Joint International Meeting

of Chinese Mathematical Society and American Mathematical Society

中美数学会联合年会

Program and Abstract

日程及报告摘要

June 11-14, 2018 Shanghai, China

中国上海 2018 年 6 月 11–14 日

Welcome Letter

Welcome to the Joint International Meeting of the Chinese Mathematical Society (CMS) and the American Mathematical Society (AMS), a sequel to the Joint Meeting of the Shanghai Mathematical Society (SMS) and AMS held at Fudan University in December of 2008.

The idea of having a joint meet was conceived when President Robert Bryant of AMS met President Shicheng Wang of CMS at Peking University in August of 2015. Subsequently, the Program Committee was appointed to identify 6 plenary speakers and organizers of 31 special sessions. The session organizers in turn invited more than 500 speakers.

The distinguished program has attracted more than 760 participants as of May 31, 2018. We thank you for your participation. It is our belief that the joint meeting shall disseminate recent research results, shall develop and strengthen the ties between mathematicians from China and the USA as well as from other countries and regions.

We would like to thank the Shanghai Mathematical Society who appointed the Local Organization Committee, and the faculty, staff and student volunteers (those with green ribbons for their name-tags) of Fudan University in particular, for the hard work of preparation. We also like to acknowledge the financial supports of Fudan University, the National Science Foundation of China, and the American Mathematical Society.

The Chinese Mathematical Society

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Yi-Jun YAO, *Fudan University & Shanghai Mathematical Society*

Meeting Schedule

	June 11	June 12	June 13	June 14
8:30-10:30	**Registration (8:30-)** **Opening Ceremony (9:00-9:30)** --- **Chair:** ***Gang Tian*** **Invited Talk 1** **Richard M. Schoen** (9:30-10:30)	**Chair:** ***Meng Chen*** **Invited Talk 3** **Kenneth A. Ribet** (8:30-9:30) --- **Chair:** ***Xiaoshan Gao*** **Invited Talk 4** **Chenyang Xu** (9:30-10:30)	**Special Session talks**	**Chair:** ***Jiaxing Hong*** **Invited Talk 5** **Sijue Wu** (8:30-9:30) --- **Chair:** ***Min Chen*** **Invited Talk 6** **Yuhong Dai** (9:30-10:30)
10:30-11:00	**Tea Break**			
11:00-12:30	**Chair:** ***Xiangdong Ye*** **Invited Talk 2** **Jiangong You** (11:00-12:00)	**Special Session Talks**	**Special Session talks**	**Special Session talks**
12:30-14:00	**Lunch Break**			
14:00-15:30	**Special Session talks**	**Special Session Talks**	**Special Session talks**	**Special Session talks**
15:30-16:00	**Tea Break**			
16:00-17:30	**Special session talks**	**Special session Talks**	**Special session talks**	**Special session talks**
	Reception		**Banquet** ***(by Invitation)***	

Venue: Yifu Science & Technology Building

Plenary Session

9:30-10:30, Monday, June 11

Speaker: Richard M. Schoen (University of California, Irvine)

Title: *Geometry and general relativity*

Abstract: This talk will be a survey of some of the geometric problems and ideas which either arose from general relativity or have direct bearing on the Einstein equations. It is intended for a general mathematical audience with minimal physics background. Topics will include an introduction to the Cauchy problem for the Einstein equations, problems related to gravitational mass which are closely related to the Riemannian geometry of positive scalar curvature, and trapped surfaces which are related to the mean curvature and minimal surfaces.

11:00-12:00, Monday, June 11

Speaker: Jiangong You (Chern Institute of Mathematics)

Title: *Spectral theory of Schrödinger operators*

Abstract: The spectral theory of quasi-periodic operators is a fascinating field which continuously attracts a lot of attentions for its rich background in quantum physics as well as its rich connections with many mathematical theories and methods. In this lecture, I will give a brief introduction to this field, including the main problems and their connections with dynamical systems. I will also talk about recent results by Avila-You-Zhou on the Dry Ten Martini problem and the phase transition in Almost Mathieu Operators.

8:30-9:30, Tuesday, June 12

Speaker: Kenneth A. Ribet (University of California, Berkeley)

Title: *The Eisenstein ideal and the arithmetic of modular curves and their Jacobians*

Abstract: Congruences that relate modular forms of different types often have striking arithmetic significance. For example, Ramanujan's congruence modulo 691 between the nth coefficient of the power series $q \prod_{k=1}^{\infty} \left(1 - q^k\right)^{24}$ and the sum $\sum_{d|n} d^{11}$ is connected to the arithmertic of the cyclotomic field $\mathbf{Q}(e^{2\pi i/691})$.

An important fact is that that congruences between modular forms tend to have a cohomological interpretation (or origin, if you prefer). For example, supose that E is

an elliptic curve over $\mathbf{Q}$ that is "strong" in the sense that the modular parametrization $\pi : X_0(N) \to E$ associated with E induces an embedding of E into the Jacobian of $X_0(N)$. (The integer N is the conductor of the curve E.) It is easy to see that the degree of π divides the "congruence number" associated with the modular form f attached to E. This number measures congruences between f and other Hecke eigenforms in the same space as f. A theorem of Agashe, Ribet, Stein asserts that the ratio between the "congruence number" and the degree of π is divisible only by primes whose squares divide the conductor N.

In recent work with Bruce Jordan and Anthony Scholl, we showed that an argument analogous to that of Agashe–Ribet–Stein links congruences relating cusp forms and Eisestein series with the cuspidal subgroup of the Jacobian of the associated modular curve.

9:30-10:30, Tuesday, June 12

Speaker: Chenyang Xu (Peking University)

Title: *Compact moduli spaces*

Abstract: In algebraic geometry, one feature is that the parametrizing space of algebraic objects form an algebraic object itself, which is called a moduli space. In this talk, I will discuss the construction of (compact) moduli spaces parametrizing varieties whose first Chern class has a sign. The main ingredients come from the minimal model program and K-stability.

8:30-9:30, Thursday, June 14

Speaker: Sijue Wu (University of Michigan)

Title: *On the motion of 2d water waves with angled crests*

Abstract: In this talk I will present some recent results concerning the water wave equation. The water wave equation describes the motion of the interface separating a vacuum from an inviscid, incompressible and irrotational fluid, with or without surface tension. We will show that there is a regime that includes non-C^1 interfaces, so that in this regime, the gravity water wave equation (i.e. the surface tension is zero) is well-posed. We will also discuss the work of Siddhant Agrawal on the gravity and capillary-gravity water wave equations.

9:30-10:30, Thursday, June 14

Speaker: Yu-Hong Dai (AMSS, Chinese Academy of Sciences)

Title: *Steepest descent methods revisited*

Abstract: The steepest decent method plays a special role in the development of nonlinear optimization and numerical analysis. The classical steepest decent method, which was dated back to Cauchy (1847), keeps a monotone decrease in the objective function at each iteration, but performs very slow even when the problem is ill-conditioning and possesses the notorious zigzagging phenomenon. By imposing a certain quasi-Newton property, Barzilai and Borwein (1988) proposed a novel gradient method, which has a heavy non-monotone behavior in the objective function, but greatly improves the numerical efficiency. In this talk, we shall revisit both monotone and non-monotone steepest descent methods and point out some possible research problems.

SS 1. Additive Combinatorics including its Interplay with Factorization Theory

Organizers: Weidong Gao, Alfred Geroldinger & David J. Grynkiewicz

	June 11	June 12	June 13	June 14
Chair				
9:00-9:30			**Guoqing Wang**	
9:30-10:00			**Jiyou Li**	
10:00-10:30			**Salvatore Tringali**	
10:30-11:00	**Tea Break**			
Chair				
11:00-11:30		**Hao Pan**		
11:30-12:00		**Chunlin Wang**		
12:00-12:30		**Benjamin Girard**		
12:30-14:00	**Lunch Break**			
Chair				
14:00-15:30	**Gyula Károlyi** (14:00-14:45) **Qinghai Zhong** (14:45-15:30)	**Hanbin Zhang** (14:00-14:30) **Guixin Deng** (14:30-15:00) **Xiaoyu He** (15:00-15:30)		
15:30-16:00	**Tea Break**			
Chair				
16:00-16:30	**Wolfgang Schmid**	**Pingzhi Yuan**		
16:30-17:00	**Jinhui Fang**	**Péter Pál Pach**		
17:00-17:30	**Pablo Candela**	**Yushuang Fan**		
	Reception		**Banquet** ***(by Invitation)***	

Venue: Room 116, Center for American Studies

SS1. Additive Combinatorics including its Interplay with Factorization Theory

14:00-14:45, Monday, June 11

Speaker: Gyula Karolyi (Alfred Renyi Institute of Mathematics, Hungarian Academy of Sciences)

Title: *The combinatorial nullstellensatz and its relatives*

Abstract: During the last two decades, the Combinatorial Nullstellensatz has become an essential tool for studying additive problems in combinatorial arithmetic. Most often its consequence, a non-vanishing criterion, is what can be most effectively applied. It requires the computation of a leading coefficient of a suitable polynomial assigned to the problem. In many cases, the so-called Coefficient Lemma, based on Lagrange interpolation, can help in the computation of this coefficient, encoding a lot of combinatorial information. The aim of my talk is to demonstrate the use of this technique, from additive problems through algebraic combinatorics to statistical mechanics.

14:45-15:30, Monday, June 11

Speaker: Qinghai Zhong (University of Graz)

Title: *Krull monoids and additive combinatorics*

Abstract: Let H be a Krull monoid (e.g., a Dedekind domain) with finite class group G and suppose that every class contains a prime divisor. Then every non-unit $a \in H$ can be written as a product of irreducible elements, say $a = u_1 \cdot \ldots \cdot u_k$. The number of irreducible factors is called the length of the factorization, and $\mathsf{L}(a) = \{k \mid a\text{has a factorization of length}k\} \subset \mathbb{N}$ denotes the set of lengths of a. Then $\mathcal{L}(H) = \{\mathsf{L}(a) \mid a \in H\}$ is the system of all sets of lengths of H. Here are some simple observations:

- H is a factorial monoid if and only if $|G| = 1$.
- (Carlitz 1960) $|G| \le 2$ if and only if $|\mathsf{L}(a)| = 1$ for all non-units $a \in H$.
- If $|G| \ge 3$, then all sets of lengths are finite, and for every $m \in \mathbb{N}$, there is an $a_m \in H$ with $|\mathsf{L}(a_m)| = m$.

Sets of lengths in H can be studied in the monoid of zero-sum sequences $\mathcal{B}(G)$ associated to H. A zero-sum sequence means a finite unordered sequence of group elements from G (repetition is allowed) which sums up to zero. The set of zero-sum

sequences forms a monoid where the operation is just the juxtaposition of sequences. This monoid $\mathcal{B}(G)$ is a Krull monoid again and its system of sets of lengths coincides with the system of our starting monoid H. Indeed, we have

$$\mathcal{L}(H) = \mathcal{L}\big(\mathcal{B}(G)\big) =: \mathcal{L}(G).$$

The system $\mathcal{L}(G)$ is studied with methods from Additive Combinatorics. In this talk we offer a survey on what is known on $\mathcal{L}(G)$ and discuss open questions. The main conjecture on $\mathcal{L}(G)$ runs as follows:

Conjecture: Let G be a finite abelian group with Davenport constant $\mathsf{D}(G) \ge 4$. If G' is an abelian group with $\mathcal{L}(G) = \mathcal{L}(G')$, then G and G' are isomorphic.

We present recent progress on this conjecture.

16:00-16:30, Monday, June 11

Speaker: Wolfgang Schmid (LAGA, University Paris 8)

Title: *A realization theorem for sets of distances*

Abstract: Let H be an atomic monoid. The set of distances of H is the set of all d with the following property: there is a k and there is a product of k irreducible elements that is equal to a product of $k + d$ irreducibles yet not to a product of m irreducibles for any m between k and $k + d$.

It is well-known (and easy to show) that, if the set of distances is nonempty, then its minimum is the greatest common divisor of all elements.

Conversely, for every finite nonempty set D whose minimum is the greatest common divisor of all elements there is a finitely generated Krull monoid whose set of distances is equal to D.

The talk discuss this result (joint work of A. Geroldinger and the speaker) and related problems.

16:30-17:00, Monday, June 11

Speaker: Jinhui Fang (Nanjing University of Information Science & Technology)

Title: *A quantitative form of the Erdös-Birch theorem*

Abstract: This work is joint with Prof. Yong-Gao Chen. In 1959, B. J. Birch [Math. Proc. Cambridge Philos. Soc. 55(1959), 370-373] proved that for any coprime integers p, q greater than 1, there exists a number B such that every $n > B$ can be expressed as the sum of distinct terms taken from $\{p^a q^b \mid a \ge 0, b \ge 0, a, b \in \mathbb{Z}\}$. In 2017, we

[Acta Arith. 178(2017), 301-311] proved that there exist two positive integers K and B with $\log_2 \log_2 K < q^{2p}$ and $\log_2 \log_2 \log_2 B < q^{2p}$ such that every integer $n \geq B$ can be expressed as the sum of distinct terms taken from $\{p^a q^b \mid a \geq 0, 0 \leq b \leq K, a+b > 0, a, b \in \mathbb{Z}\}$, where $\log_2$ means the logarithm to the base 2. Up to our knowledge, this is the first bound for B.

17:00-17:30, Monday, June 11

Speaker: Pablo Candela (Universidad Autónoma de Madrid)

Title: *Recent results related to the 3k-4 conjecture for cyclic groups of prime order*

Abstract: Freiman's $3k-4$ theorem is a classical result in combinatorial number theory, which states that if A is a set of integers of finite cardinality k and the sumset $A+A$ has cardinality at most $3k-4$, then A can be covered by an arithmetic progression of cardinality at most $|A+A|-|A|+1$. When A is a subset of a cyclic group of prime order, a similar result is conjectured to hold, and much work and partial progress has been made towards it, but the real extent to which the result holds is still unknown. I shall discuss recent work related to this conjecture, especially certain variants of it as well as applications of partial progress towards it.

11:00-11:30, Tuesday, June 12

Speaker: Hao Pan (Nanjing University of Finance and Economic)

Title: *Restricted sumsets in finite groups*

Abstract: We introduce some results on the restricted sumsets in finite groups.

11:30-12:00, Tuesday, June 12

Speaker: Chunlin Wang (Sichuan Normal University)

Title: *On zero-sum subsequence of length not exceeding a given number*

Abstract: Let G be an additive finite abelian group. For a positive integer k, let $\mathsf{s}_{\leq k}(G)$ denote the smallest integer l such that each sequence of length l has a non-empty zero-sum subsequence of length at most k. We determine $\mathsf{s}_{\leq k}(G)$ for all finite abelian groups of rank two and we also discuss the inverse problem for this constant.

12:00-12:30, Tuesday, June 12

Speaker: Benjamin Girard (IMJ-PRG, Université Paris-Sorbonne)

Title: *An asymptotically tight bound for the Davenport constant*

Abstract: In this talk, we will present a new upper bound for the Davenport constant of finite Abelian groups of the form C_n^r. An old conjecture in zero-sum theory asserts that $\mathsf{D}(C_n^r) = r(n-1)+1$ holds for all integers $n, r \geq 1$ and still widely stands to this day. In this context, our bound turns out be particularly relevant as it implies that for every integer $r \geq 1$, the Davenport constant $\mathsf{D}(C_n^r)$ is asymptotic to rn when n tends to infinity, thus proving the conjecture in an asymptotic sense. This improves on the best previously known upper bound which was $\mathsf{D}(C_n^r) \leq n(1+(r-1)\log n)$. An extension of our theorem to a wider framework as well as related open problems will also be discussed.

