上海交通大學 SHANGHAI JIAO TONG UNIVERSITY

数学科学学院 SCHOOL OF MATHEMATICAL SCIENCES

2019 Winter Young Mathematician Forum

Organized by the School of Mathematical Sciences,

Shanghai Jiao Tong University

Conference Program

Shanghai Jiao Tong University, Shanghai, China

December 21-22, 2019

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Organizing Committee

Congming Li (Shanghai Jiao Tong University)

Weike Wang (Shanghai Jiao Tong University)

Dongmei Xiao (Shanghai Jiao Tong University)

Feng Xie (Shanghai Jiao Tong University)

Fang Wang (Shanghai Jiao Tong University)

Local Information

Conference Venue

Dec. 21-22

Room 706, School of Mathematical Sciences, No. 6 Building, Science Buildings

理科群楼 6 号楼数学科学学院 706 室

Address: No. 800, Dongchuan Road, Minhang District, Shanghai, China

上海交通大学闵行校区地址：上海市闵行区东川路 800 号

Accommodation

Manhattan Hotel

曼哈顿酒店（闵行店）

Bldgs 5-6, 900 Heqing Road (near Bijiang Road), Minhang District

闵行区鹤庆路 900 号 5-6 号楼（近碧江路）

Tel: 86-21-67281666

Hotel Check-in

We have reserved a room with breakfast under your name. Please check in with your ID card or passport at the reception of the hotel.

WiFi

Network: LargeConference
Password: 12345678

Dining

- ✧ Breakfast: available at the hotel from 7:00 am to 9:00 am;
- ✧ Lunches on Dec. 21 and Dec. 22: Academic Exchange Center (学术活动中心) at SJTU Minhang Campus;
- ✧ Dinners on Dec. 21 and Dec. 22: Liu Yuan Restaurant (留园) at SJTU Minhang Campus.

