variety of long-term behaviors for processes in this class and provide explicit criteria to discriminate between them. That includes the situation of long term coexistence maintained by selection alone, which is a new phenomenon in this context and has interesting biological implications. When fixation or extinction occur almost surely, we derive decay rates for the probability that fixation or extinction has not essentially taken place after a long time. This decay is sometimes polynomial and sometimes exponential, depending on parameter choices. When both fixation and extinction occur with positive probability we provide a representation of the fixation probability. Aspects of our methodology include a Siegmund duality for our processes, approximation by Lévy processes that allow to use fluctuation theory of Lévy processes, building renewal times for the dual process, and studying coalescing properties of its flow. Our methods allow us to treat models that so far could not be analyzed by means of classical dualities and to close an existing gap in the literature.

李瞳（运筹学与信息科学研究室）

简　介：2022 年入职中国科学院数学与系统科学研究院应用数学研究所。主要研究方向为极值组合、染色标号和随机图过程。在 Journal of Graph Theory、Electronic Journal of Combinatorics 等期刊发表多篇论文。

题　目：图论中的染色与极值问题

摘　要：本次报告主要介绍了图论的起源发展以及结构图论和极值图论中的部分问题。

孟世旭（微分方程与计算物理研究室）

简　介：2020 年入职中国科学院数学与系统科学研究院应用数学研究所。2016 年特拉华大学博士毕业，之后在明尼苏达大学 IMA 研究所做博士后研究员和密歇根大学做博士后助理教授。研究兴趣包括声波和电磁波的采样法、反散射特征值问题、周期介质波传播、数据驱动反问题等。

题　目：Wave propagation and inverse problems

摘　要：Wave propagation describes the interaction of waves with natural or manufactured perturbations of the medium through which they propagate. The corresponding inverse problem is to estimate the medium from observations of the wave field. It has applications in a broad spectrum of scientific and engineering disciplines, such as medical diagnosis, health and wellness, tunnel imaging, seismic imaging, non-destructive material testing, sub-wavelength imaging, and material design.

This talk is to introduce briefly my research on sampling methods, eigenvalues in inverse scattering and complex media. In particular, I shall discuss imaging in waveguide which is mainly motivated by its applications in ocean acoustics, non-destructive testing of pipes, imaging in tunnels and others. Sampling methods such as the linear sampling method, the factorization method, and their extensions have attracted much attention. These sampling methods require less a priori information on the scattering objects, and provide both theoretical justifications and efficient numerical algorithms. This talk discusses my recent work on imaging in acoustic and electromagnetic waveguides with various types of data, including limited- or full-aperture multi-static data at a single frequency and multi-frequency data.

盛赢（概率统计研究室）

简　介：2021 年入职中国科学院数学与系统科学研究院应用数学研究所。2018 年毕业于中科院数学与系统科学研究院，获得理学博士学位。主要研究领域有可更新估计、整合分析、高维数据分析、缺失数据分析、生存分析、精准医学等。研究成果发表在 Biometrics、Statistics in Medicine、Computational Statistics & Data Analysis、Journal of Multivariate Analysis 等学术期刊。

题　目：Synthesizing external aggregated information in the presence of population heterogeneity

摘　要： With the increasing availability of data in the public domain, there has been a growing interest in exploiting information from external sources to improve the analysis of smaller-scale studies. An emerging challenge in the era of big data is that the subject-level data are high-dimensional, but the external information is at an aggregate level and of a lower dimension. Moreover, heterogeneity and uncertainty in the auxiliary information are often not accounted for in information synthesis. In this paper, we propose a unified framework to summarize various forms of aggregated information via estimating equations and develop a penalized empirical likelihood approach to incorporate such information in logistic regression. When the homogeneity assumption is violated, we extend the method to account for population heterogeneity among different sources of information. When the uncertainty in the external information is not negligible, we propose a variance estimator adjusting for the uncertainty. The proposed estimators are asymptotically more efficient than the conventional penalized maximum likelihood estimator and enjoy the oracle property even with a diverging number of predictors. Simulation studies show that the proposed approaches yield higher accuracy in variable selection compared with competitors. We illustrate the proposed methodologies with a pediatric kidney transplant study. This is a joint work with Yifei Sun, Chiung-Yu Huang, and Mi-Ok Kim.