14:00-14:30, Tuesday, June 12

Speaker: Hanbin Zhang (AMSS, Chinese Academy of Sciences)

Title: *Erdos-ginzburg-ziv theorem and noether number for some non-abelian groups*

Abstract: Let G be a multiplicative finite group and $S = a_1 \cdot \ldots \cdot a_k$ a sequence over G. We call S a product-one sequence if $1 = \prod_{i=1}^{k} a_{\tau(i)}$ holds for some permutation τ of $\{1, \ldots, k\}$. The small Davenport constant $\mathsf{d}(G)$ is the maximal length of a product-one free sequence over G. For a subset $L \subset \mathbb{N}$, let $\mathsf{s}_L(G)$ denote the smallest $l \in \mathbb{N}_0 \cup \{\infty\}$ such that every sequence S over G of length $|S| \geq l$ has a product-one subsequence T of length $|T| \in L$. Denote $\mathsf{e}(G) = \max\{\mathrm{ord}(g) : g \in G\}$. Some classical product-one (zero-sum) invariants including $\mathsf{D}(G) := \mathsf{s}_{\mathbb{N}}(G)$ (when G is abelian), $\mathsf{E}(G) := \mathsf{s}_{\{|G|\}}(G)$, $\mathsf{s}(G) := \mathsf{s}_{\{\mathsf{e}(G)\}}(G)$, $\eta(G) := \mathsf{s}_{[1,\mathsf{e}(G)]}(G)$ and $\mathsf{s}_{d\mathbb{N}}(G)$ ($d \in \mathbb{N}$) have received a lot of studies. The Noether number $\beta(G)$ which is closely related to zero-sum theory is defined to be the maximal degree bound for the generators of the algebra of polynomial invariants.

In this talk, I will give a brief introduction to the studies of the above constants and provide some new results relate to these constants. In particular, let $G \cong C_m \ltimes_\varphi C_{mn}$, we will show that

$$\mathsf{E}(G) = \mathsf{d}(G) + |G| = m^2 n + m + mn - 2$$

and $\beta(G) = \mathsf{d}(G) + 1 = m + mn - 1$. Moreover, if G is a non-cyclic nilpotent group and p is the smallest prime divisor of $|G|$, we show that $\beta(G) \leq \frac{|G|}{p} + p - 1$ except if $p = 2$ and G is a dicyclic group, in which case $\beta(G) = \frac{1}{2}|G| + 2$.

14:30-15:00, Tuesday, June 12

Speaker: Guixin Deng (Guangxi Teachers Education University)

Title: *Long minimal zero-sum sequences over integers*

Abstract: Let G be an abelian group (written additively) and X be a subset of G. Minimal zero-sum sequences over X and their maximal length – the Davenport constant $D(X)$ are important objects to be studied in Zero-sum theory. First we focus on the case when $G = Z$ and $X = [-m, n]$. We characterize the structure of the minimal zero-sum sequences S which satisfies one of the following conditions:

i: $|S| > n+m2+1$, $n \geq m22-1$ and $m \geq 6$; ii: $|S| \geq n+m-\sqrt{min\{m,n\}}+3$.

As a corollary, it is shown that $D([-m, n]) = max\{s + t\gcd(s, t) \mid 1 \leq s \leq m, 1 \leq t \leq n\}$ for all but a finite number of pairs (m, n). We also make an attempt toward dimension 2: prove that $D([-1, m]\times[-1, n]) = (m+1)(n+1)$ and characterize the extreme sequences.

15:00-15:30, Tuesday, June 12

Speaker: Xiaoyu He (Stanford University)

Title: *Cross number invariants of finite abelian groups*

Abstract: The cross number of a sequence S over a finite abelian group G is the sum of the inverse orders of the elements of S. We study two related cross number invariants: $k(G)$, introduced by Krause, which is the largest cross number of a zero-sum free sequence over G, and $K_1(G)$, introduced by Gao and Wang, which is the largest cross number of a unique factorization sequence over G. In particular, we show using a compression argument how to compute the values of $k(G)$ and $K_1(G)$ when G is a cyclic group of order n and the prime factors of n are far apart.

16:00-16:30, Tuesday, June 12

Speaker: Pingzhi Yuan (South China Normal University)

Title: *On the index of zero-sum sequences over a finite cyclic group*

Abstract: Let G be an additively written finite cyclic group of order $|G| = n$. For a sequence over G,

$$S = (n_1g) \cdot \ldots \cdot (n_lg), \text{ where } 1 \leq n_1, \ldots, n_l \leq n,$$

the index of S is defined by $ind(S) = \min\{\|S\|_g \,|\, g \in G \text{ with } G = \langle g\rangle\}$ where

$$\|S\|_g = \frac{n_1 + \cdots + n_l}{\mathrm{ord}(g)}.$$

The index of a sequence is a crucial invariant in the investigation of (minimal) zero-sum sequences (resp. of zero-sum free sequences) over cyclic groups. Recently, there are many results on this topic. The main purpose of this talk is to give a survey on the index and the related invariants of minimal zero-sum sequences over cyclic groups.

16:30-17:00, Tuesday, June 12

Speaker: Péter Pál Pach (University of Warwick)

Title: *Polynomials, rank and cap sets*

Abstract: In this talk we will look at a new variant of the polynomial method which was first used to prove that sets avoiding 3-term arithmetic progressions in groups like $\mathbb{Z}_4^n$ (Croot, Lev and myself) and $\mathbb{Z}_3^n$ (Ellenberg and Gijswijt) are exponentially small (compared to the size of the group). We will discuss lower and upper bounds for the size of the extremal subsets, including some recent bounds found by Elsholtz and myself. We will also mention some further applications of the method, for instance, the solution of the Erdös-Szemerédi sunflower conjecture.

17:00-17:30, Tuesday, June 12

Speaker: Yushuang Fan (China University of Geosciences)

Title: *On the decomposition of finite subsets of integers into sumsets of irreducible sets*

Abstract: Denote by $\mathcal{P}_{\text{fin}}(\mathbf{Z})$ the family of all non-empty finite subsets of the integers. A set $A \in \mathcal{P}_{\text{fin}}(\mathbf{Z})$ is irreducible if $|A| \geq 2$ and there do not exist $X, Y \subseteq \mathbf{Z}$ with $A = X + Y$ and $|X|, |Y| \geq 2$. Then, given $\{0\} \neq X \in \mathcal{P}_{\text{fin}}(\mathbf{Z})$, we let $L(X)$ be the set of all integers $k \geq 1$ such that $X = A_1 + \cdots + A_k$ for some irreducible $A_1, \ldots, A_k \in \mathcal{P}_{\text{fin}}(\mathbf{Z})$.

In this talk, we will discuss various arithmetic properties related to the decomposition of a set $X \in \mathcal{P}_{\text{fin}}(\mathbf{Z})$ into sumsets of irreducible sets, and some partial results towards an answer to the following open question: Show that, for every non-empty finite set $L \subseteq \mathbf{N} \setminus \{0, 1\}$, there exists $X \in \mathcal{P}_{\text{fin}}(\mathbf{Z})$ with $\mathsf{L}(X) = L$. This is based on joint work with Salvatore Tringali.

9:00-9:30, Wednesday, June 13

Speaker: Guoqing Wang (Tianjin Polytechnic University)

Title: *Erdös-burgess constant and davenport constant for semingroups*

Abstract: Let S be a semigroup. An element e of S is said to be idempotent if $e * e = e$. The Erdös-Burgess constant of the semigroup S is defined as the smallest $\ell \in \mathbb{N} \cup \{\infty\}$ such that any sequence of terms from S and of length at least ℓ contains a nonempty subsequence the product of whose terms, in some order, is an idempotent. The Davenport constant of the semigroup S is defined as the smallest $t \in \mathbb{N} \cup \{\infty\}$ such that any sequence of terms from S and of length at least t is reducible. In this talk, some recent results on Erdös-Burgess constant and Davenport constant for semigroups will be presented.

9:30-10:00, Wednesday, June 13

Speaker: Jiyou Li (Shanghai Jiao Tong University)

Title: *Counting polynomial subset sums*

Abstract: Let D be a subset of a finite commutative ring R with identity. Let $f(x) \in R[x]$ be a polynomial of degree d. For a nonnegative integer k, we study the number $N_f(D, k, b)$ of k-subsets S in D such that $\sum_{x \in S} f(x) = b$.

In this talk, based on joint work with Daqing Wan, I introduce some recent results on this problem and their applications in combinatorics, number theory and coding theory. In particular, we give an affirmative answer to a question raised by Stanley.

10:00-10:30, Wednesday, June 13

Speaker: Salvatore Tringali (University of Graz)

Title: *Structural properties of subadditive sequences and applications*

Abstract: Let $\mathfrak{X} = (X_k)_{k \ge k_0}$ be a sequence of non-empty subsets of $\mathbf{Z}$ such that $X_h + X_k \subseteq X_{h+k}$ for all $h, k \ge k_0$. We say that $\mathfrak{X}$ is an almost arithmetic, periodic sequence (shortly, AAPS) if there exist $M \in \mathbf{N}$, $d, \mu \in \mathbf{N}^+$, $X'_0, X''_0, \dots, X'_{\mu-1}, X''_{\mu-1} \subseteq [0, M]$, and $x_1, x_2, \dots \in \mathbf{Z}$ such that, for all but finitely many k,

$$X_k = \big(\inf X_k + X'_{k \mod \mu}\big) \uplus \mathscr{P}_k \uplus \big(\sup X_k - X''_{k \mod \mu}\big) \subseteq x_k + d \cdot \mathbf{Z},$$

where $\mathscr{P}_k := (x_k + d \cdot \mathbf{Z}) \cap [\inf X_k + M, \sup X_k - M]$ is an arithmetic progression (with difference d).

We provide sufficient and necessary conditions for the sequence $\mathfrak{X}$ to be an AAPS, and from this we show how to derive new and old results on the (asymptotic) structure of sets of lengths and their unions (in atomic monoids and rings), as well as of sumsets over the integers.

SS 2. Algebraic and Geometric Topology

Organizers: Michael Hill, Zhi Lü, Jiming Ma & Yifei Zhu

	June 11	June 12	June 13	June 14
Chair			***Douglas Ravenel***	
9:00-9:30			**Michael Hopkins**	
9:30-10:00			**Yang Su**	
10:00-10:30			**Min Yan**	
10:30-11:00	**Tea Break**			
Chair		***Zhi Lü***	***Douglas Ravenel***	***Jiming Ma***
11:00-11:30		**Douglas Ravenel**	**Haibao Duan**	**Jie Wu**
11:30-12:00		**Wenyuan Yang**	**Yifei Zhu**	**Shengkui Ye**
12:00-12:30		**Agnès Beaudry**	**Jeremy Hahn**	**Fengling Li**
12:30-14:00	**Lunch Break**			
Chair			***Yifei Zhu***	***Jiming Ma***
14:00-14:30			**Emily Riehl**	**Yi Liu**
14:30-15:00			**Xuezhi Zhao**	**Zhiyun Cheng**
15:00-15:30			**Li Yu**	**XiaoLin Danny Shi**
15:30-16:00	**Tea Break**			
Chair			***Yifei Zhu***	***Zhi Lü***
16:00-16:30			**Guozhen Wang**	**Zhouli Xu**
16:30-17:00			**Xianan Jin**	**Nora Ganter**
17:00-17:30			**Ivan Limonchenko**	**Ruizhi Huang**
	Reception		**Banquet** ***(by Invitation)***	

Venue: June 12th , Room 408, West Side Building ;
June 13th(morning) Room 402, (afternoon) Room 404, West Side Building;
June 14th , Room 2001, East Main Tower, Guanghua Building

SS 2. Algebraic and Geometric Topology

11:00-11:30, Tuesday, June 12

Speaker: Douglas Ravenel (University of Rochester)

Title: *Model categories and spectra*

Abstract: This expository talk is a self-contained variant of the one I gave in Shenzhen. Its purpose is to introduce the use of Quillen model categories in stable homotopy theory. It is joint work with Mike Hill and Mike Hopkins.

11:30-12:00, Tuesday, June 12

Speaker: Wenyuan Yang (Peking University)

Title: *Counting conjugacy classes in groups*

Abstract: In this talk, we introduce a class of statistically convex-cocompact groups and count conjugacy classes when a contracting element is present. Our main result is an asymptotic formula for the number of conjugacy classes of all elements. As corollaries, our results hold for relatively hyperbolic groups, CAT(0) groups with a rank-1 element, and certain subgroups of mapping class groups. As a consequence of this formula, the generating function for conjugacy classes is transcendental, resolving a conjecture of Rivin for these groups. This is joint work with Ilya Gekhtman.

12:00-12:30, Tuesday, June 12

Speaker: Agnès Beaudry (University of Colorado Boulder)

Title: *Dispersion and reassembly in the homotopy groups of spheres*

Abstract: Understanding the stable homotopy groups of spheres is one of the great challenges of algebraic topology. They form a ring which, despite its simple definition, carries an amazing amount of structure. It is filtered by simpler rings called the chromatic layers. Each layer corresponds to a periodic family whose elements repeat at a certain frequency. The terminology is meant to remind us of the electromagnetic spectrum. This point of view organizes the homotopy groups and reveals patterns.

In this talk, we will come to one of the basic and motivating conjectures in the field, the Chromatic Splitting Conjecture, which is about the gluing data between the different layers of the chromatic filtration. This work is joint with Paul Goerss and Hans-Werner Henn and the results of this talk are contained available at arXiv:1712.08182v2

9:00-9:30, Wednesday, June 13

Speaker: Michael Hopkins (Harvard University)

Title: *The Wilson space hypothesis*

Abstract: In his 1972 thesis Steve Wilson established the remarkable fact that the spaces representing even dimensional complex cobordism have cell decompositions with only even dimensional cells. This has many consequences in homotopy theory and there is mounting evidence that Wilson's result is part of something much more general which we call the "Wilson space hypothesis." The Wilson space hypothesis is known to hold in equivariant homotpy theory (for cyclic groups of 2-power order) and believed to hold in motivic homotopy theory where it has applications to the problem of classifying algebraic vector bundles. The purpose of this talk is to explain the Wilson space hypothesis and describe the current state of affairs concerning its formulation and application. This talk represents a combination of joint work with Mike Hill and with Aravind Asok and Jean Fasel.

9:30-10:00, Wednesday, June 13

Speaker: Yang Su (AMSS, Chinese Academy of Sciences)

Title: *On the mapping class group of 3-dimensional complex complete intersections*

Abstract: In this talk I will introduce the computation of the mapping class group of a class of 6-dimensional manifolds. This class of manifolds includes 3-dimensional complex complete intersections in complex projective spaces, especially the quintic Calabi-Yau 3-fold. I will compare the result with the classical mapping class group of surfaces. This is a joint work with M. Kreck.

10:00-10:30, Wednesday, June 13

Speaker: Min Yan (Hong Kong University of Science and Technology)

Title: *Converse of Smith Theory*

Abstract: In 1942, P. A. Smith showed that the fixed point of a p-group action on a finite Z/pZ-acyclic complex is still Z/pZ-acyclic. In 1971, Lowell Jones showed that any Z/pZ-acyclic finite CW-complex is the fixed point of a Z/pZ-action on a finite contractible CW-complex. In 1974, Robert Oliver showed that, for a finite group G of not prime order power, there is a number n(G), such that a finite CW-complex F is the fixed point of a general action of G on a finite contractible CW-complex if and only if the Euler characteristic of F is 1 module n(G).

We extend these classical results to non-contractible case. Suppose G is a finite group, and $f : F \to Y$ is a map between finite CW-complexes. Is it possible to extend F to become the fixed point of a finite G-CW complex X, and extend f to a G-map $g : X \to Y$ (G acts trivially on Y), such that g is a homotopy equivalence after forgetting the G-action?

In case of general G-action, we find that Oliver's theory largely remains true. In case of semi-free G-action, the problem has an obstruction in K0, and we calculate some examples. This is a joint work with Sylvain Cappell of New York University, and Shmuel Weinbeger of University of Chicago.

11:00-11:30, Wednesday, June 13

Speaker: Haibao Duan (AMSS, Chinese Academy of Sciences)

Title: *The characteristic classes and Weyl invariants of the Spin geometry*

Abstract: Based on a pair of new cohomology operations on 2-formal spaces we determine the integral cohomology rings of the classifying spaces $B_{Spin(n)}$ and $B_{Spin^c(n)}$. As applications, we introduce the characteristic classes for the topological K_{Spin} and K_{Spin^c} theories, and present an effective algorithm to produce the integral Weyl invariants of the Lie groups $Spin(n)$ and $Spin^c(n)$.