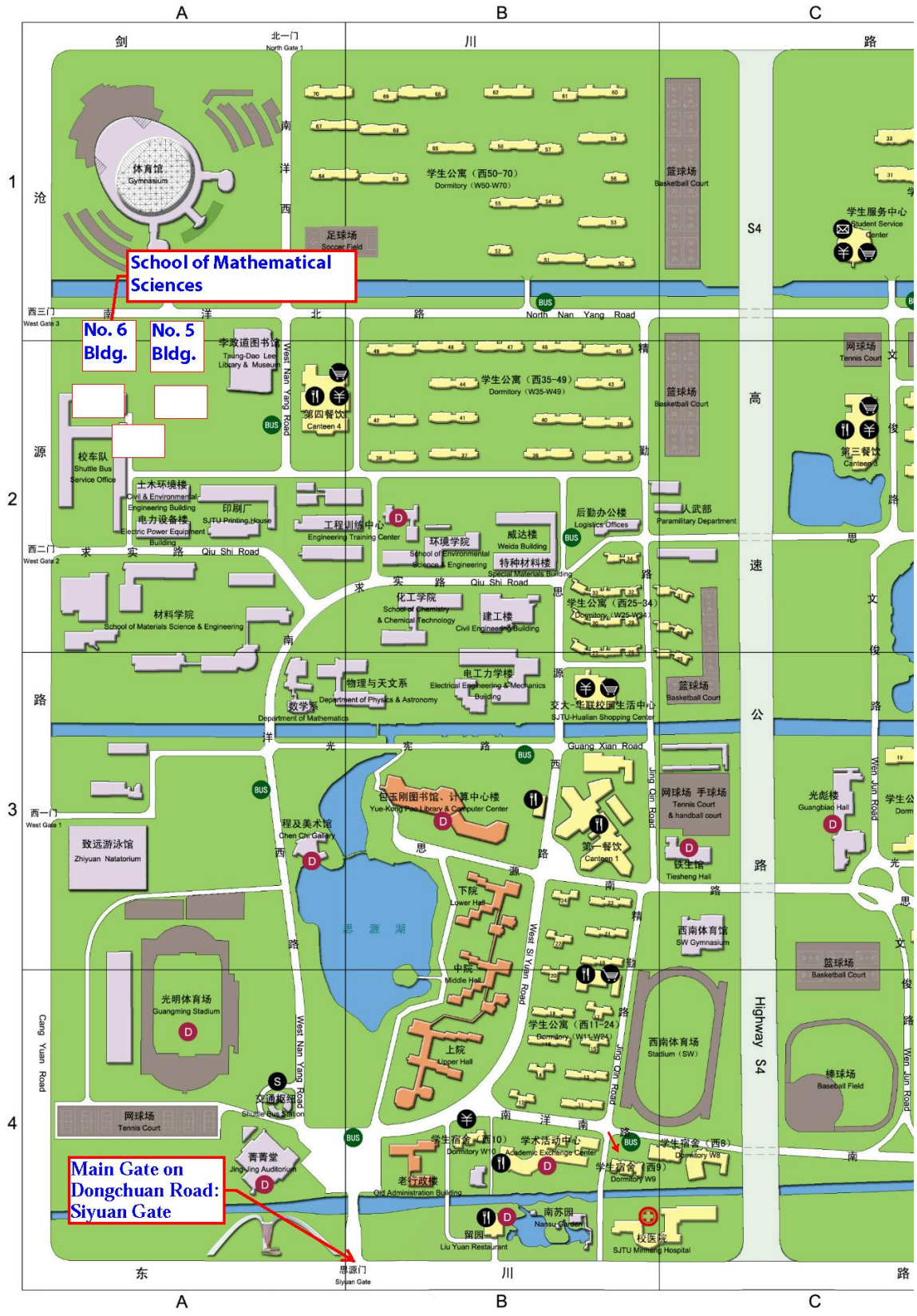
Shuttle Bus Service

There will be shuttle buses commuting between Manhattan Hotel and the School each day before the morning sessions and after the dinners. The timetable is as follows:

Date	Time	Route
Dec. 21	8:10	Manhattan Hotel – School of Mathematical Sciences
	20:00 (subject to change)	Restaurant – Manhattan Hotel
Dec. 22	8:30	Manhattan Hotel – School of Mathematical Sciences
	20:00 (subject to change)	Restaurant – Manhattan Hotel

Transportation

- ✧ **From Pudong Airport (PVG) to the Hotel**
  - 🚘 52 km, around 200 RMB by taxi (1 hour)
  - 🚇 27 RMB by metro (2 hours):
    - ◆ Take airport shuttle bus No. 9 to the terminal—Xinzhuang (莘庄);
    - ◆ Walk to the metro station and take metro Line 5 and get off at Jinping Road (金平路地铁站);
    - ◆ Walk around 900 meters to the hotel;
- ✧ **From Hongqiao Airport (Train Station) to the Hotel**
  - 🚘 32 km, around 110 RMB by taxi (45 mins.)
- ✧ **School of Mathematical Sciences (refer to next page)**


