

# 第4届长三角代数会议

## 会议 手册



上海交通大学数学科学学院

2018年10月26-28日

# 第 4 届长三角代数会议

2018 年 10 月 26-28 日

为加强长三角地区 (沪苏皖浙) 代数学工作者之间的学术联系, 促进研究生之间的学术交流, 2018 年 10 月 26 日至 28 日在上海交通大学闵行校区举行第 4 届长三角代数会议. 26 日 (周五) 下午报到, 28 日下午离会.

会议由 12 个邀请报告以及 12 个研究生论坛报告组成. 会议由

李方教授、秦厚荣教授、吴泉水教授、叶郁教授、章璞教授

组成学术委员会, 负责确定会议邀请报告人和研究生论坛报告人.

会议不收会务费. 会议统一住宿在维也纳国际酒店上海交大沪闵路店: 上海市闵行区沪闵路 280 号. 自 26 日下午 3 点起, 在酒店大堂, 会议设有注册台.

会议地点: 上海交大闵行校区东上院 **115 教室**. 为保证会议按时举行, 27 日和 28 日有早车在维也纳国际酒店上海交大沪闵路店门口, 早 8:05 分发车, 开往东上院 115 教室 (如果路熟, 步行约需 40 分钟).

从地铁 5 号线东川路站步行至会议地点约需 35 分钟 (其中从地铁 5 号线东川路站步行至交大东川路 800 号门约需 20 分钟).

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联系电话: 荣石 13472756549 陈伟钊 18817818613 尤翰洋 15618295193

会议组织者: 上海交通大学数学科学学院

章璞 费佳睿 高云 姜翠波 蒋启芬 马家骏 覃帆 司梅 武同锁 张光连 张跃辉

## 第 4 届长三角代数会议日程表

早车 8:05 分准时从维也纳国际酒店交大沪闵路店出发

会议地点: 上海交大闵行校区东上院 115 教室

### 10 月 27 日

时间	报告	主持人
8:35–8:40	开幕式	王建磐
8:40–9:10	付 强 (同济大学): Presenting affine Schur algebras	
9:15–9:45	杨 东 (南京大学): Silting $t$ -structures	丁南庆
9:50–10:25	秦晓珊 (复旦大学): Noncommutative quasi-resolutions	陈建龙
(每场 15 分钟)	刘琳琳 (东南大学): Rota-Baxter operators and Pre-Lie $H$ -pseudoalgebras over a cocommutative Hopf algebra $H$	
10:25–10:55	照相、茶歇	
10:55–11:25	宋林亮 (同济大学): Affine Brauer category and parabolic category $\mathcal{O}$ in types $B, C, D$	芮和兵
10:30–12:05	刘思阳 (浙江大学): Periodicities in cluster algebras and cluster automorphism groups	黄兆泳
(每场 15 分钟)	张博野 (浙江大学): Hopf differential graded Galois extensions	
12:10–13:35	工作午餐 (地点: 上海交大学术活动中心)	
13:40–14:10	张红莲 (上海大学): Quantum toroidal algebras and their representations	王卿文
14:15–14:45	周贵松 (宁波大学): Quasi-homogeneity of superpotentials	卢涤明
14:50–15:25	程 腾 (南京大学): Primitive prime divisors for weighted homogeneous polynomial	朱晓胜
(每场 15 分钟)	郑军领 (南京大学): An upper bound for the dimension of bounded derived categories	
15:25–15:35	茶歇	
15:35–16:05	刘公祥 (南京大学): A classification result on prime Hopf algebras of GK-dimension one	朱胜林
16:10–16:40	鲍炎红 (安徽大学): Restricted Poisson algebras	李立斌
16:45–17:15	刘 东 (湖州师范学院): Representations on the super Virasoro algebra	胡乃红
17:20–17:55	董俊斌 (同济大学): Alvis-Curtis duality over principal representations of reductive groups with Frobenius maps	时俭益
(每场 15 分钟)	周 凯 (浙江大学): Grassmannian, symmetric functions and cyclotomic nilHecke algebras	
18:00	晚餐 (地点: 上海交大留园餐厅)	