11:30-12:00, Wednesday, June 13

Speaker: Yifei Zhu (Southern University of Science and Technology)

Title: *Power operations in elliptic cohomology and related arithmetic topics*

Abstract: Power operations are natural transformations on generalized cohomology theories. In a precise way, they lift Frobenius maps on commutative rings. They have powerful applications to questions beyond classical algebraic topology, such as in Voevodsky's proof of the Milnor conjecture. In the context of an "elliptic" cohomology theory, its characteristic classes tie its power operations intimately with the arithmetic of a family of elliptic curves. I'll discuss some of these aspects, including explicit calculations of the power operation algebra and integral models for modular curves.

12:00-12:30, Wednesday, June 13

Speaker: Jeremy Hahn (Harvard University)

Title: *Eilenberg-MacLane spectra as equivariant Thom spectra*

Abstract: I explain work, joint with Dylan Wilson, that constructs equivariant Eilenberg-MacLane spectra as Thom spectra. The theorem holds for any finite, p-power cyclic group, generalizing work of Wilson and Behrens for the cyclic group of order 2. The proof involves an analysis of power operations on spectra with norms, and exploits a natural SU(2) action on quaternionic projective space.

14:00-14:30, Wednesday, June 13

Speaker: Emily Riehl (Johns Hopkins University)

Title: *A model-independent theory of infinity-categories*

Abstract: We develop the theory of infinity-categories from first principles in a "model-independent" fashion, that is, using a common axiomatic framework that is satisfied by a variety of models. Our "synthetic" definitions and proofs may be interpreted simultaneously in many models of infinity-categories, in contrast with "analytic" results proven using the combinatorics of a particular model. Nevertheless, we prove that both "synthetic" and "analytic" theorems transfer across specified "change of model" functors to establish the same results for other equivalent models.

14:30-15:00, Wednesday, June 13

Speaker: Xuezhi Zhao (Capital Normal University)

Title: *A generalization of degree*

Abstract: Given a map, the topological degree counts algebraically the number of pre-image of a given point. We obtain a kind of generalization of degree on the context of pre-image, which includes fixed point theory and intersection theory.

15:00-15:30, Wednesday, June 13

Speaker: Li Yu (Nanjing University)

Title: *Small covers, fundamental group and scalar curvature*

Abstract: We discuss the relations between the fundamental group of a small cover and the combinatorics of the underlying simple polytope. As an application, we find that any 3-dimensional small cover has a 2-dimensional pi_1-injective facial submanifold. Then by some theorem of Schoen and Yau, we can characterize all the 3-dimensional small covers that admit Riemannian metrics with nonnegative scalar curvature.

16:00-16:30, Wednesday, June 13

Speaker: Guozhen Wang (Fudan University)

Title: *Motivic homotopy and Ctau modules*

Abstract: Motivic homotopy theory is the homotopy theory for smooth schemes. The application of motivic homotopy theory to algebraic geometry is a success, solving important problems such as the Milnor conjecture and the Bloch-Kato conjecture.

On the other hand, the Betti realization functor relates motivic homotopy theory to classical homotopy theory. This produces powerful methods for studying classical homotopy theory, such as Isaksen's computations of stable homotopy groups of spheres up to stem 59.

In this talk, I will present joint work with Gheorghe, Isaksen and Xu on the latter direction. We will show that the category of cellular Ctau modules over the complex numbers is equivalent to the derived category of BP_{*BP}-comodules as infinity categories. This implies that the algebraic Novikov spectral sequence is isomorphic to the motivic Adams spectral sequence for Ctau, providing a systematic way to generate non-trivial Adams differentials using algebraic computations. Using this method, we can do the computations of stable homotopy groups of spheres up to the 90-stem, and many new phenomena in stable homotopy groups are discovered in this new range.

16:30-17:00, Wednesday, June 13

Speaker: Xian-an Jin (Xiamen University)

Title: *Zeros of Jones polynomials of graphs*

Abstract: Motivated by the Jones polynomial of knots and links, we introduce the Jones polynomial of a graph $G = (V, E)$ with k components as the following specialization of the Tutte polynomial:

$$J_G(t) = (-1)^{|V|-k} t^{|E|-|V|+k} T_G(-t, -t^{-1}).$$

Its basic properties and certain extreme coefficients will be firstly given. Then we prove:
(1) $(-\infty, 0]$ is a zero-free interval of Jones polynomials of connected bridgeless graphs while for any small $\epsilon > 0$ or large $M > 0$, there is a zero of the Jones polynomial of a plane graph in $(0, \epsilon)$, $(1 - \epsilon, 1)$, $(1, 1 + \epsilon)$ or $(M, +\infty)$.
(2) Let $r(G)$ be the maximum moduli of zeros of $J_G(t)$. By applying Sokal's result on

zeros of Potts model partition functions and Lucas's theorem, we prove that

$$\frac{q_s - |V| + 1}{|E|} \leq r(G) < 1 + 6.907652\Delta_G$$

for any connected bridgeless and loopless graph $G = (V, E)$ of maximum degree Δ_G with q_s parallel classes.

As a consequence of the upper bound, X.-S. Lin's conjecture holds if the positive checkerboard graph of a connected alternating link has a fixed maximum degree and a sufficiently large number of edges. This is a joint work with Fengming Dong et al.

References

[1] Fengming Dong, Xian'an Jin*, Zeros of Jones polynomials of graphs, The Electronic Journal of Combinatorics, 22 (2015) 3:#P3.23.
[2] Helin Gong, Mengchen Li, Xian'an Jin, Several extreme coefficients of the Tutte polynomial of graphs, arXiv:1705.10023 [math.CO]

17:00-17:30, Wednesday, June 13

Speaker: Ivan Limonchenko (Fudan University)

Title: *On Calabi-Yau manifolds in the SU bordism theory*

Abstract: To find nice geometric representatives of bordism classes and bordism ring generators for various bordism theories has been a classical problem in algebraic and differential topology since 1960s. In 1958 F. Hirzebruch stated a problem, which remains open until now: to find a nonsingular (connected) complex algebraic variety in a given unitary bordism class. It was proved in 1960s that Milnor hypersurfaces generate the unitary bordism ring over integers, which is a polynomial ring due to a classical result of J. Milnor and S. P. Novikov, and similar generators also exist for unoriented and oriented bordism rings. In 1962 S. P. Novikov proved that the special unitary bordism ring over the integers with 2 reversed is isomorphic to a polynomial ring with one generator in each even real dimension greater than two. Z. Lu and T. E. Panov (2014) constructed a quasitoric representative for each multiplicative generator of this ring, starting with real dimension 10; quasitoric manifolds represent zero in dimensions 4, 6, and 8.

In this talk we are going to discuss Hirzebruch's problem for SU-bordism. J. Mosley (2016) proved that a nonsingular complex algebraic variety may not exist in a given SU-bordism class already in dimension 4. However, we show that for each multiplicative generator in the SU-bordism ring such a representative (disconnected in general) can be found using V. V. Batyrev's construction (1993) of Calabi-Yau hypersurfaces in

toric Fano varieties over reflexive polyhedra. This is a joint work with Zhi Lu (Fudan University) and Taras E. Panov (Moscow State University).

11:00-11:30, Thursday, June 14

Speaker: Jie Wu (National University of Singapore)

Title: *On the exponent problem in homotopy theory—the history and new progress*

Abstract: This is an introductory talk on the article titled "Combinatorics of double loop suspensions, evaluation maps and Cohen groups" joint work with Ruizhi Huang. The project was carried out by Ruizhi Huang as one of the chapters in his PhD thesis. We will start from historic review on the exponent problem in homotopy theory, introduce the combinatorial approach in Cohen's program and report our new progress on the topic. The talk will aim to the general audience.

11:30-12:00, Thursday, June 14

Speaker: Shengkui Ye (Xi'an Jiaotong - Liverpool University)

Title: *Euler characteristics and topological Zimmer's conjecture*

Abstract: When the Euler characteristic of an orientable manifold M is not divisible by 6, any topological action of $SL(n, Z)$ (and Aut(F_n)) on M is trivial by homeomorphisms when dim$(M) < n - 1$. This confirms the Zimmer conjecture for these manifolds.

12:00-12:30, Thursday, June 14

Speaker: Fengling Li (Dalian University of Technology)

Title: *Reducible handle additions to weakly reducible Heegaard splittings*

Abstract: Let $V \cup_S W$ be an irreducible Heegaard splitting of M and F a component of $\partial_- V$. A simple closed curve J in F is called reducible if $M_J = V_J \bigcup_S W$ is reducible, where M_J is obtained by attaching a 2-handle to M along J. In this talk, we give a sufficient condition for the diameter of the set of reducible curves in F to be bounded in $C(F)$ for the keen weakly reducible Heegaard splittings. Moreover, an upper bound of the diameter of the set of the reducible curves in F is given under some circumstance for the weakly reducible Heegaard splittings. This is joint work with Liang Liang and Jingyan Li.

14:00-14:30, Thursday, June 14

Speaker: Yi Liu (Peking University)

Title: *Virtual homological spectral radii of surface automorphisms*

Abstract: Given an orientable self-homeomorphism of a closed orientable surface, a virtual homological spectral radius is the largest modulus of the homological eigenvalues for some lift of the homeomorphism to some finite cover of the surface. We show that pseudo-Anosov automorphisms admits a virtual homological radius greater than 1, which confirms a conjecture of C. T. McMullen.

14:30-15:00, Thursday, June 14

Speaker: Zhiyun Cheng (Beijing Normal University)

Title: *An invitation to virtual knots*

Abstract: Virtual knot theory was introduced by Louis Kauffman in the end of last century. As an extension of classical knot theory, virtual knot theory attracts a lot of attention and plays an important role in low-dimensional topology. In this talk, I will give a brief survey on virtual knots. In particular, some recent progress on parity and its generalization will be discussed.

15:00-15:30, Thursday, June 14

Speaker: XiaoLin Danny Shi (Harvard University)

Title: *Real orientations of Lubin–Tate spectra*

Abstract: We show that Lubin–Tate spectra at the prime 2 are Real oriented and Real Landweber exact. The proof is by application of the Goerss–Hopkins–Miller theorem to algebras with involution. For each height n, we compute the entire homotopy fixed point spectral sequence for E_n with its C_2-action given by the formal inverse. We study, as the height varies, the Hurewicz images of the stable homotopy groups of spheres in the homotopy of these C_2-fixed points.

16:00-16:30, Thursday, June 14

Speaker: Zhouli Xu (Massachusetts Institute of Technology)

Title: *Smooth structures on the 61-sphere*

Abstract: Following Kervaire-Milnor, Browder and Hill-Hopkins-Ravenel, Guozhen Wang and I showed that the 61-sphere has a unique smooth structure and is the last odd dimensional case—the only odd dimensional spheres with unique smooth structures are in dimensions 1, 3, 5 and 61. The proof is a computation of homotopy groups of spheres.

16:30-17:00, Thursday, June 14

Speaker: Nora Ganter (University of Melbourne)

Title: *Categorical tori*

Abstract: Intimately related to affine representation theory, string theory and moonshine, categorical groups (2-groups) are the formalism capturing any situation where symmetries are related by symmetries of their own. In the finite case, their representation and character theory is well understood. In the Lie case, the picture is still emerging. In this talk I will try to give an impression of ongoing work surrounding the maximal tori of said categorical Lie groups.

17:00-17:30, Thursday, June 14

Speaker: Ruizhi Huang (AMSS, Chinese Academy of Sciences)

Title: *Homotopy theory of gauge groups over high dimensional closed manifolds*

Abstract: The homotopy types of gauge groups have been investigated by many experts in the latest twenty years. So far the works mainly focus on bundles over 4-dimensional manifolds, the gauge theory of which play a crucial role in Donaldson's theory. In this talk, we will study the homotopy theory of gauge groups over higher dimensional manifolds. For instance, we will study the gauge groups over (n-1)-connected 2n-manifolds, the classification of which was determined by Wall and Freedman. We will further investigate other 2n-manifolds and sphere bundles as well based on the work of James and Whitehead. For dimension 5 which is the first high dimension (in the sense, for instance, of surgery theory), we will study gauge groups over non-simply-connected 5-manifolds, where the fundamental groups play a role. We will show many homotopy decompositions of gauge groups under the mentioned cases. The methods are also valid for rational cases, and reveal periodicity of homotopy groups of gauge groups as well.

SS 3. Algebraic Geometry

Oganizors: Davesh Maulik & Chenyang Xu

	June 11	June 12	June 13	June 14
9:00-10:30				
10:30-11:00	**Tea Break**			
Chair				
11:00-11:45		**Zhiyuan Li**		**Ljudmila Kamenova**
11:45-12:30		**Alex Perry**		**Bohan Fang**
12:30-14:00	**Lunch Break**			
Chair				
14:00-14:45	**Jason Starr**	**Jarod Alper**		**Zhi Jiang**
14:45-15:30	**Baohua Fu**	**Dawei Chen**		**Will Donovan**
15:30-16:00	**Tea Break**			
Chair				
16:00-16:45	**Yun Gao**	**Daniel Litt**		**Ben Bakker**
16:45-17:30	**Shuai Guo**	**Mao Sheng**		**Changzheng Li**
	Reception		**Banquet** *(by Invitation)*	

Venue: June 12th Morning, Yifu Science and Technology Building; otherwise, 2201 East Main Tower, Guanghua Building.

SS 3. Algebraic Geometry

14:00-14:45, Monday, June 11

Speaker: Jason Starr (Stony Brook University)

Title: *Rationally simply connected varieties and pseudo algebraically closed fields*

Abstract: The cohomological dimension of a field is the largest degree with non-vanishing Galois cohomology. Serre's "Conjecture II" predicts that for every perfect field of cohomological dimension 2, every torsor over the field for a semisimple, simply connected algebraic group is trivial. A field is perfect and "pseudo algebraically closed" (PAC) if every geometrically irreducible curve over the field has a rational point. These have cohomological dimension 1. Every transcendence degree 1 extension of such a field has cohomological degree 2. We prove Serre's "Conjecture II" for such fields of cohomological degree 2 provided either the field is of characteristic 0 or the field contains primitive roots of unity for all orders n prime to the characteristic. The method uses "rational simple connectedness" in an essential way. With the same method, we prove that such fields are C2-fields, and we prove that "Period equals Index" for the Brauer groups of such fields. Finally, we use a similar method to reprove and extend a theorem of Fried-Jarden: every perfect PAC field of positive characteristic is C2.

14:45-15:30, Monday, June 11

Speaker: Baohua Fu (MCM & AMSS, Chinese Academy of Sciences)

Title: *Equivariant compactifications of vector groups of high index*

Abstract: I'll report a joint work with P. Montero, in which we classify equivariant compactifications of vector groups of co-index at most 3. As an application, we obtain the classification of equivariant compactifications of vector groups with Picard number one up to dimension 5.

16:00-16:45, Monday, June 11

Speaker: Yun Gao (Shanghai Jiao Tong University)

Title: *k-linear spaces in the hypersurfaces in P^n and Fano schemes*

Abstract: Let X be a smooth hypersurface of degree $2n-3$ in n dimensional complex projective space P^n. Counting the number of k-linear spaces in X is a classical problem in enumerative algebraic geometry which is equivalent to find the number of connected

components of some Fano scheme. In this talk, I will explain the relation between this counting problem and the Fano scheme. Moreover, I will give explicit formulas of the number of k-linear space in X instead of the that given by the generating functions in representation theory.

16:45-17:30, Monday, June 11

Speaker: Shuai Guo (Peking University)

Title: *BCOV's Feymann rule and MSP*

Abstract: I will talk about the physics and mathematics approaches to the Gromov-Witten invariants of quintic 3-fold, and how they are related via the language of R-matrix action on CohFT. This is a joint work with H-L Chang and Jun Li.

11:00-11:45, Tuesday, June 12

Speaker: Zhiyuan Li (Shanghai Center for Mathematical Science)

Title: *Supersingular irreducible symplectic varieties*

Abstract: The supersingular K3 surfaces are first introduced by Artin via the formal Brauer groups. Artin has conjectured that all supersingular K3 surface are unirational. Recently, this conjecture has been confirmed by Liedtke, and Bragg-Lieblich. In this talk, we introduce several notions of supersingular irreducible symplectic (IS) varieties over fields of positive characteristic p, which are conjecturally equivalent. By analogy with K3 surfaces, there is a natural generalization of Artin's conjecture for supersingular IS varieties. We will show that the conjectures hold for most known examples of IS varieties. This is a joint work with Lie Fu.