School of Mathematical Sciences
No. 6 Bldg.
No. 5 Bldg.
Main Gate on Dongchuan Road: Siyuan Gate
North Nan Yang Road
Qiu Shi Road
Guang Xian Road
West Nan Yang Road
West Si Yuan Road
Jing Qin Road
Wen Jun Road
Cang Yuan Road
Highway S4
体育馆 Gymnasium
学生公寓（西50-70） Dormitory（W50-W70）
篮球场 Basketball Court
学生服务中心 Student Service Center
足球场 Soccer Field
李政道图书馆 Tsung-Dao Lee Library & Museum
第四餐饮 Canteen 4
学生公寓（西35-49） Dormitory（W35-W49）
网球场 Tennis Court
第三餐饮 Canteen 3
校车队 Shuttle Bus Service Office
土木环境楼 Civil & Environmental Engineering Building
印刷厂 SJTU Printing House
电力设备楼 Electric Power Equipment Building
工程训练中心 Engineering Training Center
环境学院 School of Environmental Science & Engineering
威达楼 Weida Building
特种材料楼 Special Materials Building
后勤办公楼 Logistics Offices
人武部 Paramilitary Department
学生公寓（西25-34） Dormitory（W25-W34）
材料学院 School of Materials Science & Engineering
化工学院 School of Chemistry & Chemical Technology
建工楼 Civil Engineering Building
电工力学楼 Electrical Engineering & Mechanics Building
物理与天文系 Department of Physics & Astronomy
数学系 Department of Mathematics
交大-华联校园生活中心 SJTU-Hualian Shopping Center
包玉刚图书馆、计算中心楼 Yue-Kong Pao Library & Computer Center
程及美术馆 Chen Chi Gallery
致远游泳馆 Zhiyuan Natatorium
第一餐饮 Canteen 1
网球场 手球场 Tennis Court & handball court
铁生馆 Tiesheng Hall
光彪楼 Guangbiao Hall
下院 Lower Hall
中院 Middle Hall
上院 Upper Hall
思源湖
西南体育馆 SW Gymnasium
光明体育场 Guangming Stadium
学生公寓（西11-24） Dormitory（W11-W24）
西南体育场 Stadium（SW）
棒球场 Baseball Field
交通枢纽 Shuttle Bus Station
网球场 Tennis Court
青青堂 Jing-Jing Auditorium
学生宿舍（西10） Dormitory W10
学术活动中心 Academic Exchange Center
学生宿舍（西8） Dormitory W8
学生宿舍（西9） Dormitory W9
老行政楼 Old Administration Building
南苏园 Nansu Garden
留园 Liu Yuan Restaurant
校医院 SJTU Minhang Hospital
思源门 Siyuan Gate

Schedule by Day

December 21

8:30-8:50	Registration
8:50-9:00	Opening
Morning Session I	**Chair: Congming Li**
9:00-9:45	**Fei Wang** *The inviscid limit for the Navier-Stokes equations with data analytic only near the boundary*
9:45-10:30	**Jiaqi Liu** *Rigorous analysis of completely integrable PDEs*
10:30-11:00	**Tea Break & Photo**
Morning Session II	**Chair: Feng Xie**
11:00-11:45	**Joris Roos** *Spherical maximal functions and fractal dimensions*
12:00-14:00	**Lunch**
Afternoon Session I	**Chair: Weike Wang**
14:00-14:45	**Jianping Jiang** *Critical and near-critical models in statistical physics*
14:45-15:30	**Cheng Zheng** *Limiting distributions of translates of orbits in homogeneous spaces*
15:30-16:00	**Tea Break**
Afternoon Session II	**Chair: Pu Zhang**
16:00-16:45	**Rasool Hafezi** *Representation theory of monomorphims categories*
16:45-17:30	**Qing Zhang** *Several integrals involving the exceptional group G2*
18:00	**Banquet**

December 22

Morning Session I	**Chair: Zhenli Xu**
9:00-9:45	**Dong Wang** *The iterative convolution thresholding method (ICTM) and its applications*
9:45-10:30	**Liu Liu** *A study of multiscale kinetic equations with uncertainties*
10:30-11:00	**Tea Break**
Morning Session II	**Chair: Dongmei Xiao**
11:00-11:45	**Peng Luo** *An FBSDE approach to market impact games with stochastic parameters*
12:00-14:00	**Lunch**
Afternoon Session I	**Chair: Dong Han**
14:00-14:45	**Tao Luo** *Generalization, optimization, and frequency principle of deep learning*
14:45-15:30	**Jaehoon Kang** *Heat kernel estimates and their stabilities for symmetric jump processes with general mixed polynomial growths on metric measure spaces*
15:30-16:00	**Tea Break**
Afternoon Session II	**Chair: Xin Chen**
16:00-16:45	**Lin Liu** *Nearly assumption-free inference for causal inference with machine*
16:45-17:30	**Haojie Ren** *Dynamic sampling and testing in large-scale datastreams*
18:00	**Dinner**