## 10月28日

时间	报告	主持人
8:30–9:00	朱海燕 (浙江工业大学): <b>Balanced pairs, cotorsion triplets and quiver representations</b>	苏育才
9:05–9:35	周国栋 (华东师范大学): <b>An introduction to Tate-Hochschild cohomology</b>	陈惠香
9:40–10:15	熊荣川 (华东师范大学): <b>On finite-dimensional Hopf algebras over non-pointed basic Hopf algebras of dimension <math>4p</math></b>	王栓宏
(每场 15 分钟)	朱瑞鹏 (复旦大学): <b>Homological determinant for skew Calabi-Yau algebras</b>	
10:10–10:25	茶歇	
10:25–10:55	杨一超 (常熟理工学院): <b>The geometrical description of cluster structure of type <math>D</math> infinity and some applications</b>	李 方
11:00–11:35	郑奇莲 (南京师范大学): <b>Mutation pairs and <math>(n+2)</math>-angulated quotient categories</b>	叶 郁
(每场 15 分钟)	郭 鹏 (上海交通大学): <b>Exceptional cycles and auto-equivalences of <math>K^b(A\text{-proj})</math> for gentle algebras</b>	
11:35–12:05	陈小伍 (中国科学技术大学): <b>Standard derived equivalences and Brown representability</b>	吴泉水
12:10–13:50	工作午餐 (地点: 上海交大留园餐厅)	

# 会议邀请报告摘要

## Restricted Poisson algebras

鲍炎红 (安徽大学)

In this talk, we will re-formulate Bezrukavnikov-Kaledin's definition of a restricted Poisson algebra, provide some natural and interesting examples, and discuss connections with other research topics. This is a joint work with Yu Ye and James J. Zhang.

## Standard derived equivalences and Brown representability

陈小伍 (中国科学技术大学)

The fundamental open problem in the derived Morita theory asks whether any derived equivalence is standard. We will report on some progress on this problem. More recent work indicates that the famous Brown representability theorem might play a role.

## Presenting affine Schur algebras

付强 (同济大学)

Beilinson, Lusztig, and MacPherson (BLM) gave a geometric realization for the quantum enveloping algebra  $U(\mathfrak{gl}_n)$  of  $\mathfrak{gl}_n$ . Using BLM's work, a presentation of  $q$ -Schur algebras was derived by Doty-Giaquinto and Du-Parshall. We will use BLM realization of the universal enveloping algebra  $\mathcal{U}(\widehat{\mathfrak{gl}}_n)$  of  $\widehat{\mathfrak{gl}}_n$  to study the structure of affine Schur algebras. In particular, we give a presentation of the affine Schur algebra  $\mathcal{S}_\Delta(n, r)_{\mathbb{Q}}$ .

## Representations on the super Virasoro algebra

刘东 (湖州师范学院)

The super Virasoro algebra is the fundamental algebraic structures in conformal and superconformal field theory. The super Virasoro algebra are also named as the  $N = 1$  superconformal algebra. In this talk, we introduce some progresses on the representations on the super Virasoro algebra based on some joint researches with Profs. Pei and Xia.

## A classification result on prime Hopf algebras of GK-dimension one

刘公祥 (南京大学)

Based on our previous work, we want to give a try to classify prime Hopf algebras of GK-dimension one without requirement on regularity. Some applications will be given too.

## Affine Brauer category and parabolic category $\mathcal{O}$ in types $B, C, D$

宋林亮 (同济大学)

A strict monoidal category referred to as affine Brauer category  $\mathcal{AB}$  is introduced over a commutative ring  $\kappa$  containing multiplicative identity 1 and invertible element 2. We prove that morphism spaces in  $\mathcal{AB}$  are free over  $\kappa$ . The cyclotomic (or level  $k$ ) Brauer category  $\mathcal{CB}^f(\omega)$  is a quotient category of  $\mathcal{AB}$ . We prove that any morphism space in  $\mathcal{CB}^f(\omega)$  is free over  $\kappa$  with maximal rank if and only if the  $\mathbf{u}$ -admissible condition holds. Affine Nazarov-Wenzl algebras and cyclotomic Nazarov-Wenzl algebras will be realized as certain endomorphism algebras in  $\mathcal{AB}$  and  $\mathcal{CB}^f(\omega)$ , respectively. We will establish higher Schur-Weyl duality between cyclotomic Nazarov-Wenzl algebras and parabolic BGG categories  $\mathcal{O}$  associated to symplectic and orthogonal Lie algebras over the complex field  $\mathbb{C}$ . This enables us to use standard arguments to compute decomposition matrices of cyclotomic Nazarov-Wenzl algebras. The level two case was considered by Ehrig and Stroppel. This is a joint work with Hebing Rui.