11:45-12:30, Tuesday, June 12

Speaker: Alex Perry (Columbia University)

Title: *Deformation and derived equivalent but non-birational Calabi-Yau threefolds*

Abstract: I will construct a pair of Calabi-Yau threefolds which are deformation and derived equivalent, but not birationally equivalent. I will explain how this gives a counterexample to the birational Torelli problem for Calabi-Yau threefolds, as well as new examples of zero divisors in the Grothendieck ring of varieties. This is joint work with Lev Borisov and Andrei Caldararu.

14:00-14:45, Tuesday, June 12

Speaker: Jarod Alper (University of Washington)

Title: *Valuative criteria for moduli problems*

Abstract: We will discuss various valuative criteria for algebraic stacks that hold for many moduli problems parameterizing objects that may have positive dimensional stabilizers (eg. semistable vector bundles over a curve). We have three applications in mind: (1) existence of Cartan–Iwahori decompositions for reductive groups, (2) semistable reduction theorems for moduli problems, and (3) existence of moduli schemes/algebraic spaces parameterizing objects up to S-equivalence. This is a report on joint work in progress with Daniel Halpern-Leistner and Jochen Heinloth.

14:45-15:30, Tuesday, June 12

Speaker: Dawei Chen (Boston College)

Title: *Are affine invariant submanifolds affine?*

Abstract: An abelian differential defines a flat metric such that the underlying Riemann surface can be realized as a plane polygon. Varying the shape of such polygons induces a GL(2,R)-action on the moduli space of abelian differentials. The corresponding GL(2,R)-orbit closures are called affine invariant submanifolds, where affinity refers to a locally linear structure under period coordinates. In this talk we study the amusing question whether affine invariant submanifolds are affine varieties in the sense of algebraic geometry.

16:00-16:45, Tuesday, June 12

Speaker: Daniel Litt (Columbia University)

Title: *Arithmetic representations of fundamental groups*

Abstract: Let X be a complex algebraic variety. Which representations of the fundamental group arise from geometry, i.e. as subquotients of monodromy representations on the cohomology of smooth proper varieties over X? I'll propose a simple (conjectural) arithmetic answer to this question, and provide some evidence for it. As a sample result, I show that there are finitely many representations of the fundamental group of X into $GL_n(Q_l)$ which arise from geometry, which is a mild strengthening of a theorem of Deligne (who proved an analogous result with Q replacing Q_l).

16:45-17:30, Tuesday, June 12

Speaker: Mao Sheng (University of Science and Technology of China)

Title: *Mass formula for Shimura curves*

Abstract: The classical Eichler-Deuring mass formula counts the number of j-invariants of supersingular elliptic curves over $\bar{F}_p$. In this talk, I explain its analogue for Shimura curves. This is a recent joint work with Raju Krishnamoothy.

11:00-11:45, Thursday, June 14

Speaker: Ljudmila Kamenova (Stony Brook University)

Title: *Algebraic non-hyperbolicity of hyperkaehler manifolds*

Abstract: A projective manifold is algebraically hyperbolic if the degree of any curve is bounded from above by its genus times a constant, which is independent from the curve. This is a property which follows from Kobayashi hyperbolicity. Together with M. Verbitsky we prove that hyperkaehler manifolds are not algebraically hyperbolic when the Picard rank is at least 3, or if the Picard rank is 2 and the SYZ conjecture on existence of Lagrangian fibrations is true. We also prove that if the automorphism group of a hyperkaehler manifold is infinite then it is algebraically non-hyperbolic.

11:45-12:30, Thursday, June 14

Speaker: Bohan Fang (Peking Univjersity)

Title: *Crepant resolution conjecture and holomorphic anomaly equation from the remodeling conjecture*

Abstract: I will survey some applications of the remodeling conjecture, such as holomorphic anomaly equations and the crepant resolution conjectures. This talk is based on the joint works with Chiu-Chu Melissa Liu and Zhengyu Zong, as well as on the joint work Yongbin Ruan, Yingchun Zhang and Jie Zhou.

14:00-14:45, Thursday, June 14

Speaker: Zhi Jiang (Fudan University)

Title: *Cohomological rank functions and Severi type inequalities*

Abstract: We will explain some nice properties of cohomological rank functions on abelian varieties, which is introduced by Barja-Pardini-Stoppino and Pareschi and myself. Then we will use these functions to study the geometry of varieties with large irregularities.

14:45-15:30, Thursday, June 14

Speaker: Will Donovan (Tsinghua University)

Title: *Twists and braids for general threefold flops*

Abstract: If a complex surface contains a (-2)-curve, this curve corresponds to a spherical object in the derived category of coherent sheaves on the surface. For certain arrangements of such curves, Seidel and Thomas used these objects to establish a braid group action on the derived category. I explain joint work with Michael Wemyss giving a generalisation to curves on threefolds: this uses braid-type groups associated to hyperplane arrangements, and relative spherical objects over noncommutative base rings.

16:00-16:45, Thursday, June 14

Speaker: Benjamin Bakker (University of Georgia)

Title: *Hodge theory and o-minimal geometry*

Abstract: Hodge structures on cohomology groups are fundamental invariants of algebraic varieties; they are parametrized by quotients D/Γ of periods domains by arithmetic groups. Except for a few very special cases, such quotients are never algebraic varieties, and this leads to many difficulties in the general theory. We explain how to partially remedy this situation by equipping D/Γ with an o-minimal structure, and show that period maps are "definable" with respect to this structure. As a consequence, we obtain an easy proof of a result of Cattani–Deligne–Kaplan on the algebraicity of Hodge loci, a strong piece of evidence for the Hodge conjecture. The proof of the main theorem also refines work of Schmid, Kashiwara, and Cattani–Kaplan–Schmid on the asymptotics of degenerations of Hodge structures. This is joint work with B. Klingler and J. Tsimerman.

16:45-17:30, Thursday, June 14

Speaker: Changzheng Li (Sun Yat-sen University)

Title: *Gamma conjecture I for del Pezzo surfaces*

Abstract: Conjecture O and the underlying Gamma conjecture I for Fano manifolds were proposed by Galkin, Golyshev and Iritani recently. Conjecture O is concerned with eigenvalues of an operator on the quantum cohomology of X induced by the quantum multiplication by the first Chern class of X. Gamma conjecture I relates Givental's J-function with Gamma class of X. In this talk, we will discuss the two conjectures in the special case of del Pezzo surfaces X. This is my joint work with Huazhong Ke, Jianxun Hu and Tuo Yang.

SS 4. Asymptotically Hyperbolic Einstein Manifolds and Conformal Geometry

Organizers: Jie Qing, Mijia Lai, Fang Wang & Meng Wang

	June 11	June 12	June 13	June 14
9:00-10:30				
10:30-11:00	**Tea Break**			
Chair			***Mijia Lai***	***Meng Wang***
11:00-11:45			**Shiguang M**	**Jih-Hsin Cheng**
11:45-12:30			**Xiao Zhang**	**Zhizhang Wang**
12:30-14:00	**Lunch Break**			
Chair			***Mijia Lai***	***Meng Wang***
14:00-14:45			**Wei Yuan**	**Xuezhang Chen**
14:45-15:30			**Jinhua Wang**	**Jingang Xiong**
15:30-16:00	**Tea Break**			
Chair			***Mijia Lai***	***Meng Wang***
16:00-16:45			**Jingyang Zhong**	**Biao Ma**
16:45-17:30			**Weiming Shen**	**Chao Xia**
	Reception		**Banquet** ***(by Invitation)***	

Venue: 1501, East Main Tower, Guanghua Building

SS 4. Asymptotically Hyperbolic Einstein Manifolds and Conformal Geometryb

11:00-11:45, Wednesday, June 13

Speaker: Shiguang Ma (Nankai University)

Title: *Hyperconvex hypersurfaces in H^{n+1}*

Abstract: I will talk about our recent work about hypersurfaces with nonnegative sectional curvature or nonnegative Ricci curvature in H^{n+1}. There are two kinds of problems we are interested in. The first kind is whether immersed hypersurfaces are embedded. The second kind is to analyze the behavior of embedded hypersurfaces. These are joint works with V. Bonini and J. Qing.

11:45-12:30, Wednesday, June 13

Speaker: Xiao Zhang (AMSS, Chinese Academy of Sciences)

Title: *Eigenvalue estimates of the Dirac operator on manifolds with boundary and the rigidity of PE manifolds*

Abstract: We re-visit some eigenvalue lower bound estimates for the Dirac operator on manifolds with boundary obtained early by Hijazi-Montiel-Zhang. We show that how they give the rigidity of PE manifolds when the smallest eigenvalue is achieved. The talk is based on the joint work with Daguang Chen and Fang Wang.

14:00-14:30, Wednesday, June 13

Speaker: Wei Yuan (Sun Yat-sen University)

Title: *Gap phenomena for obstruction-flat metrics*

Abstract: Obstruction tensor is a trace-free symmetric 2-tensor, which indicates whether a given representative for the conformal infinity of a conformally compact Einstein manifold can be smoothly extended to the interior of the manifold. As a special case for 4-dimensional manifolds, obstruction tensor is exactly the well-known Bach tensor. In this talk, we will present a type of gap phenomena associated to closed manifolds with vanishing obstruction tensor. Moreover, we will apply the idea of such gap results to study the geometry and topology of manifolds of certain dimensions. This talk is based on a series of joint works with Dr. Fang Yi in Anhui University of Technology.

14:45-15:30, Wednesday, June 13

Speaker: Jinhua Wang (Xiamen University)

Title: *Future stability of the* $1+3$ *Milne model for Einstein-Klein-Gordon system*

Abstract: We study small perturbations of the $1+3$-dimensional Milne model for the Einstein-Klein-Gordon (EKG) system. We prove the nonlinear future stability, and show that the perturbed spacetimes are future causally geodesically complete. For the proof, we work within the constant mean curvature (CMC) gauge and focus on the $1+3$ splitting of Bianchi-Klein-Gordon (BKG) equations. Moreover, we treat the BKG equations as evolution equations and establish a partial energy scheme in the sense that we only commute the BKG equations with spatially covariant derivatives while scaling (or normal derivative) is not allowed.

16:00-16:45, Wednesday, June 13

Speaker: Jingyang Zhong (Tsinghua university)

Title: *Scalar conformal invariants and global invariants for hypersurfaces on sphere*

Abstract: For a hypersurface in S^{n+1}, we use the conformal Gauss map and the conformal transform to construct the associate hypersurface in $R^{1,n+2}$, build up a way to construct and collect scalar conformal invariants. By calculation of special invariant of the associate hypersurface, we set up a new global conformal invariant in, in the case $n=4$, it could be considered as generalized Willmore energy in higher order.

16:45-17:30, Wednesday, June 13

Speaker: Weiming Shen (Peking University)

Title: *The rigidity and gap theorem for Liouville's equation*

Abstract: In this talk, I will talk about the properties of the first global term in the polyhomogeneous expansions for Liouville's equation. We obtain rigidity and gap results for the boundary integral of the global coefficient. We prove that such a boundary integral is always nonpositive, and is zero if and only if the underlying domain is a disc. More generally, we prove some gap theorems relating such a boundary integral to the number of components of the boundary. The conformal structure plays an essential role.

11:00-11:45, Thurday, June 14

Speaker: Jih-Hsin Cheng (Academia Sinica)

Title: *Biholomorphically invariant curves and surfaces on the boundary of a strongly pseudoconvex domain in C^2*

Abstract: I will talk about biholomorphically invariant curves and surfaces on the boundary of a strongly pseudoconvex domain in C^2. A distinguished class of such invariant curves satisfies a system of 2nd order ODEs, called chains in CR geometry. We interpret chains as geodesics of a Kropina metric in Finsler geometry. The associated energy functional of a curve on the boundary can be recovered as the log term coefficient in a weighted renormalized area expansion of a minimal surface that it bounds inside the domain. For surfaces, we express two CR invariant surface area elements in terms of quantities in pseudohermitian geometry. We deduce the Euler-Lagrange equations of the associated energy functionals. Many solutions are given and discussed. In relation to the singular CR Yamabe problem, we show that one of the energy functionals appears as the coefficient (up to a constant multiple) of the log term in the associated volume renormalization. The results presented are joint works with two groups of collaborators: Andrea Malchiodi, Paul Yang and Yongbing Zhang on the one hand; Taiji Marugame, Vladimir Matveev and Richard Montgomery on the other hand.

11:45-12:30, Thurday, June 14

Speaker: Zhizhang Wang (Fudan University)

Title: *The Weyl problem in warped spaces and related topics*

Abstract: In this talk, we will concern the Weyl problem in warped product spaces and its application in the generalization of the quasi-local mass. We will discuss the openness, the non uniqueness and the generalization of the definition of the Brown-York mass in the spatial Schwarzchild manifold. We also will concern the Lu-Miao's local Penrose inequality and the work of Lu-Miao for solving the rigidity of their inequality. Meanwhile, the rigidity also raise a question about the uniqueness of the isometric embedded hypersurfaces with the same mean curvature which has been partially solved by Li-Miao-Wang

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14:00-14:45, Thurday, June 14

Speaker: Xuezhang Chen (Nanjing University)

Title: *The Weyl problem in warped spaces and related topics*

Abstract: First, we will present our recent advances on the Han-Li conjecture in boundary Yamabe problem. Second, using such solutions of these Yamabe problems as compacted metrics, we derive three types of inequalities involving the Yamabe constants of Poincare-Einstein manifold and its conformal infinity, further prove some rigidity theorems when equality occurs. Also some generalization of Obata type rigidity theorems on compact manifolds will be mentioned. The front part is joint with Yuping Ruan and Liming Sun, the latter part is joint with Mijia Lai and Fang Wang.

14:45-15:30, Thurday, June 14

Speaker: Jingang Xiong (Beijing Normal University)

Title: *On the isoperimetric quotient over scalar-flat conformal classes*

Abstract: Let (M, g) be a smooth compact Riemannian manifold of dimension n with smooth boundary ∂M. Suppose that (M, g) admits a scalar-flat conformal metric. We prove that the supremum of the isoperimetric quotient over the scalar-flat conformal class is strictly larger than the best constant of the isoperimetric inequality in the Euclidean space, and consequently is achieved, if either (i) $n \geq 12$ and ∂M has a nonumbilic point; or (ii) $n \geq 10$, ∂M is umbilic and the Weyl tensor does not vanish at some boundary point.

16:00-16:45, Thurday, June 14

Speaker: Biao Ma (University of Iowa)

Title: *Constant Q-curvature metrics on conic 4-manifolds*

Abstract: In this talk, I will discuss some recent joint work with Prof. Hao Fang on finding constant Q-curvature metric on conic 4-manifolds. In dimension 2, classical uniformization theory has been generalized by Troyanov and others to discuss conic surfaces with constant scalar curvature. In dimension 4, classical works of Branson-Chang-Yang and Chang-Gursky-Yang reveal an analogue theory for constant Q-curvature metrics, which depends on sharp analytic inequalities of Moser, Trudinger, Adams and Bechner. We generalize Adams' inequality to a version with singular weights and apply it to prove that for subcritical conformal conic 4-folds, the variational approach produces a constant Q-curvature metric. We will also discuss the critical case, where some delicate solutions are constructed.

16:45-17:30, Thurday, June 14

Speaker: Chao Xia (Xiamen University)

Title: *A volume preserving local mean curvature flow for hypersurfaces with free boundary in a ball*

Abstract: Motivated by a recent Minkowski type formula established in our previous work, we study a volume preserving local mean curvature flow, which was first introduced by Guan-Li for closed hypersurfaces in Euclidean space, in the setting of hypersurfaces with free boundary in a ball. Using the Mobius transformation, we transfer the problem into an equivalent problem in half space which is equipped with a conformal flat metric. A concept of "star-shapedness" in this setting will be introduced. We show that if the the flow from a "star-shapedness" hypersurface will exist for all time and converges smoothly to a spherical cap in the ball. This is a joint work with Guofang Wang (Freiburg).