Abstracts

Representation theory of monomorphims categories

Rasool Hafezi
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Let $\CX$ be a contravariantly finite resolving subcategory of $\rm{mod}\mbox{-} \La$, the category of finitely generated right $\La$-modules over an Artin algebra $\La$. We associate to $\CX$ the subcategory $\CS_{\CX}(\La)$ of the morphism category $\rm{H}(\La)$ consisting of all monomorphisms $(A\st{f}\rt B)$ with A, B and $\rm{Cok} \ f$ in $\CX$. In this talk, we aim to explain how the representation theory of $\CS_{\CX}(\La)$ can be connected to the that of $\rm{mod}\mbox{-} \underline{\CX}$, the category of finitely presented functors over the stable category $\underline{\CX}$, which is known and easier to work. This talk is based on my recent works \cite{H1, H2, HM}.

[H1] Rasool Hafezi, On Cohen-Macaulay Auslander algebras, available on arXiv:1802.05156.

[H2] Rasool Hafezi, From subcategories to the entire module categories, available on arXiv:1905.08597.

[HM] Rasool Hafezi and Intan Muchtadi-Alamsyah, Different exact structures on the monomorphism categories, available on arXiv:1910.03403

Critical and near-critical models in statistical physics

Jianping Jiang
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We introduce and review several two-dimensional lattice models from statistical physics and their conformally invariant scaling limits. Then we focus on the two dimensional near-critical Ising model and its scaling limit. In joint work with Camia and Newman, we proved exponential decay of correlations in this model; we also constructed a Gaussian process using the magnetization field. Both are related to an old physics conjecture about particle masses.

Heat kernel estimates and their stabilities for symmetric jump processes with general mixed polynomial growths on metric measure spaces

Jaehoon Kang
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In this talk, we consider a symmetric pure jump Markov process X on a general metric measure space that satisfies volume doubling condition. We study estimates of the transition density $p(t,x,y)$ of X and their stabilities when the jumping kernel for X has general mixed polynomial growths. In our setting, the rate function which gives growth of jumps of X may not be comparable to the scale function which provides the borderline for $p(t,x,y)$ to have either near-diagonal estimates or off-diagonal estimates. Under the assumption that the lower scaling index of scale function is strictly bigger than 1, we establish stabilities of heat kernel estimates. If underlying metric measure space admits a conservative diffusion process which has a transition density satisfying a general sub-Gaussian bounds, we can obtain heat kernel estimates without the assumption that lower scaling index of scale function is strictly bigger than 1. In this case, scale function is explicitly given by the rate function and the function F related to walk dimension of underlying space. This is a joint work with Joohak Bae, Panki Kim and Jaehun Lee.

Rigorous analysis of completely integrable PDEs

Jiaqi Liu
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In this talk I will present some recent progress on the analysis of completely integrable PDEs. The modified KdV equation and the derivative nonlinear Schrodinger equation will be used as examples. The key ingredients of the analysis are the inverse scattering transform/nonlinear steepest descent method. I will also make comparison of the advantages and shortcomings of PDE techniques and inverse scattering transform and how can they benefit each other. Some open problems will also be discussed.

Nearly assumption-free inference for causal inference with machine learning

Lin Liu
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In the era of big data and AI, applications of black-box machine learning in causal analysis will become the rule rather than the exception. Before we have a completely understanding on the theory of black-box machine learning, even the state-of-the-art causal effect estimates -- the double machine learning (DML) estimators -- may have bias so large that prohibits valid inference. Invalid inference of causal effect estimates can have severe consequence when causal analysis may eventually change how treatment is prescribed to patients or how policy is changed to the society. In this talk, we describe a nearly assumption-free procedure which can either detect mis-coverage of the confidence interval

associated with the DML estimators of some causal effect of interest or falsify the certificates (i.e. the mathematical conditions) that, if otherwise to be true, could ensure valid inference. This work shows how higher-order influence functions can be used in modern causal data analysis.