## Silting $t$ -structures

杨东 (南京大学)

Let  $A$  be a finite-dimensional algebra, and denote by  $\text{silt}(A)$  the set of isomorphism classes of silting complexes in the bounded homotopy category of finitely generated projective  $A$ -modules and by  $\text{tstr}(A)$  the set of bounded  $t$ -structures on the bounded derived category of finite-dimensional  $A$ -modules. It is known that there is a canonical injective map  $\varphi_A$  from  $\text{silt}(A)$  to  $\text{tstr}(A)$ . This map was first studied by Keller and Vossieck in [1] for  $A$  the path algebra of a Dynkin quiver. In this case, they show that  $\varphi_A$  is bijective, and thus allows us to classify  $t$ -structures using silting complexes. For which algebra  $A$  is  $\varphi_A$  bijective? The following conditions are equivalent:

- (i) the map  $\varphi_A$  is bijective,
- (ii)  $A$  is silting-discrete (roughly speaking, the number of silting complexes is ‘locally finite’),
- (iii)  $A$  is  $t$ -discrete (roughly speaking, the number of bounded  $t$ -structures is ‘locally finite’),
- (iv) the heart of every bounded  $t$ -structure is equivalent to a module category.

This is based on a joint work with Takahide Adachi and Yuya Mizuno.

- [1] Bernhard Keller and Dieter Vossieck, *Aisles in derived categories*, Bull. Soc. Math. Belg. Sér. A **40** (1988), no. 2, 239–253.

## The geometrical description of cluster structure of type $D$ infinity and some applications

杨一超 (常熟理工学院)

Cluster categories, constructed by Buan, Marsh, Reineke, Reiten and Todorov, give a categorical model for Fomin and Zelevinsky’s cluster algebras. More recently, Buan, Iyama, Reiten and Scott introduced the notion of cluster structure through replacing cluster-tilting objects by cluster-tilting subcategories.

In this talk, we shall start with the definition of cluster category for 2-Calabi-Yau triangulated category. We shall mainly speak about the canonical orbit category of the bounded derived category of type  $D$  infinity without infinite paths is a cluster category. Moreover, we give a geometrical description of the cluster structure of type  $D$  infinity inspired by Liu and Paquette’s  $A$  double infinity work. As an application, we shall construct a cluster category of non-simply-laced type by using the covering theory. This is a joint work with Prof. Fang Li, Prof. Shiping Liu and Dr. Min Huang.

## Quantum toroidal algebras and their representations

张红莲 (上海大学)

In this talk, we focus on quantum toroidal algebras. We will review some results of the structures and representations of quantum toroidal algebras, and we discuss some new properties on quantum toroidal algebras. This talk is based on the joint work with Prof. Y. Gao, N. Jing and L. Xia.

## Quasi-homogeneity of superpotentials

周贵松 (宁波大学)

In noncommutative differential calculus, Jacobi algebra (or superpotential algebra) plays the role of Milnor algebra in the commutative case. The study of superpotential algebras is of broad interest to researchers in cluster algebra, representation theory and singularity theory.

In this talk, we study the quasi-homogeneity of a superpotential in a complete free algebra over an algebraically closed field of characteristic zero. We will show that a superpotential with finite dimensional Jacobi algebra is right equivalent to a weighted homogeneous superpotential if and only if the corresponding class in the 0-th Hochschild homology group of the Jacobi algebra is zero. This result can be viewed as a noncommutative version of the famous theorem of Kyoji Saito on isolated hypersurface singularities.