SS 5. Complex Geometry and Several Complex Variables

Organizers: Qingchun Ji, Min Ru & Xiangyu Zhou

	June 11	June 12	June 13	June 14
9:00-10:30				
10:30-11:00	**Tea Break**			
Chair				
11:00-11:20			**Songying Li**	**Siqi Fu**
11:30-11:50			**Feng Rong**	**Taishun Liu**
12:00-12:20			**Xiaoshan Li**	**Chunhui Qiu**
12:30-14:00	**Lunch Break**			
Chair				
14:00-14:20			**Takeo Ohsawa**	**Xu Wang**
14:30-14:50			**Langfeng Zhu**	**Xianhui Meng**
15:00-15:20			**Fusheng Deng**	
15:30-16:00	**Tea Break**			
Chair				
16:00-16:30			**Julie Tzu-Yueh Wang**	**Wei Wang**
16:30-17:00			**Qiming Yan**	**Sui-Chung Ng**
17:00-17:30			**Nikhil Savale**	
	Reception		**Banquet** *(by Invitation)*	

Venue: June 13th , Room 2201; June 14th, Room 2901, East Main Tower, Guanghua Building

SS 5. Complex Geometry and Several Complex Variables

11:00-11:20, Wednesday, June 13

Speaker: Songying Li (University of California, Irvine)

Title: *Forelli type theorem on harmonic maps*

Abstract: I will present a joint work with Jie Luo on Forelli type theorem on harmonic map. Forelli theorem says that if a continuous function on the unit ball B_n in $\mathbf{C}^n$ which is C^∞ at origin 0. If $f(\lambda\xi)$ is harmonic on the unit disc $D(0,1)$ for any $\xi \in \partial B_n$, then f is pluriharmonic in B_n. I will present our results for harmonic map, namely, the target manifolds more general than $\mathbf{R}$ or $\mathbf{C}$.

11:30-11:50, Wednesday, June 13

Speaker: Feng Rong (Shanghai Jiaotong University)

Title: *A brief overview of local holomorphic dynamics in higher dimensions*

Abstract: In this talk, we will give a brief overview of local holomorphic dynamics in higher dimensions, with emphasis on extending the well-known "Leau-Fatou Flowers Theorem". We will mainly talk about some important local invariants and the associated blow-up procedure.

12:00-12:20, Wednesday, June 13

Speaker: Xiaoshan Li (Wuhan University)

Title: *On the stability of equivariant embedding of CR manifolds with circle actions*

Abstract: The stability of embedding of compact strongly pseudoconvex CR manifold is related to the moduli space of the CR structures. Tanaka established that any CR embedding is stable when the dimension of the CR manifold is greater or equal to five and the dimension of the first Kohn-Rossi cohomology is invariant with respect to the deformation of the CR structures. However, examples of unstable embedding exist when the dimension is three. In this talk, on three dimensional CR manifold with circle action we will show the equivariant embedding is stable under the circle invariant deformation of the CR structure. This talk is based on a series of joint work with H. Herrmann, C.-Y. Hsiao and G. Marinescu.

14:00-14:20, Wednesday, June 13

Speaker: Takeo Ohsawa (Nagoya University)

Title: *Applications of the L^2 extension theorem to analytic families*

Abstract: It is known that a locally Stein family of Riemann surfaces is locally trivial if the fibers are euivalent to the complex plane. A new proof of this theorem will be given by applying the L^2 extension theorem. Other applications will also be mentioned.

14:30-14:50, Wednesday, June 13

Speaker: Langfeng Zhu (Wuhan University)

Title: *The optimal L^2 extension problem and Siu's lemma*

Abstract: At first we discuss an optimal L^2 extension theorem on weakly pseudoconvex Kähler manifolds. Then, we discuss an optimal L^q extension theorem on weakly pseudoconvex Kähler manifolds and the log-plurisubharmonicity of the relative Bergman kernel in the Kähler case. Finally, we discuss a generalization of Siu's lemma. These are joint works with Professor Xiangyu Zhou.

15:00-15:20, Wednesday, June 13

Speaker: Fusheng Deng (University of Chinese Academy of Sciences)

Title: *Ohsawa-Takegoshi extension and positivity of Hodge-type bundles*

Abstract: We will give a new characterization of plurisubharmonic functions, and show that the Griffiths positivity of the direct image of the twisted relative canonical bundle associated to a family of compact Khler manifolds of Stein manifolds can be deduced from the Ohsawa-Takegoshi extension theorem.

16:00-16:20, Wednesday, June 13

Speaker: Julie Tzu-Yueh Wang (Academia Sinica)

Title: *Asymptotic GCD and Quotient Problem of Entire Functions*

Abstract: Let a and b be multiplicatively independent positive integers. A fundamental question is to study the non-trivial upper bound for $\gcd(a-1, b-1)$ and the asymptotic behavior of the sequence $\gcd(a^n-1, b^n-1)$. It is also interesting to study the gcd problem for two entire analytic functions, i.e. giving upper bounds for the counting function of their common zeros. Indeed, a lot more can be done in the complex case than the

number field situation. In the first part of the talk, we will discuss gcd bounds in various settings. It covers a joint work with Hector Pasten where techniques from analytic number theory and Diophantine approximation in the context of entire and meromorphic functions were applied to study the problem. It also include a recent joint work with Ji Gou where an upper bound of the gcd of $f^n - 1$ and $g^n - 1$ for sufficient large n for multiplicatively independent entire functions f and g was established following the recent developments of formulating the second main theorem of the Nevanlinna theory for general divisors and an effort to establish a version the the second main theorem with truncated counting functions.

For the second part of the talk, we will discuss quotient problem of entire functions. The starting problem is to decide the finiteness of the set $\mathcal{N}$ of nature numbers such that their ratio $f^n - 1/g^n - 1$ is an entire function, where f and g are multiplicatively independent entire functions. I will report some results and developments including more general situation in this direction.

16:30-16:50, Wednesday, June 13

Speaker: Qiming Yan (Tongji University)

Title: *Second main theorems for holomorphic curves intersecting divisors in subgeneral position*

Abstract: In this talk, we refine the concept of subgeneral position by introducing the notion of the index of subgeneral position. With this new notion we give some second main theorem type results. This is the joint work with Qingchun Ji and Guangsheng Yu.

17:00-17:20, Wednesday, June 13

Speaker: Nikhil Savale (Universitzät zu Köln)

Title: *Embedding three dimensional CR manifolds of finite type*

Abstract: We prove that weakly pseudoconvex three dimensional CR manifolds of finite type are embeddable, generalizing known results of Christ and Lempert. Based on joint work with C.Y. Hsiao.

11:00-11:20, Thursday, June 14

Speaker: Siqi Fu (Rutgers University-Camden)

Title: *Spectral asymptotics of the $\bar{\partial}$-Neumann Laplacian*

Abstract: In this talk, we study spectral asymptotics of the $\bar{\partial}$-Neumann Laplacian. It has been shown that spectral behavior of the $\bar{\partial}$-Neumann Laplacian can be used to determine geometric properties such as pseudoconvexity in $\mathbf{C}^n$ and finite type conditions in $\mathbf{C}^2$. We shall review these results and discuss recent developments in this direction.

11:30-11:50, Thursday, June 14

Speaker: Taishun Liu (Huzhou University)

Title: *Some results on geometric function theory in SCV*

Abstract: We will introduce some results obtained by ourselves on geometric function theory in several complex variables. These results involve the growth, covering, distortion, decomposition theorems and the estimation of expansion coefficients for some subclasses of normalized biholomorphic mappings; Schwarz lemma and rigidity property at the boundary for holomorphic self-mappings and so on. In addition, some open problems will be introduced.

12:00-12:20, Thursday, June 14

Speaker: Chunhui Qiu (Xiamen University)

Title: *Comparison and Wu's theorems in Finsler geometry*

Abstract: In this paper, we first give several comparison theorems and their applications in Finsler geometry. Moreover, by Hessian comparison theorem of real Finsler metric, we generalize Wu's theorem on a strongly convex weakly Kahler Finsler manifold with a pole. From Further discussions, we give a definition of horizontal flag curvature of Kahler Finsler metric and then we can prove Wu's theorem directly. This work is joint with Jinling Li.

14:00-14:20, Thursday, June 14

Speaker: Xu Wang (Norwegian University of Science and Technology)

Title: *The Hard Lefschetz Condition on cohomology groups*

Abstract: This is a joint work with Adriano Tomassini. We discuss the Hard Lefschetz Condition on various cohomology groups and verify them for the Nakamura manifold of completely solvable type and the Kodaira-Thurston manifold. A general abstract

Demailly-Griffiths-Khler identity is also given.

14:30-14:50, Thursday, June 14

Speaker: Xianhui Meng (Tsinghua University)

Title: *Pseudoeffective line bundles over holomorphically convex manifolds*

Abstract: In this talk, we will present some results related to the analytic cohomology groups with multiplier ideal sheaves.

16:00-16:20, Thursday, June 14

Speaker: Wei Wang (Zhejiang University)

Title: *The Neumann problem for the k-Cauchy-Fueter complexes on $\mathbf{R}^4$ and the L^2 estimate*

Abstract: The k-Cauchy-Fueter operators are quaternionic counterparts of the Cauchy-Riemann operator in the theory of several complex variables. To develop the function theory of several quaternionic variables, we need to solve the non-homogeneous k-Cauchy-Fueter equations over a domain under the compatibility condition, which naturally leads to a Neumann problem. The method of solving the dbar-Neumann problem in the theory of several complex variables is applied to this Neumann problem. We introduce notions of k-plurisubharmonic functions and k-pseudoconvex domains, establish the L^2 estimate and solve the Neumann problem over k-pseudoconvex domains in $\mathbf{R}^4$. Namely, we get a vanishing theorem for the first cohomology group of the k-Cauchy-Fueter complex over k-pseudoconvex domains in $\mathbf{R}^4$.

16:30-16:50, Thursday, June 14

Speaker: Sui-Chung Ng (East China Normal University)

Title: *Extension of local holomorphic maps respecting homogeneous subspaces on rational homogeneous manifolds*

Abstract: In this talk, we will look at local biholomorphisms defining on a rational homogeneous space X that respect certain families of homogeneous subspaces of X. The guiding case is where the relevant homogeneous subspaces are rational curves. This is the so-called Cartan-Fubini extension problem and has been extensively studied by Hwang-Mok, etc. We will discuss how one can do the extension for more general cases. This is a joint-work with Jaehyun Hong.

SS 6. Computer Science

Organizer: Erich Kaltofen & Lihong Zhi

	June 11	June 12	June 13	June 14
Chair			***Michael Burr***	
9:00-9:45			**Feng Guo**	
9:45-10:30			**Ke Ye**	
10:30-11:00	**Tea Break**			
Chair			***Manfred Minimair***	
11:00-11:45			**Shaoshi Chen**	
11:45-12:30			**Ruyong Feng**	
12:30-14:00	**Lunch Break**			
Chair	***Erich Kaltofen***	***Ruyong Feng***	***Daniel Lichtblau***	***Zhengfeng Yang***
14:00-14:45	**Mark Giesbrecht**	**Chee Yap**	**Zhengfeng Yang** (14:00-14:30) **Zhihong Yang** (14:30-15:00) **Lihong Zhi** (15:00-15:30)	**Dongming Wang**
14:45-15:30	**Xiaoshan Gao**	**Michael Burr**		**Eric Schost**
15:30-16:00	**Tea Break**			
Chair	***Ke Ye***	***Shaoshi Chen***	***Xiaohong Jia***	***Lihong Zhi***
16:00-16:45	**Jeremy Johnson**	**Xiaohong Jia**	**Chenqi Mou**	**Manfred Minimair**
16:45-17:30	**Bican Xia**	**Daniel Lichtblau**	**Arne Storjohann**	**Erich Kaltofen**
	Reception		**Banquet** ***(by Invitation)***	

Venue: Room 108, Center for American Studies

SS 6. Computer Science

14:30-14:45, Monday, June 11

Speaker: Mark Giesbrecht (University of Waterloo)

Title: *An optimization approach to low-rank approximation and interesting Smith forms of matrix polynomials*

Abstract: We take an optimization approach to two related problems concerning matrix polynomials with floating-point coefficients. We first consider the problem of finding a nearby matrix polynomial of reduced, prescribed rank. We prove that such lower rank matrices at minimal distance always exist, satisfy regularity conditions, and are all isolated and surrounded by a basin of attraction of non-minimal solutions. We describe an iterative algorithm which, on given input produces a nearby matrix polynomial of prescribed rank. The algorithm is efficient and is proven to converge quadratically given a sufficiently good starting point. Second, we consider the problem of finding a nearby matrix polynomial with an "interesting" Smith form. The Smith form is a canonical diagonalization of a matrix polynomial which is unimodularly equivalent to the original matrix polynomial. We describe an effective optimization technique to find a nearby matrix polynomial with a non-trivial Smith form and then generalize this to the computation of a matrix polynomial having a maximum specified number of ones in the Smith Form (i.e., with a maximum specified McCoy rank). We discuss the geometry and existence of solutions and how our results can used for a backwards error analysis. We also develop an optimization-based approach to computing such Smith forms, and demonstrate an iterative numerical method for computing a nearby matrix polynomial with the desired spectral properties. This is joint work with Joseph Haraldson and George Labahn.

14:45-15:30, Monday, June 11

Speaker: Xiaoshan Gao (AMSS, Chinese Academy of Sciences)

Title: *Quantum algorithms for polynomial system solving and optimization over finite fields, and applications in cryptanalysis*

Abstract: In this talk, we present quantum algorithms for two fundamental computation problems: solving polynomial systems and optimization over finite fields. The quantum algorithms can solve these problems with any given probability and have complexities polynomial in the size of the input and the condition number of certain polynomial system related to the problem. So, we achieved exponential speedup for these problems when their condition numbers are small. We apply the quantum algorithm to the cryptanalysis of the stream cipher Trivum, the block cipher AES, the hash function

SHA-3/Keccak, the multivariate public key cryptosystems, lattice based cipher NTRU, and show that they are secure under quantum algebraic attack only if the condition numbers of the corresponding equation systems are large.

16:00-16:45, Monday, June 11

Speaker: Jeremy Johnson (Drexel University)

Title: *Verification of fast signal transform algorithms*

Abstract: In this talk we review the SPIRAL algorithm and code generation system and outline several ideas for defining and verifying the semantics of SPIRAL expressions. The SPIRAL (www.spiral.net) system generates state-of-the-art code for various digital signal processing algorithms on a variety of computing platforms and has been used by Intel for their IPP and MKL libraries. SPIRAL uses rewrite rules, at multiple levels, to transform mathematical expressions into code. At the highest level SPIRAL specifies a computation with a high-level mathematical description and then transforms the specification into mathematically equivalent expressions capturing different algorithm for performing the desired computation. Further mathematical transformations are performed to enhance parallelism and vectorization. Then the resulting mathematical expression is transformed into a lower level mathematical expression that allows various optimizations such as loop merging. Finally, the lower level expression is, in a fairly straightforward way, transformed into code which is then further optimized using code level transformations. The important point, is that at each level there is a well defined mathematical semantics and it is possible, using this semantics, to prove correctness of the rules at each level. Verification proofs are carried out formally using the Coq proof assistant. In this talk we outline and show examples of how this is done.

16:45-17:30, Monday, June 11

Speaker: Bican Xia (Peking University)

Title: *Nonlinear craig interpolant generation*

Abstract: Interpolation-based techniques have become popularized in recent years because of their inherently modular and local reasoning, which can scale up existing formal verification techniques like theorem proving, model-checking, abstraction interpretation, and so on, while the scalability is the bottleneck of these techniques. Craig interpolant generation plays a central role in interpolation-based techniques, and therefore has drawn increasing attentions. In the literature, there are various works done on how to automatically synthesize interpolants for decidable fragments of first-order

logic, linear arithmetic, array logic, equality logic with uninterpreted functions (EUF), etc., and their combinations. But Craig interpolant generation for non-linear theory and its combination with the aforementioned theories are still in infancy, although some attempts have been done. In this talk, it is first proven that a polynomial interpolant of the form h(x)>0 exists for two mutually contradictory polynomial formulas F(x,y) and G(x,z), which contain only non-strict polynomial inequalities in x,y or x,z, and the quadratic module generated by those polynomials is Archimedean. Then it is shown that such interpolant can be computed efficiently through solving a semi-definite programming problem (SDP). The results can be verified through symbolic computation to avoid the unsoundness caused by numerical error in SDP solving. Besides, we demonstrate how to apply our approach to invariant generation in program verification.