A study of multiscale kinetic equations with uncertainties

Liu Liu
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In this talk, we introduce a bi-fidelity numerical method for solving high-dimensional parametric kinetic equations. We first briefly discuss about the Boltzmann equation and its fluid dynamic limit, then introduce a bi-fidelity stochastic collocation method for its uncertainty quantification problem. By combining computational efficiency of the low-fidelity model--chosen as the compressible Euler system--with high accuracy of the high-fidelity (Boltzmann) model, our bi-fidelity approximation can successfully capture well the macroscopic quantities of solution to the Boltzmann equation in the random space. A uniform error estimate of the bi-fidelity method, based on hypocoercivity theory for the Boltzmann equation, will be shown. Lastly we present numerical results to validate the efficiency and accuracy of our proposed method.

An FBSDE approach to market impact games with stochastic parameters

Peng Luo
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We consider n risk averse agents who compete for liquidity in illiquid markets with both instantaneous and persistent price impact. In our model, the asset price has stochastic drift and diffusion coefficients and the agents don't need to close their positions in the end. Our problem can be described as a Nash equilibrium for a stochastic linear quadratic differential game. Using a martingale method, we characterize the Nash equilibrium in terms of a fully coupled FBSDE. We investigate the existence of the solution of the corresponding FBSDE which implies the existence of Nash equilibrium.

Generalization, optimization, and frequency principle of deep learning

Tao Luo
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Expect many successful applications, more and more empirical studies of deep neural networks (DNNs) emerge in order to understand the optimization and generalization of DNNs. Recently, our empirical studies of DNNs show a universal phenomenon of Frequency Principle (F-Principle): a DNN tends to learn a target function from low to high frequencies during the training. In this talk, I will introduce the F-Principle phenomenon and then provide some rigorous investigation of the F-Principle for the training dynamics of DNNs. Moreover, I will present some state-of-the-art results on two central issues of DNNs: estimates of the generalization error and convergence of optimization methods.

Dynamic sampling and testing in large-scale datastreams

Haojie Ren
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In the modern era, technological advances have led to the emergence of an increasing number of applications requiring analysis of large-scale data streams that are consisted of multiple indefinitely long and time evolving sequences. Consequently, it is often necessary to develop statistical methodologies that perform inferential tasks in an online manner, and can continuously revise the model to reflect the current status of the underlying process. In this talk, I will briefly some recent development in constructing large-scale dynamic tracking and screening procedures capable of rapidly detecting detecting global anomaly and identifying irregular individual streams.

Spherical maximal functions and fractal dimensions

Joris Roos
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Spherical maximal functions are a classical topic in real harmonic analysis arising from the study of differentiability properties of functions, going back to works of Stein and Bourgain. In this talk we are concerned with spherical maximal functions in dimensions $d\ge 2$ with a supremum taken over a fractal set of radii. Our discussion will focus on optimal L^p improving properties, i.e. the sharp range of $(1/p, 1/q)$ such that $L^p\to L^q$ boundedness holds. It turns out that this range depends on various fractal dimensions of the set of radii, such as Minkowski and Assouad dimensions and the Assouad spectrum. We characterize all convex sets that can arise as L^p improving region of such a spherical maximal operator, up to endpoints. Surprisingly, a critical segment of the boundary of such a set is given by an essentially arbitrary convex curve, which leads to non-polygonal L^p improving regions. An application of our L^p improving properties

are new weighted L^p estimates for an associated global spherical maximal operator. Based on joint works with A. Seeger and with T. Anderson, K. Hughes, A. Seeger.