This is a joint work with Zheng Hua of the University of Hong Kong. The preprint of this work has been posted at arXiv:1808.03754.

## **An introduction to Tate-Hochschild cohomology**

周国栋 (华东师范大学)

Modeled on Tate cohomology of finite groups and Hochschild cohomology, Tate-Hochschild cohomology was introduced by R.-O. Buchweitz in a famous unpublished manuscript. The theory, however, has been developed slowly. One important reason was the lack of an adequate canonical complex computing Tate-Hochschild cohomology as the role played by the Hochschild cochain complex for Hochschild cohomology. This problem was solved in the thesis of Zhengfang Wang. He constructed the so-called singular Hochschild complex and used this complex to establish the Deligne conjecture for Tate-Hochschild cohomology. With M. Rivera, he considered the Tate-Hochschild cohomology of a symmetric algebra and related it to Rabinowitz Floer homology. Recently with Zhengfang Wang and Yuming Liu, we studied the Tate-Hochschild cohomology of the group algebra of a finite group via the additive decomposition. This talk will be a survey of the above results and some open problems.

## **Balanced pairs, cotorsion triplets and quiver representations**

朱海燕 (浙江工业大学)

Balanced pairs appear naturally in the realm of Relative Homological Algebra associated to the balance of right derived functors of the Hom functor. A natural source to get such pairs is by means of cotorsion triplets. In this paper we study the connection between balanced pairs and cotorsion triplets by using recent quiver representation techniques. In doing so, we find a new characterization of abelian categories having enough projectives and injectives in terms of the existence of complete hereditary cotorsion triplets. We also give a short proof of the lack of balance for derived functors of Hom computed by using flat resolutions which extends the one showed by Enochs in the commutative case. This report is a joint work with S. Estrada and M. A. Pérez.

# 研究生论坛邀请报告摘要

## Primitive prime divisors for weighted homogeneous polynomial

程腾 (南京大学)

From Mersenne sequence to elliptic divisibility sequence, it is an important problem in number theory to prove the existence of primitive prime divisors of an arithmetically defined sequence, *i.e.*, the finiteness of the relevant Zsigmondy set. In this talk, we prove that the Zsigmondy set defined by iteration of weighted homogeneous polynomial is a finite set. More precisely, let  $f_t(x)$  be a weighted homogeneous polynomial of degree  $d$  and weight  $e$ . Let  $t \in \mathbb{Q} \setminus \{0\}$  and let  $Z(f_t, 0)$  be the Zsigmondy set for the zero orbit  $\{f_t^n(0) \mid n \in \mathbb{N}\}$ , then there exists a constant  $k_{t,e,d}$  such that  $\#Z(f_t, 0) \leq k_{t,e,d}$ .

## Alvis-Curtis duality over principal representations of reductive groups with Frobenius maps

董俊斌 (同济大学)

We introduce the principal representation category of reductive groups with Frobenius maps and show that this category is a highest weight category when the ground field is  $\mathbb{C}$ . We also generalize Alvis-Curtis duality to the abstract representations of reductive groups with Frobenius maps. Analogous to the case of representation of finite reductive groups, we show that the Alvis-Curtis duality of infinite type also interchanges irreducible representations.

## Exceptional cycles and auto-equivalences of $K^b(A\text{-proj})$ for gentle algebras

郭鹏 (上海交通大学)

For a gentle algebra  $A$ , we show that the mouth of every characteristic component of  $K^b(A\text{-proj})$  forms an exceptional cycle in the sense of Broomhead, Pauksztello and Ploog. Thus, one has auto-equivalences of  $K^b(A\text{-proj})$ , and we compute the action of these auto-equivalences on complexes of  $K^b(A\text{-proj})$ . This is a joint work with Professor Pu Zhang.