Speaker: Chee Yap (New York University)

Title: *Subdivision algorithm for isolating roots of real polynomial systems, with complexity analysis*

Abstract: We describe a new algorithm for isolating simple roots of a zero-dimensional real polynomial system. Our subdivision-based algorithm can be directly implementable using BigFloat arithmetic. The main predicate is the Moore-Kostelides (MK) test, which is based on the Miranda Theorem (1940). Although the MK test is well-known and developed as a root finding technique, it has never been previously developed into a complete algorithm. We also provide a complexity analysis of our algorithm in terms of geometric parameters.

Speaker: Michael Burr (Clemson University)

Title: *Interval arithmetic and subdivision in symbolic algebra*

Abstract: Subdivision methods take a region of interest, such as a subset of R^d, and recursively subdivide the region into subregions until some problem-specific test succeeds on each subregion. Interval arithmetic finds an over-approximation to the image of a function or a polynomial when evaluated over a region. In this talk, I will discuss interval arithmetic-based tests for subdivision schemes. In particular, I will discuss recent work that addresses both the correctness and complexity of algorithms based on these tests which address the symbolic algebra problem of accurately approximating embeddings of algebraic varieties.

Speaker: Xiaohong Jia (AMSS, Chinese Academy of Sciences)

Title: *Singularity computation of rational curves and surfaces by mu-bases*

Abstract: Mu-Bases are a new representation for rational curves and surfaces that connect their parametric forms and implicit forms. Mu-bases inherite all intrinsic geometric properties of rational curves and surfaces, and have many advantages in algebraic computations. Mu-bases are well known in fast implicitization, and we shall further show their power in expanding singularity trees of rational curves and surfaces.

Speaker: Daniel Lichtblau (Wolfram Research Institute)

Title: *Extracting exoplanet periods from light curves*

Abstract: The Kepler spacecraft mission has found a number of varying light curves that indicate possible presence of transiting exoplanets. It can be a challenge to separate the effects of the transit from noise, especially inn cases where there are more than one such planet. For example, a star known as Kepler-11 has a complicated light curve that has been analyzed and found to show transits of six such planets. This analysis was based on significant computational simulation. Using hybrid Symbolic-Numeric methods, in particular the irregular discrete Fourier transform and diophantine approximation, we show how to recover similar information. As we only analyze the light curve data and require no simulation, this is computationally cheaper than the methods currently in use.

Speaker: Feng Guo (Dalian University of Technology)

Title: *Extremal tests for critical points of polynomial optimization problems*

Abstract: In this talk, we first consider the problem of identifying the type (local minimizer, maximizer or saddle point) of a given isolated real critical point c, which is degenerate, of a multivariate polynomial function f. To this end, we introduce the definition of faithful radius of c by means of the curve of tangency of f. We show that the type of c can be determined by the local optima of f over the Euclidean ball centered at c with a faithful radius. Assuming that an isolation radius of c is known, we propose algorithms to compute a faithful radius of c and determine its type. Next, we extend this idea to constrained polynomial optimization problems. We present an algorithm to test the extremality of KKT points at which the second necessary optimality condition holds but the second sufficient optimality condition fails. This is joint work with Liguo Jiao, Do Sang Kim and Tien Son Pham.

Speaker: Ke Ye (AMSS, Chinese Academy of Sciences)

Title: *Tensor decomposition on algebraic varieties*

Abstract: Tensors are high dimensional generalizations of matrices which appear in many scenarios such as signal processing, machine learning and quantum computing. The idea of decomposing a tensor into the sum of simpler tensors is mainly employed to analyze data of a gigantic size. In this talk, we will discuss a framework for decomposing a symmetric tensor into the sum of tensors on a given algebraic variety. In particular, we will discuss how our algorithm could be used to solve a problem arising from signal processing: determining a Vandermonde decomposition of a tensor. We will present other theoretic results about decompositions of tensors on a variety and if time permits, we will also present more numerical examples.

Speaker: Shaoshi Chen (AMSS, Chinese Academy of Sciences)

Title: *Reduction-based algorithms for creative telescoping*

Abstract: Creative telescoping is the core of Zeilberger's method for computer-generated proofs of identities in combinatorics and special functions. Since the early 1990s, four classes of algorithms have been developed for creative telescoping. The fourth and most recent one is based on Hermite reduction and its variants. This idea was first worked out for bivariate rational functions in 2010. It has since been extended to more general classes of functions, such as hyperexponential functions, hypergeometric terms, algebraic functions and most recently D-finite functions. In this talk, we will explain the idea of this approach and a striking advantage over earlier algorithms.

Speaker: Ruyong Feng (AMSS, Chinese Academy of Sciences)

Title: *Direct problem in difference Galois theory*

Abstract: Difference Galois theory is a generalization of the ordinary Galois theory to linear difference equations. The direct problem asks how to compute the Galois group of a given linear difference equation, which is one of fundamental problems in this theory. In this talk, we shall present a method to compute the Galois groups of linear difference equations with rational function coefficients. We will also discuss a potential application of our method in combinatorics.

Speaker: Zhengfeng Yang (East China Normal University)

Title: *Darboux-type barrier certificates for safety verification of nonlinear hybrid systems*

Abstract: In this talk, we propose a set of verification conditions that helps to construct a new type of barrier certificate for non-linear hybrid system , namely, the Darboux-type barrier certificate made of Darboux polynomial. The proposed verification conditions provide powerful aids in nonlinear hybrid system verification as the Darboux-type barrier certificates can verify systems that may not be settled by existing verification conditions. Furthermore, we give a novel computational approach, combining the sampling-based relaxation method with least-squares and quadratic programming (LS-QP) alternating projection, to find Darboux-type barrier certificates. We demonstrate on the benchmark examples from the literature that our verification conditions can enhance the capability of barrier certificate based approaches through successfully verifying those systems that are difficult to be handled by existing verification conditions, and our algorithm is efficient.

Speaker: Zhihong Yang (AMSS, Chinese Academy of Sciences)

Title: *On the complexity of computing real radicals of polynomial systems*

Abstract: Let I be an ideal in a multivariate polynomial ring over the rational field. Assume that the complex variety of I is smooth, we prove that the real radical of I has a set of generators with degrees bounded by the degree of the complex variety of I. We give a probabilistic algorithm to compute generators of all minimal primes of the real radical of I. The complexity of this algorithm is singly exponential in the number of variables. For general cases, we use rational parametrizations to represent complex varieties and radical ideals. We give a probabilistic algorithm to compute rational parametrizations for all minimal primes of the real radical of I. The complexity of this algorithm is doubly exponential in the dimension of I, and if the dimension of I is fixed, then the complexity of this algorithm is singly exponential in the number of variables.

Speaker: Lihong Zhi (AMSS, Chinese Academy of Sciences)

Title: *Global optimization of polynomials over real algebraic sets*

Abstract: Let $f, g_1, \ldots, g_s$ be polynomials in $R[X_1, \ldots, X_n]$. Based on topological properties of generalized critical values, we give a method to compute the global infimum f^* of f over an arbitrary given real algebraic variety $V = \{x \in R^n \mid g_1(x) = 0, \ldots, g_s(x) = 0\}$, where V is not required to be compact or smooth. We also general-

ize this method to solve the problem of optimizing f over a basic closed semi-algebraic set $S = \{x \in R^n \mid g_1(x) \geq 0, \ldots, g_s(x) \geq 0\}$.

Speaker: Chenqi Mou (Beihang University)

Title: *Decomposition of polynomial sets into characteristic pairs*

Abstract: A characteristic pair is a pair (G, C) of polynomial sets in which G is a reduced lexicographic Groebner basis, C is the minimal triangular set contained in G, and C is normal. In this talk we show that any finite polynomial set P can be decomposed algorithmically into finitely many characteristic pairs with associated zero relations, which provide representations for the zero set of P in terms of those of Groebner bases and those of triangular sets. The algorithm we propose for the decomposition makes use of the inherent connection between Ritt characteristic sets and lexicographic Groebner bases and is based essentially on the structural properties and the computation of lexicographic Groebner bases. Several nice properties about the decomposition and the resulting characteristic pairs, in particular relationships between the Groebner basis and the triangular set in each pair, are established. This talk is based on the joint work with Dongming Wang and Rina Dong.

Speaker: Arne Storjohann (University of Waterloo)

Title: *Computing the Hermite form of an integer matrix*

Abstract: The set of all integer linear combinations of the rows of an integer matrix A comprise a lattice. The Hermite canonical form gives a triangular presentation for this lattice. In this talk I will survey some of the algorithms developed to compute the Hermite form, ranging from early elimination methods, to recent methods based on linear system solving.

Speaker: Dongming Wang (Beihang University, Guangxi University for Nationalities, CNRS)

Title: *Characteristic decomposition of polynomial sets*

Abstract: Let G be a reduced lexicographic Groebner basis. A polynomial g in G is said to be minimal if g has the lowest order among all those polynomials in G which have the same leading variable as g. The minimal polynomials in G form a triangular set, called the W-characteristic set of G or of the ideal generated by G. G is said to be

normal if for every minimal polynomial g in G, the initial of g does not involve the leading variable of any other polynomial in G. We show that

- there are inherent connections between Ritt characteristic sets and lexicographic Groebner bases,
- normal Groebner bases and their W-characteristic sets possess a number of interesting properties, and
- any polynomial set can be decomposed into finitely many normal Groebner bases with associated zero relations.

The decomposition algorithm is based on the structural properties we have established and the computation of lexicographic Groebner bases. We discuss briefly the implementation of our decomposition algorithm with some experiments. Part of the work presented in this talk was done jointly with Rina Dong and Chenqi Mou.

Speaker: Eric Schost (University of Waterloo)

Title: *Roadmaps for quadratic polynomials*

Abstract: It has been known since work of Barvinok in the 1990's that optimization problems defined by systems of quadratic equations can be solved in time polynomial in the number of variables and exponential in the number of constraints. In this work, we consider a related question: connectivity queries on algebraic sets defined by quadratic equations. Our results, while not as strong as those obtained for optimization problems, are significantly better than those obtained by means of generalist algorithms. Joint work with Mohab Safey El Din

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Speaker: Manfred Minimair (Seton Hall University South Orange)

Title: *Developing a social mathematical machine for computational network analysis*

Abstract: A social mathematical machine is a networked system integrating humans and software to cooperatively solve mathematical problems. The software system MathChat impelments an instance of a social mathematical machine for collaboratively carrying out mathematical computations by entering instructions in a command shell. The software design of the MathChat system tightly integrates chat with command entry to support user communication and coordination. A theoretical model for the MathChat system is proposed. The theoretical model is based on the psychological theory of Distributed Cognition and the formalism of Message Passing in distributed

computation, which allows formalizing the knowledge acquired by the system through repeated computations. In addition to elaborating on the software design and theoretical model, an application of the MathChat system to computational network analysis at Seton Hall University will be described.

Speaker: Erich Kaltofen (North Carolina State University)

Title: *Proof-of-work certificates for high complexity mathematical computations*

Abstract: Computations done by high-power cloud servers such as a Google data center can yield outputs that are easy to verify, such as the factors of an integer, but outputs can also be non-trivial to certify quickly, such as the determinant of a high-dimensional sparse matrix or the summation of a very large number of consecutive prime numbers.

Interactive proof protocols speed the complexity of the output verification by interaction between the high-power prover and the verifier, in fact, a polynomial-time verifier can certify all computational problems of PSPACE. The interaction can be removed to yield a proof-of-work certificate whose correctness is based on cryptographic assumptions on what the prover cannot do. I will give a selection of certificates, among them Freivalds's [1979] classical matrix multiplication verification algorithm, our 2016 sparse matrix determinant proof-of-work protocol, and a version of the Goldwasser-Kalai-Rothblum [2008] protocol for summation of exponentially many terms for which log-depth circuit complexity is open, such as the well-known polynomial-time primality tests.

SS 7. Cybernetics

Organizers: Alberto Bressan & Xu Zhang

	June 11	June 12	June 13	June 14
9:00-10:30				
10:30-11:00	**Tea Break**			
Chair				
11:00-11:30				**Jiongmin Yong**
11:30-12:00				**Can Zhang**
12:00-12:30				**Qiong Zhang**
12:30-14:00	**Lunch Break**			
Chair				
14:00-15:30	**Bingyu Zhang**		**Matthias Kawski**	**Zhiqiang Wang**
15:30-16:00	**Lijuan Wang**		**Hongwei Lou**	**Yashan Xu**
Chair	**Xiaoyu Fu**		**Qi Lv**	
16:00-16:30	**Tea Break**			
16:30-17:00				
17:00-17:30	**Shaolin Ji**		**Peipei Shang**	**Qianqian Xia**
11:00-11:30	**Ping Lin**		**Yufeng Shi**	**William McEneaney**
11:30-12:00	**Zhuangyi Liu**		**Ming Wang**	
	Reception		**Banquet** *(by Invitation)*	

Venue: June 11th, Room 205; June 13th Room 304, West Side Building, Guanghua Building. June 14th, Polyvalent Hall, Level 13, Guanghua Building.

SS 7. Cybernetics

14:00-14:30, Monday, June 11

Speaker: Bingyu Zhang (University of Cincinnati)

Title: *Non-homogeneous boundary value problems of the nonlinear Schrödinger Equation*

Abstract: In this talk, we will discuss recent progresses in studying non-homogeenous boundary value problems of the nonlinear Schr ödinger equations.

14:30-15:00, Monday, June 11

Speaker: Lijuan Wang (Wuhan University)

Title: *Minimal time control of exact synchronization for parabolic systems*

Abstract: This work studies a kind of minimal time control problems related to the exact synchronization for a controlled linear system of parabolic equations.Each problem depends on two parameters: the bound of controls and the initial state.The purpose of such a problem is to find a control (from a constraint set) synchronizing components of the corresponding solution vector for the controlled system in the shortest time. In this work, we build up a necessary and sufficient condition for the optimal time and the optimal control; we also obtain how the existence of optimal controls depends on the above mentioned two parameters. (This is a joint work with Dr. Qishu Yan.)

15:00-15:30, Monday, June 11

Speaker: Xiaoyu Fu (Sichuan University)

Title: *Stabilization of the weakly coupled wave-types system with one internal damping*

Abstract: This talk is addressed to a stabilization problem of a system coupled by a wave and a Euler-Bernoulli plate equation. Under some assumption about the damping and the coupling terms, it is shown that sufficiently smooth solutions of the system decay logarithmically at infinity without any geometric conditions on the effective damping domain. (Jointly work with Qi Lü).

16:00-16:30, Monday, June 11

Speaker: Shaolin Ji (Shandong University)

Title: *The existence and uniqueness of viscosity solutions to generalized Hamilton-Jacobi-Bellman equations*

Abstract: In this work, we study the existence and uniqueness of viscosity solutions to generalized Hamilton-Jacobi-Bellman (HJB) equations combined with algebra equations. This generalized HJB equation is related to a stochastic optimal control problem for which the state equation is described by a fully coupled forward-backward stochastic differential equation (FBSDE). By extending Peng's backward semigroup approach to this problem, we obtain the dynamic programming principle (DPP) and show that the value function is a viscosity solution to this generalized HJB equation. As for the proof of the uniqueness of viscosity solution, the analysis method by Barles, Buckdahn and Pardoux does not work for this fully coupled case. With the help of the uniqueness of the solution to FBSDEs, we propose a novel probabilistic approach to study the uniqueness of the solution to this generalized HJB equation. We obtain that the value function is the minimum viscosity solution to this generalized HJB equation. Especially, when the coefficients are independent of the control variable or the solution is smooth, the value function is the unique viscosity solution.