The iterative convolution thresholding method (ICTM) and its applications

Dong Wang
University of Utah
dwang@math.utah.edu

In this talk, we will present a novel iterative convolution-thresholding method (ICTM) that is applicable to a wide range of variational models for image segmentation and topology optimization for fluid. A variational model usually minimizes an energy functional consisting of a fidelity term and a regularization term. In the ICTM, the interface is implicitly represented by their characteristic functions and the regularized term is approximated by a functional of characteristic functions in terms of heat kernel convolution. This allows us to design an iterative convolution-thresholding method to minimize the approximate energy. The method is simple, efficient and enjoys the energy-decaying property. Numerical experiments show that the method is easy to implement, robust and applicable to a wide class of models. If time permits, we will also discuss data-driven approaches for interface motions and some future work.

The inviscid limit for the Navier-Stokes equations with data analytic only near the boundary

Fei Wang
University of Maryland, CP
fwang256@umd.edu

I will talk about the inviscid limit for the Navier-Stokes equations in a half space (in both 2D and 3D case), with initial datum that is analytic only close to the boundary of thedomain, and has finite Sobolev regularity in the complement. We prove that for such data the solution of the Navier-Stokes equations converges in the vanishing viscosity limit to the solution of the Euler equation, on a constant time interval.

Several integrals involving the exceptional group G2

Qing Zhang
University of Calgary
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Local gamma factors are very important invariants in the study of representations of p-adic groups and the local Langlands conjectures. For exceptional groups, little is known about the local gamma factors. In this talk, I will introduce several integrals developed by D. Ginzburg related to the exceptional group G2. Then I will discuss several multiplicity one theorems inspired by these integrals, define local gamma factors for G2 twisted by GL(1) and GL(2). This is a joint work with Baiying Liu.

Limiting distributions of translates of orbits in homogeneous spaces

Cheng Zheng
Technion-Israel Institute of Technology
zcheng066@sina.com

We define a natural topology on the set of (equivalence classes up to scaling of) locally finite measures on a homogeneous space and prove that in this topology, pushforwards of certain infinite-volume orbits equidistribute in the ambient space. If time permits, we will discuss an application of our results in a counting problem, where we prove an asymptotic formula for the number of integral points in a ball on some varieties as the radius goes to infinity. This is a joint work with Uri Shapira.

Participants

1	Jinyan Fan	Shanghai Jiao Tong University
2	Rasool Hafezi	University of Isfahan, Iran
3	Dong Han	Shanghai Jiao Tong University
4	Yucheng Ji	University of California, Irvine
5	Cuibo Jiang	Shanghai Jiao Tong University
6	Jianping Jiang	NYU Shanghai
7	Shi Jin	Shanghai Jiao Tong University
8	Jaehoon Kang	Bielefeld University
9	Congming Li	Shanghai Jiao Tong University
10	Anning Liu	Tsinghua University
11	Bowen Liu	University of Augsburg, Germany
12	Jiaqi Liu	University of Toronto
13	Lin Liu	Harvard TH Chan School of Public Health
14	Liu Liu	University of Texas at Austin
15	Weidong Liu	Shanghai Jiao Tong University
16	Peng Luo	University of Waterloo
17	Tao Luo	Purdue University
18	Haojie Ren	Penn State University
19	Joris Roos	University of Wisconsin-Madison
20	Yunfeng Shi	Peiking University
21	Changliang Wang	Max Planck Institute for Mathematics, Bonn

22	Dong Wang	University of Utah
23	Fang Wang	Shanghai Jiao Tong University
24	Fei Wang	University of Maryland, CP
25	Weike Wang	Shanghai Jiao Tong University
26	Yan Wang	Citadel Securities Americas LLC - Chicago
27	Dongmei Xiao	Shanghai Jiao Tong University
28	Feng Xie	Shanghai Jiao Tong University
29	Jie Xu	Boston University
30	Zhenli Xu	Shanghai Jiao Tong University
31	Jinjiong Yu	NYU Shanghai
32	An Zhang	USTC
33	Pu Zhang	Shanghai Jiao Tong University
34	Qing Zhang	University of Calgary
35	Xiang Zhang	Shanghai Jiao Tong University
36	Zhen Zhao	Shanghai Jiao Tong University
37	Cheng Zheng	Technion-Israel Institute of Technology