## Rota-Baxter operators and Pre-Lie $H$ -pseudoalgebras over a cocommutative Hopf algebra $H$

刘琳琳 (东南大学)

We study the Rota-Baxter operators and  $H$ -pseudoalgebras of different types on the cocommutative Hopf algebra  $H$ . Firstly, we introduce the concept of a Rota-Baxter operator on an  $H$ -pseudoalgebra, and give some basic properties and examples. Then we construct pre-Lie (resp. associative, Lie)  $H$ -pseudoalgebras via the Rota-Baxter operator on an  $H$ -pseudoalgebra of a given type. At the same time, we obtain a large number of pre-Lie (resp. associative)  $H$ -pseudoalgebras from the Rota-Baxter algebras. Finally, the annihilator algebras of the left pre-Lie  $H$ -pseudoalgebras are discussed.

## Periodicities in cluster algebras and cluster automorphism groups

刘思阳 (浙江大学)

In this talk, we study some groups related to cluster automorphisms and periodicities of seeds and exchange matrices of cluster algebras. We establish the relationships among three groups generated respectively by direct cluster automorphisms, strictly direct cluster automorphisms, and periodicities of seeds and exchange matrices in a cluster algebra.

## Noncommutative quasi-resolutions

秦晓珊 (复旦大学)

The notion of a noncommutative quasi-resolution is introduced for a general noncommutative noetherian algebra with singularities, even for a non-Cohen-Macaulay algebra. If  $A$  is a commutative normal Gorenstein domain, then a noncommutative quasi-resolution of  $A$  naturally produces a noncommutative crepant resolution (NCCR) of  $A$  in the sense of Van den Bergh, and vice versa. We prove that

- (i) in dimension two, all noncommutative quasi-resolutions of a given noncommutative algebra are Morita equivalent, and
- (ii) in dimension three, all noncommutative quasi-resolutions of a given noncommutative algebra are derived equivalent.

These assertions generalize important results of Van den Bergh, Iyama-Reiten and Iyama-Wemyss in the commutative and central-finite cases.

## On finite-dimensional Hopf algebras over non-pointed basic Hopf algebras of dimension $4p$

熊荣川 (华东师范大学)

This talk is my recent joint work with Prof. Naihong Hu. We classify finite-dimensional Hopf algebras over an algebraically closed field of characteristic zero, whose Hopf coradical is isomorphic to a non-pointed basic Hopf algebra of dimension  $4p$ , under the assumption that the diagrams are strictly graded. In particular, we obtain new Nichols algebras of non-diagonal type and new finite-dimensional Hopf algebras without the dual Chevalley property.

## Hopf differential graded Galois extensions

张博野 (浙江大学)

We introduce the concept of Hopf dg Galois extensions. For a finite dimensional semisimple Hopf algebra  $H$  and an  $H$ -module dg algebra  $R$ , we show that  $\mathcal{D}(R\#H) \cong \mathcal{D}(R^H)$  is equivalent to  $R/R^H$  being a Hopf dg Galois extension. We present a weaker version of Hopf dg Galois extensions and show the relationships between Hopf dg Galois extensions and Hopf Galois extensions.

## An upper bound for the dimension of bounded derived categories

郑军领 (南京大学)

Let  $\Lambda$  be an artin algebra. We give an upper bound for the dimension of the bounded derived category of the category  $\text{mod } \Lambda$  of finitely generated right  $\Lambda$ -modules in terms of the projective and injective dimensions of certain class of simple right  $\Lambda$ -modules as well as the radical layer length of  $\Lambda$ . In addition, we give an upper bound for the dimension of the singularity category of  $\text{mod } \Lambda$  in terms of the radical layer length of  $\Lambda$ . This is a joint work with Zhaoyong Huang.

## Mutation pairs and $(n+2)$ -angulated quotient categories

郑奇莲 (南京师范大学)

The notion of mutation pairs of subcategories in an  $n$ -exangulated category is defined in this article. Let  $\mathcal{D} \subseteq \mathcal{E}$  be subcategories of an  $n$ -exangulated category  $\mathcal{C}$ . Then the quotient category  $\mathcal{E}/\mathcal{D}$  carries naturally an  $(n+2)$ -angulated structure whenever  $(\mathcal{E}, \mathcal{D})$  forms a  $\mathcal{D}$ -mutation pair and  $\mathcal{E}$  is  $n$ -extension closed. Moreover, we introduce strongly functorially finite subcategories of  $n$ -exangulated categories and show that the corresponding quotient categories are one-sided  $(n+2)$ -angulated categories. Finally, we study homological finiteness of subcategories in a mutation pair.