16:30-17:00, Monday, June 11

Speaker: Ping Lin (Northeast Normal University)

Title: *Global blowup controllability of heat equation with feedback control*

Abstract: This paper concerns a global controllability problem for heat equations. In the absence of control, the solution to the linear heat system globally exists. While for each initial data, we can find a feedback control acting on an internal subset of the space domain such that the corresponding solution to the system blows up at given time.

17:00-17:30, Monday, June 11

Speaker: Zhuangyi Liu (University of Minnesota-Duluth)

Title: *Stability of thermoelastic systems with Inertial terms*

Abstract: We investigate coupled systems of thermoelastic type in a general abstract form both modeling Fourier and Cattaneo type heat conduction. In particular we take into account a possible inertial term. A complete picture of the regions of exponential stability resp. non-exponential stability for the arising parameters (two arising from the type of thermoelastic system, one arising from the inertial term) is given. The regions of loss of exponential stability, while moving from the Fourier to the Cattaneo law, are

thus clearly recognized and interestingly large. The polynomial stability in regions of non-exponential stability is also characterized.

14:00-14:30, Wednesday, June 13

Speaker: Matthias Kawski (Arizona State university)

Title: *Highly oscillatory controls, path planning and subRiemannian geometry*

Abstract: For nonholonomic control systems the length of the iterated Lie bracketsthat yield accessibility coincides with the growth rate of the geodesic balls, and the complexity of highly oscillatory controls needed to arbitrarily closely track desired paths. A common approach is to iteratively generate and concatenate motions in the direction of higher order Lie brackets. For planar systems without drift, wepresent simple explicit formulas for sinusoidal controls that generate, up to a certain order, such pure motions by annihilating all iterated integral functionals (IIF) of lower order. While these controls do not form dual bases, their actions are triangular on bases of Hall bases of IIF. The frequencies we use are of far lower order than those presented in recent literature.

14:30-15:00, Wednesday, June 13

Speaker: Hongwei Lou (Fudan University)

Title: *Turnpike properties of optimal relaxed control problems*

Abstract: In this talk, three kinds of turnpike properties for optimal relaxed control problems are considered. Under some convexity and controllability assumptions, we obtain the uniform boundedness of the optimal pairs and the adjoint functions. On the basis, we prove the integral turnpike property, the mean square turnpike property and the exponential turnpike property, respectively. (Jointly with Weihan Wang)

15:00-15:30, Wednesday, June 13

Speaker: Qi Lü (Sichuan University)

Title: *Finite dimensional approximate controllability for linear stochastic control systems*

Abstract: We consider controllability problems of linear stochastic control systems with controls acting only on the drift terms. It is well known that such system is not exactly controllable. We first show that it is not approximately controllable under

some natural condition in general by an example. Next we introduce the notion of finite dimensional approximate controllability and reveal that it is equivalent to some weak unique continuation property of backward stochastic evolution equations. Then we prove that unique continuation property holds. Finally, two examples concerning controlled stochastic parabolic and stochastic Schrödinger equations are presented.

16:00-16:30, Wednesday, June 13

Speaker: Peipei Shang (Tongji University)

Title: *Exponential boundary feedback stabilization of a shock steady state for the inviscid Burgers equation*

Abstract: In this work, we study the exponential stabilization of a shock steady state for the inviscid Burgers equation on a bounded interval. Our analysis relies on the construction of an explicit strict control Lyapunov function. We prove that by appropriately choosing the feedback boundary conditions, we can stabilize the state as well as the shock location to the desired steady state in H2-norm, with an arbitrary decay rate.

16:30-17:00, Wednesday, June 13

Speaker: Yufeng Shi (Shandong University)

Title: *BSDEs with linear growth in z*

Abstract: In the theory of BSDEs, in order to get the existence and uniqueness of solutions to BSDEs, one usually supposes that the generator g is Lipschitz with respect to y and z or other similar hypothetical conditions. That is the variable z satisfies the similar assumptions as the variable y. However, from the process of solving BSDEs, we know that the variable z is determined by y and obtained by the martingale representation theorem. This implies that the assumptions on the variable z can be weakened. In this paper, under the following conditions:
(1) the generator g is uniformly continuous with respect to y;
(2) g is linear continuous and linear growth with respect to z, we show that the corresponding BSDEs also has a unique solution.

17:00-17:30, Wednesday, June 13

Speaker: Ming Wang (Huazhong University of Science and Technology)

Title: *Observability and unique continuation inequality for Schrödinger equations*

Abstract: In this talk, we present several observability and unique continuation inequalities for the free Schrödinger equation in the whole space. The observations in these inequalities are made either at two points in time or one point in time. These inequalities correspond to different kinds of controllability for the free Schrödinger equation. We also show that the observability inequality at two points in time is equivalent to the uncertainty principle.

11:00-11:30, Thursday, June 14

Speaker: Jiongmin Yong (University of Central Florida)

Title: *Optimization of the principal eigenvalue for elliptic operators*

Abstract: Optimization problems of the principle eigenvalue for elliptic operators of divergence form are considered. The eigen map of elliptic operator is introduced and the continuity as well as the differentiability of such a map is established. For maximization problem, the admissible control set is convexified to get the existence of optimal solutions. Whereas, for minimization problem, the relaxation of the problem under H-convergence is used to get a relaxed optimal solution. Some necessary conditions are presented for both problems and illustrative examples are presented as well. (joint with Hongwei Lou)

11:30-12:00, Thursday, June 14

Speaker: Can Zhang (Wuhan University)

Title: *Optimal control problems in large time*

Abstract: In this talk, we will introduce periodic and exponential turnpike properties for optimal control problems in large time. The approach to analyze these turnpike theorems is from the viewpoint of Pontryagin maximum principle as well as the saddle point theory of Hamiltonian system.

12:00-12:30, Thursday, June 14

Speaker: Qiong Zhang (Beijing Institute of Technology)

Title: *Stability of the Timoshenko beam equation with Kelvin-Voigt damping*

Abstract: We consider the Timoshenko beam equation with locally distributed Kelvin-

Voigt damping, i.e., the damping is e ective only in a part of the spatial domain for both shear stress and bending moment. We prove eventual di erentiability, exponential and polynomial stability of the associated semigroup under some smoothness condition on the damping coefficient functions, particularly, at the interface of the damped and undamped region.

14:00-14:30, Thursday, June 14

Speaker: Zhiqiang Wang (Fudan University)

Title: *To be announced.*

Abstract: To be announced.

15:00-15:30, Thursday, June 14

Speaker: Yashan Xu (Fudan University)

Title: *Saddle points of obstacles for an elliptic variational inequality*

Abstract: In this talk, we consider a two-person zero-sum game problem for an elliptic variational inequality in which the obstacle is the sum of two strategies taken by two different players. A nonlinear equation involving the obstacle operator is introduced to equivalently describe the solution to the corresponding elliptic variational inequality. Using these nonlinear equations, a necessary condition of the optimal solutions, namely, the saddle points of the game problem, is established. We find that, whenever the optimal solution exists, it can be solved explicitly by such necessary condition.

16:00-16:30, Thursday, June 14

Speaker: Qianqian Xia (Nanjing University of Information Science and Technology)

Title: *Quotients of affine connection control systems*

Abstract: We investigate the existence of a subclass of quotients of affine connection control systems, which preserve the mechanical structure. Both local and global sufficient and necessary conditions are given for the geodesically accessible affine connection control systems such that they can admit this subclass of quotients. The structural properties of the quotient map and the quotient mechanical control system are discussed.

16:30-17:00, Thursday, June 14

Speaker: William McEneaney (UC San Diego)

Title: *To be announced*

Abstract: To be announced.

SS 8. Geometric Models and Methods in Quantum Gravity

Organizers: Peng Wang & P. P. Yu

	June 11	June 12	June 13	June 14
Chair				
9:00-9:45			**Gang Li**	
10:00-10:20			**Yuezhou Li**	
10:30-11:00	**Tea Break**			
Chair				
11:00-11:45		**Julie Rowlett**		
12:00-12:20		**Houwen Wu**		
12:30-14:00	**Lunch Break**			
Chair				
14:00-14:45	**Ling-Yan Hung**	**Yeuk-Kwan Edna Cheung**		
15:00-15:20	**P. P. Yu**	**Junbao Wu**		
15:30-16:00	**Tea Break**			
Chair				
16:00-16:45	**Wei Li**	**Peng Wang**		
17:00-17:20	**P. P. Yu**	**Junbao Wu**		
	Reception		**Banquet** *(by Invitation)*	

Venue: Room 414, East Side Building, Guanghua Building

SS 8. Geometric Models and Methods in Quantum Gravity

14:00-14:45, Monday, June 11

Speaker: Lingyan Hung (Fudan University)

Title: *Tensor network and p-adic AdS/CFT revisited*

Abstract: We will discuss the construction of a tensor network that recovers correlation function of a p-adic CFT and how features of the AdS/CFT dictionary is recovered. We demonstrate how this can be generalized to higher genus surfaces and discuss the connection of these tensor networks with a p-adic version of CS theory and the corresponding expectation values for networks of Wilson lines.

15:00-15:20, Monday, June 11

Speaker: P. P. Yu (Westminster College)

Title: *The heat kernel method in quantum gravity I*

Abstract: The asymptotic expansion for the heat kernel has played a prominent role in various areas of quantum physics. The moderate goal of this semi-expository talk is to illustrate the intimate connections between the short-distance expansion of the heat kernel and quantum corrections to black hole entropy.

16:00-16:45, Monday, June 11

Speaker: Wei Li (Institute of Theoretical Physics, Chinese Academy of Sciences)

Title: *W symmetry, affine Yangian, and plane partition*

Abstract: W algebra underlies the AdS3/CFT2 correspondence with higher spin symmetry and is also part of the hidden symmetry of string theory. The talk has two parts. First, I will explain a useful triangle connecting the three objects in the title. I will explain (1) How affine Yangian and W symmetry are related. (2) Plane partitions furnish a natural class of representations for affine Yangians. (3) Plane partition provides a useful new way to study representation of W algebra. (Time permitted, I will illustrate the last point with one or two examples motivated by higher spin gravity and string theory.)

In the second part, I will explain how to use this triangle as a building block to construct new VOA and affine Yangians. As an example, I will construct the $N = 2$ version of this triangle, which gives rise to a new type of affine Yangian and its twin-plane partition representations.

17:00-17:20, Monday, June 11

Speaker: P. P. Yu (Westminster College)

Title: *The heat kernel method in quantum gravity II*

Abstract: Following the heat kernel approach to the Index Theorem, the second part of the talk highlights some recent advances in the study of anomalies. Examples arising from certain condensed matter systems as well as interesting cosmological models are discussed.

11:00-11:45, Tuesday, June 12

Speaker: Julie Rowlett (Chalmers University & University of Gothenburg)

Title: *The zeta regularized determinant and its variation in singular geometric settings*

Abstract: Polyakov's formula expresses a difference of zeta-regularized determinants of Laplace operators, an anomaly of global quantities, in terms of simple local quantities. Such a formula is well known in the case of closed surfaces (Osgood, Philips, and Sarnak 1988) and surfaces with smooth boundary (Alvarez 1983). Due to the abstract nature of the definition of the zera-regularized determinant of the Laplacian, it is typically impossible to compute an explicit formula. Nonetheless, Kokotov (genus one Kokotov and Klochko 2007, arbitrary genus Kokotov 2013) demonstrated such a formula for polyhedral surfaces! I will discuss joint work with Clara Aldana and work-in-progress with Clara Aldana and Klaus Kirsten concerning the zeta regularized determinant of the Laplacian on Euclidean domains with corners. We determine a Polyakov formula which expresses the dependence of the determinant on the opening angle at a corner. Our ultimate goal is to determine an explicit formula, in the spirit of Kokotov's results, for the determinant on polygonal domains, and the results which shall be presented here are the crucial first steps towards such a formula.

12:00-12:20, Tuesday, June 12

Speaker: Houwen Wu (Sichuan University)

Title: *AdS3 metric from UV/IR entanglement entropies of CFT2*

Abstract: How to construct the $d+1$ dimensional geometry explicitly from the dual CFTd is a widely concerned problem. Specifically, given entanglement entropies of a CFT2, which is purely expressed by two dimensional parameters, can we build the dual three dimensional geometry unambiguously? To do this, one must assume nothing is known about the three dimensional geometry and starts with the most general set-

up. In this paper, by identifying the UV and IR entanglement entropies of a perturbed usual CFT2 with the geodesic lengths, we show that, the dual geometry is uniquely determined to be asymptotic AdS3. The hidden dimension is generated by the energy cut-off of the CFT2, according to the holographic principle. The pure AdS3 is obtained by taking the massless limit. Our derivations apply to both static and covariant scenarios. Moreover, what deserves special attention is that the ratio of the numberical factors of the UV/IR entanglement entropies are crucial to have a dual geometry. We are led to conjecture a necessary condition of holographic CFT2.

14:00-14:45, Tuesday, June 12

Speaker: Yeuk-Kwan Edna Cheung (Nanjing University)

Title: *Some mathematical elements arisen in scattering amplitudes computation*

Abstract: I will discuss some mathematical notions, namely bipartite diagrams, Grassmannian geometry, top-forms, sygzygy, and their connections as recently arisen in $N = 4$ Supe-symmetric Yang Mills and String Theory amplitudes computations.

15:00-15:20, Tuesday, June 12

Speaker: Junbao Wu (Tianjin University)

Title: *Sueprsymmetric Wilson loops and their gravity duals I*

Abstract: This is the first part of an invited review talk. In this part we will first focus on the Wilson loops in four dimensional $N = 4$ super Yang-Mills theory. Classification and gravity dual will be discussed. The relation of Wilson loops and amplitudes will also be mentioned. If time permit, I will also review related work in higher dimensional super Yang-Mills theories.

16:00-16:45, Tuesday, June 12

Speaker: Peng Wang (Sichuan University)

Title: *Holographic DC Conductivity and magneto-resistance for Nonlinear Electrodynamics*

Abstract: Via the holographic duality, we calculate the holographic DC conductivity and magneto-resistance of the conserved current dual to a nonlinear electrodynamics field in the boundary theory. We then discuss their properties in several nonlinear

electrodynamics models.

17:00-17:20, Tuesday, June 12

Speaker: Junbao Wu (Tianjin University)

Title: *Sueprsymmetric Wilson loops and their gravity duals II*

Abstract: In the second part of an invited review talk, I will first review relation between Wilson loops in pure Chern-Simons theory and its dual description in terms of closed topological string theory. Then I will move to BPS Wilson loops in Chern-Simons-matter theories and their holographic duals.

09:00- 09:45, Wednesday, June 13

Speaker: Gang Li (Shandong University)

Title: *On rigidity of conformally compact Einstein manifolds*

Abstract: Let (X^{n+1}, g_+) be a conformally compact Einstein (CCE) manifold with its conformal infinity $(M, [\hat{g}])$. By the classical volume comparison theorem, for the geodesic spheres centered at a fixed point the volume growth has an upper bound as the radius goes to infinity. In this talk I will show that when the Yamabe constant $Y(M, [\hat{g}])$ is positive, the lower bound of the volume growth is controlled by $Y(M, [\hat{g}])$. As an application, we give a proof of the rigidity of the hyperbolic space in general dimension. It also leads to curvature estimates of the CCE metric. In particular, the CCE metric g_+ is negatively curved when $Y(M, [\hat{g}])$ is large enough. At the end of the talk, I will mention some uniqueness result of the conformally compact Einstein metrics for given homogeneous conformal infinity data.

10:00-10:20, Wednesday, June 13

Speaker: Yuezhou Li (Tianjin University)

Title: *Exact embeddings of JT gravity in strings and M-theory*

Abstract: Exact embeddings of JT gravity in strings and M-theory Abstract: We discuss Sachdev-Ye-Kitaev (SYK) model and its holographic dual, the two-dimensional Jackiw-Teitelboim (JT) gravity. We show that JT gravity can be obtained from the consistent Kaluza-Klein reduction of a class of Einstein-Maxwell-dilaton (EMD) theories in general D dimensions. For $D = 4, 5$, the EMD theories can be themselves embedded

in suergravities. These exact embeddings provide holographic duals of the SYK model in the framework of strings and M-theory. A class of JT gravity solutions can be lifted to become time-dependent charged extremal black holes. They can be further lifted, for example, to describe the D1/D5-branes where the worldsheet is the Milne universe, rather than the typical Minkowski spacetime.