石权（概率统计研究室）

简　介：2021 年入职中国科学院数学与系统科学研究院应用数学研究所。2016 年获苏黎世大学数学博士学位，曾获瑞士国家科学基金委资助在牛津大学从事博士后研究。研究领域为概率论，主要研究方向为分枝过程和随机树，论文发表于 The Annals of Applied Probability、Bernoulli 等期刊。

题　目：The derivative martingale in a branching Lévy process

摘　要：Branching Lévy processes are continuous-time particle systems in which each particle moves according to a Lévy process and reproduces new particles at possibly infinite rate. They are the continuous-time counterparts of branching random walks and generalize several classical models including the branching Brownian motion. We obtain the necessary and sufficient condition for the convergence of the derivative martingale in a branching Lévy process to a non-trivial limit. This extends previously known results on branching Brownian motions and branching random walks. To obtain this result, we also establish a new zero-one law on the perpetual integrals of Lévy processes conditioned to stay positive. Based on a joint work with Bastien Mallein (Paris).

王长军（运筹学与信息科学研究室）

简　介：2021 年入职中国科学院数学与系统科学研究院应用数学研究所。2015 年在中科院数学与系统科学研究院获博士学位。主要从事算法博弈与机制设计、组合优化等方向的研究工作。目前已在包括 Operations Research、Mathematics of Operations Research、Information and Computation、EC、WINE 等相关领域重要国际期刊及会议发表论文二十余篇。

题　目：Best cost-sharing rule design for selfish bin packing

摘　要：In selfish bin packing, each item is regarded as a selfish player, who aims to minimize the cost-share by choosing a bin it can fit in. To have a least number of bins used, cost-sharing rules play an important role. The currently best known cost sharing rule has PoA larger than 1.45, while a general lower bound 4/3 on PoA applies to any cost-sharing rule under which no items have incentive unilaterally moving to an empty bin. In this paper, we propose a novel and simple rule with a PoA matching the lower bound 4/3, thus completely resolving this game. The new rule always admits a Nash equilibrium and its PoS is one. Furthermore, the well-known bin packing algorithm BFD (Best-Fit Decreasing) is shown to achieve a strong equilibrium, implying that a stable packing with an asymptotic approximation ratio of 11/9 can be produced in polynomial time. As an extension of the designing framework, we further study a variant of the selfish scheduling game, and design a best coordination mechanism achieving PoS=1 and PoA=4/3 as well. Joint work with Guochuan Zhang.

夏旭（微分方程与计算物理研究室）

简　介：2022 年入职中国科学院数学与系统科学研究院应用数学研究所。主要研究数学物理中的各种问题，尤其是薛定谔算子的谱理论、拟周期薛定谔算子的安德森局部化、迁移率边。

题　目：离散薛定谔算子的一些谱问题

摘　要：离散薛定谔算子的谱问题源于诺贝尔奖得主安德森的工作(某些随机格子中没有扩散，物理评论，1958），莫特随后提出了迁移率边（ME）的概念。迁移率边(ME)是区分绝对连续谱和纯点谱的数，是量子物理学的核心问题之一。本报告的目标是得到具有迁移率边(ME)的薛定谔算子，并讨论非厄米特薛定谔算子的迁移率边(ME)以及扩展的迁移率边(AME)。

杨钊（微分方程与计算物理研究室）

简　介：2022 年入职中国科学院数学与系统科学研究院应用数学研究所。2019 年博士毕业于美国印第安纳大学，之后在美国伊利诺伊大学香槟厄巴纳分校从事博士后研究，杨钊的研究方向是偏微分方程，主要从事可压缩和不可压缩流体中激波与自由表面波的定性分析研究。

题　目：Convergence of point and essential spectra in the homoclinic limit

摘　要：We revisit the analysis by R.A. Gardner of convergence of spectra of periodic traveling waves in the homoclinic, or infinite-period limit, extending his results to the case of essential rather than point spectra of the limiting homoclinic wave. Notably, convergence to essential spectra is seen to be of algebraic rate with respect to period as compared to the exponential rate of convergence to point spectra. In the course of the analysis, we show not only convergence of spectrum but also convergence of an appropriate renormalization of the associated periodic Evans function to the Evans function for the limiting homoclinic wave, a fact that is useful for numerical investigations.