## Grassmannian, symmetric functions and cyclotomic nilHecke algebras

周凯 (浙江大学)

Let  $\ell, n$  be positive integers such that  $\ell \geq n$ . Let  $\mathbb{G}_{n,\ell}$  be the Grassmannian which consists of the set of  $n$ -dimensional subspaces of  $\mathbb{C}^\ell$ . There is an  $\mathbb{Z}$ -graded algebra isomorphism between the cohomology  $H^*(\mathbb{G}_{n,\ell}, \mathbb{Z})$  of  $\mathbb{G}_{n,\ell}$  and a natural  $\mathbb{Z}$ -form  $B$  of the  $\mathbb{Z}$ -graded basic algebra of the type  $A$  cyclotomic nilHecke algebra  $\mathcal{H}_{\ell,n}^{(0)} = \langle \psi_1, \dots, \psi_{n-1}, y_1, \dots, y_n \rangle$ . In this talk, we show that the isomorphism can be chosen such that the image of each (geometrically defined) Schubert class  $(a_1, \dots, a_n)$  coincides with the basis element  $b_\lambda$  (constructed by Jun Hu and Xingfeng Liang) by purely algebraic method, where  $0 \leq a_1 \leq a_2 \leq \dots \leq a_n \leq \ell - n$  with  $a_i \in \mathbb{Z}$  for each  $i$ ,  $\lambda$  is the  $\ell$ -multipartition of  $n$  associated to  $(\ell + 1 - (a_n + n), \ell + 1 - (a_{n-1} + n - 1), \dots, \ell + 1 - (a_1 + 1))$ . A similar isomorphism between the cohomology  $H^*(\mathbb{G}_{\ell-n,\ell}, \mathbb{Z})$  of the Grassmannian  $\mathbb{G}_{\ell-n,\ell}$  and the natural  $\mathbb{Z}$ -form  $B$  of the  $\mathbb{Z}$ -graded basic algebra of  $\mathcal{H}_{\ell,n}^{(0)}$  is also obtained. As applications, we obtain a second version of Giambelli formula for Schubert classes and show that up to a sign, each basis element  $z_\lambda$  (introduced by Jun Hu and Xingfeng Liang) of the center  $Z$  of  $\mathcal{H}_{\ell,n}^{(0)}$  is equal to the evaluation of a Schur (symmetric) polynomial at  $y_1, \dots, y_n$ . This is a joint work with Jun Hu.

## Homological determinant for skew Calabi-Yau algebras

朱瑞鹏 (复旦大学)

Firstly, I will give the definition of the homological determinant of Hopf actions on (non-graded) skew Calabi-Yau algebras, which coincide with the connected graded case. Secondly, I will introduce some results about the relations between Hopf actions and Nakayama automorphisms, which also can be proved by using homological determinant. Lastly, we summarize some results about the Calabi-Yau property of Ore extensions and smash products, and we will give some applications about how homological determinant impact the Nakayama automorphisms of Ore extensions and smash products.

## 代表通讯录

(共 125 名代表: 77 位教师, 1 名博士后, 47 名研究生. 按学校汉语拼音顺序排列)

姓名	学校	邮箱地址
鲍炎红	安徽大学	baoyh@ahu.edu.cn
赵志兵	安徽大学	zbzhao@ahu.edu.cn
傅东兴	安徽大学 (研究生)	fudongxing920811@126.com
张培雨	安徽工程大学	zhangpy@ahpu.edu.cn
程 智	安徽师范大学	chengzhimath@126.com
杨一超	常熟理工学院	yichao.yang@cslg.edu.cn
陈建龙	东南大学	jlchen@seu.edu.cn
刘国华	东南大学	liuguohua@seu.edu.cn
王栓宏	东南大学	shuanhwang@seu.edu.cn
王 周	东南大学	zhouwang@seu.edu.cn
吴 霞	东南大学	wuxia80@seu.edu.cn
姚玲玲	东南大学	llyao@seu.edu.cn
张小向	东南大学	z990303@seu.edu.cn
周建华	东南大学	jhzhou@seu.edu.cn
谷 乐	东南大学 (研究生)	329579259@qq.com
刘琳琳	东南大学 (研究生)	liulinlin2016@163.com
吴泉水	复旦大学	qswu@fudan.edu.cn
朱胜林	复旦大学	mazhusl@fudan.edu.cn
李康桥	复旦大学 (研究生)	14110180008@fudan.edu.cn
刘智敏	复旦大学 (研究生)	13110180006@fudan.edu.cn
秦晓珊	复旦大学 (研究生)	13110840002@fudan.edu.cn
周景珩	复旦大学 (研究生)	14110840006@fudan.edu.cn
朱瑞鹏	复旦大学 (研究生)	14110840007@fudan.edu.cn
何济位	杭州师范大学	jwhe@hznu.edu.cn
俞晓岚	杭州师范大学	xlyu@hznu.edu.cn
刘 东	湖州师范学院	liudong@zjhu.edu.cn
王圣强	华东理工大学	sqwang@ecust.edu.cn
胡乃红	华东师范大学	nhhu@math.ecnu.edu.cn
时俭益	华东师范大学	jyshi@math.ecnu.edu.cn
王建馨	华东师范大学	jpwang@admin.ecnu.edu.cn
周国栋	华东师范大学	gdzhou@math.ecnu.edu.cn
熊荣川	华东师范大学 (研究生)	rcxiong@foxmail.com
李志伟	江苏师范大学	zhiweili@jsnu.edu.cn
丁南庆	南京大学	nqding@nju.edu.cn
黄兆泳	南京大学	huangzy@nju.edu.cn

刘公祥	南京大学	gxliu@nju.edu.cn
秦厚荣	南京大学	hrqin@nju.edu.cn
杨 东	南京大学	yangdong@nju.edu.cn
朱晓胜	南京大学	zhuxs@nju.edu.cn
程 腾	南京大学 (研究生)	mathcheng@126.com
张后俊	南京大学 (研究生)	1059378920@qq.com
郑军领	南京大学 (研究生)	zjlshuxue@163.com
朱荣民	南京大学 (研究生)	rongminzhu@hotmail.com
刘群华	南京师范大学	05402@njnu.edu.cn
魏加群	南京师范大学	weijiaqun@njnu.edu.cn
张海诚	南京师范大学	zhanghc@njnu.edu.cn
卞秀丽	南京师范大学 (研究生)	1418143305@qq.com
曹卫青	南京师范大学 (研究生)	caoweiqing18@163.com
刘大俊	南京师范大学 (研究生)	610364596@qq.com
梅玉霞	南京师范大学 (研究生)	meiyuxia2010@163.com
吴凯利	南京师范大学 (研究生)	954982103@qq.com
吴胜伟	南京师范大学 (研究生)	835223932@qq.com
邢若云	南京师范大学 (研究生)	2750439501@qq.com
徐 敏	南京师范大学 (研究生)	1427210148@qq.com
郑奇莲	南京师范大学 (研究生)	444093938@qq.com
张孝金	南京信息工程大学	xjzhang@nuist.edu.cn
罗秀花	南通大学	xiuhualuo@ntu.edu.cn
周贵松	宁波大学	10906045@zju.edu.cn
王艳华	上海财经大学	yhw@mail.shufe.edu.cn
朱云迪	上海财经大学 (研究生)	zhuyunditry@163.com
沈炳良	上海财经大学浙江学院	bingliangshen@163.com
高 楠	上海大学	nangao@shu.edu.cn
王卿文	上海大学	wqw@shu.edu.cn
张红莲	上海大学	hlzhangmath@shu.edu.cn
朱 灿	上海理工大学	czhu@usst.edu.cn
朱 林	上海理工大学	zhulin2323@163.com
王 丽	上海师范大学	wlmath@shnu.edu.cn
尹幼奇	绍兴文理学院	yinyouqi@usx.edu.cn
付 强	同济大学	q.fu@hotmail.com
芮和兵	同济大学	hbrui@tongji.edu.cn
宋林亮	同济大学	17029@tongji.edu.cn
苏育才	同济大学	ycsu@tongji.edu.cn
董俊斌	同济大学 (博士后)	dongjunbin1990@126.com
陈文静	西北师范大学	chenwenjing1003@163.com