袁谦（微分方程与计算物理研究室）

简　介：2021 年入职中国科学院数学与系统科学研究院应用数学研究所。博士毕业于香港中文大学。主要研究非线性双曲守恒律、可压缩 Navier-Stokes 方程等方程的周期扰动问题及解的长时间渐进行为。主要论文发表在 Advances in Mathematics、Communications in Mathematical Physics、 Siam Journal on Mathematical Analysis 等国际刊物上。

题　目：守恒律方程的周期扰动问题

摘　要：对于无粘性和带粘性的守恒律方程，我将介绍激波、疏散波和接触间断等基本波形在周期扰动下的非线性稳定性。周期扰动在无穷远处的持续振荡使得扰动不可积，证明的关键在于构造合适的拟设来抵消这些振荡。特别地，周期扰动对于激波的稳定性影响会产生新的平移效应。

张悦（概率统计研究室）

简　介：2022 年入职中国科学院数学与系统科学研究院应用数学研究所。主要研究领域为概率论与量子信息，在基于量子 Fisher 信息描述并刻画量子态的非经典性与非高斯性的理论研究中取得了若干成果。

题　目：量子信息理论中态的非经典性刻画

摘　要：近年来，量子信息理论的相关研究呈加速发展的态势。量子特性的刻画与应用是量子研究中极具条挑战性的理论与实验研究课题。本报告将简单介绍量子信息理论研究中的若干热点问题，并阐述我们近期在量子态非经典性的信息刻画方面的进展。相关论文发表在 Physical Review Letters、Physical Review A、Journal of Statistical Physics、Theoretical and Mathematical Physics 等刊物上。

赵国焕（概率统计研究室）

简　介：2021 年入职中国科学院数学与系统科学研究院应用数学研究所。2016 年博士毕业于北京大学数学科学学院，2016-2018 年和 2018-2021 年分别在科学院应用数学所和德国比勒费尔大学从事博士后研究。主要研究方向为随机分析、带跳马氏过程及其应用。

题　目：Non-local operators with low-order singular kernels

摘　要：The regularity estimates have well-established for second-order elliptic and parabolic equations, as well as for equations with stable-like non-local operators. Whether similar results hold for non-local operators generated by Lévy processes with low-intensity small jumps (for instance log(1-\Delta)) is unclear. In this talk, I will first briefly introduce the Markov processes and operators satisfying the positive maximal principle, especially pure jump processes and non-local operators. After that, I plan to present some regularity results for non-local operators with critically low singularity kernels that do not allow standard scaling. For instance, Schauder-type estimates for log Laplacian operators and operators generated by geometric stable processes will be discussed. To obtain desired conclusions, a new notion of Hölder spaces (depending on the operators) will be introduced, and some probabilistic methods will be shown to overcome technical difficulties. In turn, I will also show how the analytic results can be applied to stochastic analysis.

郑好（微分方程与计算物理研究室）

简　介：2022 年入职中国科学院数学与系统科学研究院应用数学研究所。主要研究方向为量子流体模型与薛定谔方程的适定性与渐进行为，在相关课题上取得了若干重要成果，发表于 Communications in Mathematical Physics、Archive for Rational Mechanics and Analysis 等刊物上。

题　目：Introduction on quantum hydrodynamic models

摘　要：Quantum hydrodynamic(QHD) models describe the group behavior of particles where quantum effects can not be ignored, which are widely used in physical and engineering applications, for example in the phenomena of superfluidity and Bose-Einstein condensation, and in the modelling of semiconductors of nano scale. In this presentation I will briefly introduce the physical background and some mathematical results of QHD models concerning the main interests of research on the QHD models.