王占平	西北师范大学	wangzp@nwnu.edu.cn
杨晓燕	西北师范大学	yxy800218@163.com
曹天涯	西北师范大学 (研究生)	caotianya1979@126.com
郭寿桃	西北师范大学 (研究生)	guoshoutao9022@126.com
饶炎平	西北师范大学 (研究生)	raoyanping0806@163.com
王 莉	西北师范大学 (研究生)	zisehua0212@126.com
谢宗阳	西北师范大学 (研究生)	zongyang_xie@163.com
陈惠香	扬州大学	hxchen@yzu.edu.cn
李立斌	扬州大学	lbli@yzu.edu.cn
刘立宇	扬州大学	lyliu@yzu.edu.cn
吴伊涛	扬州大学	wuyt@yzu.edu.cn
李 方	浙江大学	fangli@zju.edu.cn
卢涤明	浙江大学	dmlu@zju.edu.cn
吴志祥	浙江大学	wzx@zju.edu.cn
曹培根	浙江大学 (研究生)	peigencao@126.com
刘思阳	浙江大学 (研究生)	627092194@qq.com
骆立鹏	浙江大学 (研究生)	562278377@qq.com
潘 杰	浙江大学 (研究生)	panjie_zhejiang@qq.com
张博野	浙江大学 (研究生)	infnty@163.com
周 凯	浙江大学 (研究生)	1083864334@qq.com
朱海燕	浙江工业大学	hyzhu@zjut.edu.cn
沈 远	浙江理工大学	yuanshen@zstu.edu.cn
洪燕勇	浙江农林大学	hongyanyong2008@yahoo.com
焦鹏杰	中国计量大学	jiaopjie@cjlu.edu.cn
陈小伍	中国科学技术大学	xwchen@mail.ustc.edu.cn
申伊堉	中国科学技术大学	yhshen@ustc.edu.cn
叶 郁	中国科学技术大学	yeyu@ustc.edu.cn
费佳睿	上海交通大学	jiarui@sjtu.edu.cn
高 云	上海交通大学	gaoyunmath@sjtu.edu.cn
姜翠波	上海交通大学	cpjiang@sjtu.edu.cn
蒋启芬	上海交通大学	qfjiang@sjtu.edu.cn
马家骏	上海交通大学	hoxide@sjtu.edu.cn
司 梅	上海交通大学	simei@sjtu.edu.cn
覃 帆	上海交通大学	fgin11@sjtu.edu.cn
武同锁	上海交通大学	tswu@sjtu.edu.cn
张光连	上海交通大学	g.l.zhang@sjtu.edu.cn
张跃辉	上海交通大学	zyh@sjtu.edu.cn
章 璞	上海交通大学	pzhang@sjtu.edu.cn
陈伟钊	上海交通大学 (研究生)	weizhao1994@sjtu.edu.cn

代红英	上海交通大学 (研究生)	hydai@sjtu.edu.cn
郭 鹏	上海交通大学 (研究生)	guigui91@sjtu.edu.cn
Dadi Asefa Gurm	上海交通大学 (研究生)	dadi.asefa2016@sjtu.edu.cn
金 海	上海交通大学 (研究生)	jinhaifyh@sjtu.edu.cn
李 上	上海交通大学 (研究生)	1743560354@qq.com
刘阿明	上海交通大学 (研究生)	aming8809@163.com
Rabia Lqbal	上海交通大学 (研究生)	rabipu14@qq.com
荣 石	上海交通大学 (研究生)	rongshi@sjtu.edu.cn
王 冰	上海交通大学 (研究生)	ering123@sjtu.edu.cn
徐嘉骏	上海交通大学 (研究生)	876019671@qq.com
Saba Yasmeen	上海交通大学 (研究生)	sabayasmin84@gmail.com
尤瀚洋	上海交通大学 (研究生)	youhanyang910328@163.com