SS 9. Geometric Representation Theory and the Langlands Program

Organizers: Dihua Jiang, Yiqiang Li, Peng Shan & Binyong Sun

	June 11	June 12	June 13	June 14
Chair				
9:00-9:45			**Zhiyuan Li**	
9:45-10:30			**Syu Kato**	
10:30-11:00	**Tea Break**			
Chair				
11:00-11:45		**Yu Qiu**	**Michael McBreen**	
11:45-12:30		**Dongwen Liu**	**Toshiaki Shoji**	
12:30-14:00	**Lunch Break**			
Chair				
14:00-14:45	**Jayce Getz**	**Bin Xu**	**Fan Qin**	
14:45-15:30	**Jiajun Ma**	**Ryo Fujita**	**Cheng-Chiang Tsai**	
15:30-16:00	**Tea Break**			
Chair				
16:00-16:45	**Jun Yu**	**Zhaobing Fan**	**Myungho Kim**	
16:45-17:30	**Kyu-Hwan Lee**	**Xuhua He**		
	Reception		**Banquet** *(by Invitation)*	

Venue: Room 2901, East Main Building, Guanghua Building

SS 9. Geometric Representation Theory and the Langlands Program

14:00-14:45, Monday, June 11

Speaker: Jayce R. Getz (Duke University)

Title: *A Summation formula for triples of quadratic spaces*

Abstract: Braverman and Kazhdan have conjectured the existence of summation formulae that are essentially equivalent to the analytic continuation and functional equation of Langlands L-functions in great generality. Motivated by their conjectures and related conjectures of L. Lafforgue, Ngo, and Sakellaridis, Baiying Liu and I have proven a summation formula analogous to the Poisson summation formula for the subscheme cut out of three quadratic spaces (V_i, Q_i) of even dimension by the equation

$$Q_1(v_1) = Q_2(v_2) = Q_3(v_3).$$

I will sketch the proof of this formula.

14:45-15:30, Monday, June 11

Speaker: Jiajun Ma (Shanghai Jiao Tong University)

Title: *On unipotent representations of real classical groups*

Abstract: In this talk, I will present a recent work with Binyong Sun and Chengbo Zhu on unipotent representations of real classical groups (real symplectic groups, real orthogonal groups, quaternionic orthogonal groups or quaternionic symplectic groups). Unipotent representations are certain irreducible admissible representations characterized by their associated varieties and infinitesimal character. They consist the unipotent L-packet in Langlands' philosophy and they are related to the quantization of nilpotent orbits. In Barbasch and Vogan established the theory of special unipotent representations for complex classical groups and unitary groups. They also made conjectures for the general case, including a conjecture that unipotent representations attached to special nilpotent orbits should be unitarizable. In 90's, thanks to many peoples work, it become clear that iterated theta lifting could be an effective way to construct unipotent representations of real classical groups. In our work, we solved the unitarity problem for rigid special unipotent oribts utilizing algebraic and analytical properties of theta lifts. Along the proof we also established some other properties of these representations.

16:00-16:45, Monday, June 11

Speaker: Jun Yu (Peking University)

Title: *On the dimension datum of a subgroup*

Abstract: We discuss the study of dimension datum and a generalization called tau-dimension datum.

16:45-17:30, Monday, June 11

Speaker: Kyu-Hwan Lee (University of Connecticut)

Title: *A correspondence between rigid modules over path algebras and simple curves on Riemann surfaces*

Abstract: In this talk, we will propose a conjectural correspondence between the set of rigid indecomposable modules over the path algebras of acyclic quivers and the set of certain non-self-intersecting curves on Riemann surfaces, and explain the known cases.

11:00-11:45, Tuesday, June 12

Speaker: Yu Qiu (The Chinese University of Hong Kong)

Title: *X-stability conditions on Calabi-Yau-X categories*

Abstract: We introduce X-stability conditions, consisting of a Bridgeland stability condition and a complex number s, on Calabi-Yau-X categories of quivers with superpotentials. We show that certain X-stability conditions (q-stability conditions) forms a complex manifold of dimension $n+1$ and its fibers (fixing s) provide usual spaces of stability conditions of dimension n.

11:45-12:30, Tuesday, June 12

Speaker: Dongwen Liu (Zhejiang University)

Title: *On the local descent of real unitary groups*

Abstract: Assuming the local Gan-Gross-Prasad conjecture, we explain the local desecent of representations of real unitary groups with generic L-parameters. This talk is based on a work in progress joint with Dihua Jiang and Lei Zhang.

14:00-14:45, Tuesday, June 12

Speaker: Bin Xu (Tsinghua University)

Title: *Arthur packet and microlocal geometry*

Abstract: The irreducible admissible representations of Arthur class are the local components of automorphic representations. They are conjectured to be parametrized by the Arthur parameters, which can be included as a subset of the usual Langlands parameters. The set of irreducible representations associated with a single Arthur parameter is called an Arthur packet. On the other hand, Adam-Barbasch-Vogan (1992) (in real case) and Vogan (1993) (in the p-adic case) defined a set of irreducible admissible representations for each Langlands parameter through the microlocal geometry on certain parametrizing space of Langlands parameters, which can be called microlocal packet. Moreover, they suggested for an Arthur parameter, the microlocal packet is the Arthur packet. In this talk, I would like to sketch a proof of this statement for unipotent representations of p-adic general linear groups and special odd orthogonal groups. This is joint work with Clifton Cunningham, Andrew Fiori, Ahmed Moussaoui and James Mracek.

14:45-15:30, Tuesday, June 12

Speaker: Ryo Fujita (Kyoto University)

Title: *Geometric realization of Dynkin quiver type quantum affine Schur-Weyl duality*

Abstract: Attached to a Dynkin quiver Q (of type ADE), Kang-Kashiwara-Kim defined a functor connecting the module categories of the quiver Hecke (=KLR) algebra and that of the quantum affine algebra of the corresponding type, as a generalized version of the quantum affine Schur-Weyl duality. Their construction is algebraic and for its well-definedness one needs to assume a conjecture on the simpleness of some poles of normalized R-matrices, which they verified for type AD. In this talk, we present a geometric realization of Kang-Kashiwara-Kim's functor via the equivariant K-theory, imitating Ginzburg-Reshetikhin-Vasserot's geometric realization of the usual quantum affine Schur-Weyl duality. Our construction is based on Hernandez-Leclerc's isomorphism between a certain graded quiver variety and the space of representations of the quiver Q. As a by-product, we give a uniform proof of Kang-Kashiwara-Kim's conjecture for any quiver Q of type ADE. Moreover, we can also prove that the functor is fully faithful.

16:00-16:45, Tuesday, June 12

Speaker: Zhaobing Fan (Harbin Engineering University)

Title: *Equivariant K-theory and quantum symmetric pairs*

Abstract: We provide a geometric approach to quantum coideal algebra of $U_q(sl_n)$ via equivariant K-theory. This is a preliminary results joint with H. Ma and H. Xiao.

16:45-17:30, Tuesday, June 12

Speaker: Xuhua He (University of Maryland)

Title: *Cocenters and representations of reductive p-adic groups*

Abstract: It is known that the number of conjugacy classes of a finite group equals the number of irreducible representations (over complex numbers). The conjugacy classes of a finite group give a natural basis of the cocenter of its group algebra. Thus the above equality can be reformulated as a duality between the cocenter (i.e. the group algebra modulo its commutator) and the finite dimensional representations.

Now let us move from the finite groups to the p-adic groups. In this case, one needs to replace the group algebra by the Hecke algebra. The problem is that the conjugacy classes are "mixed" together, which makes the cocenter (as well as representations) of p-adic groups more difficult to understand. The question is "can you hear every note from a musical chord?" Or in our situation, "can you separate the cocenter into nice subspaces?"

In this talk, I will explain the Newton decomposition of the cocenter and then some applications to the complex and modular representations of p-adic groups, including: a generalization of Howe's conjecture on twisted invariant distributions, trace Paley-Wiener theorem for smooth admissible representations, and the abstract Selberg Principle for projective representations. I will also talk about some connection to the orbital integrals.

9:00-9:45, Wednesday, June 13

Speaker: Zhiyuan Li (Shanghai Center for Mathematical Science)

Title: *Theta correspondence and its application in moduli theory*

Abstract: In this talk, I will talk about how to relate Howe's theta correspondence to the study of moduli space of certain algebraic varieties. I will explain how to use Arthur's theory to solve a series of problems in moduli space of hyperkahler varieties. This includes Noether-Lefshcetz conjecture, Tautological conjecture and generalized

Franchetta conjecture. Those moduli spaces occur as Shimura variety of orthogonal type. If time is allowed, I will also mention some further applications in the case of unitary type.

9:45-10:30, Wednesday, June 13

Speaker: Syu Kato (Kyoto University)

Title: *Semi-infinite flag manifolds and non-symmetric Macdonald/Whittaker functions*

Abstract: We explain some ways to see (or not to see) semi-infinite flag manifolds, and how to make sense of its equivariant K-theory. Then, we exhibit that natural quasi-coherent sheaves on it represent non-symmetric Macdonald polynomials specialized to infinity and non-symmetric Whittaker functions. Our formulation naturally incorporates difference equations characterizing them, that can be seen as a semi-infinite analogue of the Demazure character formula.

If time and situation permits, I will explain more recent progress on this topic. Part of this talk is based on joint works with E.Feigin, Makedonskyi, Naito, and Sagaki.

11:00-11:45, Wednesday, June 13

Speaker: Michael McBreen (University of Toronto)

Title: *Homological mirror symmetry for hypertoric varieties I: conic equivariant sheaves*

Abstract: We consider homological mirror symmetry in the context of hypertoric varieties, showing that appropriate categories of B-branes (that is, coherent sheaves) on an additive hypertoric variety match a category of A-branes on a Dolbeault hypertoric manifold for the same underlying combinatorial data. For technical reasons, the category of A-branes we consider is the modules over a deformation quantization (that is, DQ-modules). We consider objects in this category equipped with an analogue of a Hodge structure, which corresponds to a $\mathbb{G}_m$-action on the dual side of the mirror symmetry.

This result is based on hands-on calculations in both categories. We analyze coherent sheaves by constructing a tilting generator, using the characteristic p approach of Kaledin; the result is a sum of line bundles, which can be described using a simple combinatorial rule. The endomorphism algebra H of this tilting generator has a simple quadratic presentation in the grading induced by $\mathbb{G}_m$-equivariance. In fact, we can confirm it is Koszul, and compute its Koszul dual $H^!$.

We then show that this same algebra appears as an Ext-algebra of simple A-branes in a Dolbeault hypertoric manifold. The $\mathbb{G}_m$-equivariant grading on coherent sheaves

matches a Hodge grading in this category.

11:45-12:30, Wednesday, June 13

Speaker: Toshiaki Shoji (Tongji University)

Title: *Springer correspondence for symmetric spaces associated to orthogonal groups*

Abstract: The Springer correspondence gives a natural relationship between unipotent classes of a reductive group G and irreducible representations of its Weyl group. If G is a general linear group $GL(V)$, this gives a bijective correspondence, but in general not. Generalizing the Springer correspondence, Lusztig established the theory of generalized Springer correspondence, which gives a natural bijective correspondence between certain sets associated to unipotent classes and irreducible representations of various Weyl groups.

We consider a symmetric space G/K, where $G = GL(V)$ and $K = SO(V)$, over an algebraically closed field of characteristic p. The set of K-orbits in the "unipotent part" of G/K can be regarded as an analogue of unipotent classes of reductive groups. In the case where p is odd, the number of K-orbits is finite. In this talk, we show that the generalized Springer correspondence holds for G/K whenever p is odd. We also consider the case where $p = 2$, in which case the number of K-orbits is infinite. Even so, some analogue of the Springer correspondence holds for G/K. We note, in this case, that a similar phenomenon occurs as the case of exotic symmetric spaces of higher level associated to symplectic groups.

14:00-14:45, Wednesday, June 13

Speaker: Fan Qin (Shanghai Jiao Tong University)

Title: *Cluster algebras and bases*

Abstract: In this talk, we give a review of cluster algebras. We present and compare different bases of cluster algebras: the triangular bases (dual canonical bases) and generic bases (dual semicanonical bases) arising from representation theory and categorification, and the theta bases arising from the scattering diagrams in the study of mirror symmetry. All these bases are parametrized by the tropical points of the Langlands dual cluster varieties.

14:45-15:30, Wednesday, June 13

Speaker: Cheng-Chiang Tsai (Stanford University)

Title: *An aspect of affine Springer theory*

Abstract: One way to think of (classical and generalized) Springer theory from the theory of representations of finite groups of Lie type is that Springer theory provides a framework to understand characters. In this talk, we discuss a construction with which one writes the local character of an irreducible admissible representation of reductive p-adic group in terms of Springer-theoretic data.

16:00-16:45, Wednesday, June 13

Speaker: Myungho Kim (Kyung Hee University)

Title: *Monoidal categories of modules over quantum affine algebras of type A and B*

Abstract: The monoidal category of finite-dimensional integrable representations of a quantum affine algebra has a rich structure. In this talk, I will focus on the quantum affine algebras of type $A^{(2)}_{2n-1}$ and $B^{(1)}_n$, whose Dynkin diagrams are dual to each other. We discover that the categories of finite-dimensional integrable modules over these quantum affine algebras are closely related: there exists a ring isomorphism between the Grothendieck rings of the categories, which induces a bijection between the set of classes of simple modules. Our main tool is the generalized quantum affine Schur-Weyl duality functors whose domains are the category of finite-dimensional graded modules over the quiver Hecke algebra of type A_∞.

SS 10. Geometry

Organizers: Jiayu Li & Jie Qing

	June 11	June 12	June 13	June 14
9:00-10:30				
10:30-11:00	**Tea Break**			
11:00-12:30				
12:30-14:00	**Lunch Break**			
Chair				
14:00-14:30	**Peng Lu**	**Meijun Zhu**		**Jingang Xiong**
14:30-15:00	**Zuoqin Wang**	**Xiangjin Xu**		**Miaomiao Zhu**
15:00-15:30	**Shiguang Ma**	**Qiang Guang**		**Chao Xia**
15:30-16:00	**Tea Break**			
Chair				
16:00-16:30	**Xiangwen Zhang**	**Jun Sun**		**Li Sheng**
16:30-17:00	**Ling Xiao**	**Bin Zhou**		**Ling Yang**
17:00-17:30	**Tian Chong**	**Yongjia Zhang**		
	Reception		**Banquet** *(by Invitation)*	

Venue: Room 1801, East Main Building, Guanghua Building

SS 10. Geometry

14:00-14:30, Monday, June 11

Speaker: Peng Lu (University of Oregon)

Title: *Conformal Ricci flow on asymptotically hyperbolic manifolds*

Abstract: We will talk about the existence of conformal Ricci flow on asymptotically hyperbolic manifolds and the local Shi's type curvature derivative estimate for conformal Ricci flow. This is a joint work with Professor Jie Qing and Yu Zheng.

14:30-15:00, Monday, June 11

Speaker: Zuoqin Wang (University of Science and Technology of China)

Title: *Eigenvalues of Riemannian manifolds admitting large symmetry*

Abstract: Let M be a compact Riemannian manifold on which a compact Lie group acts by isometries. In this talk I will explain how the symmetry induces extra structures in the spectrum of Laplace-type operators, and how to apply symplectic techniques to study the induced equivariant spectrum. This is based on joint works with V. Guillemin and with Y. Qin.

15:00-15:30, Monday, June 11

Speaker: Shiguang Ma (Nankai University)

Title: *n-Laplacian equation and Ricci curvature*

Abstract: This is a joint work with Professor Jie Qing. In this talk, I will mention two kinds of problems. The first kind is to study noncompact locally conformally flat manifolds with nonnegative Ricci curvature. The second kind is to study noncompact hypersurfaces with nonnegative Ricci curvature of hyperbolic space. Both problems are related to n-Laplacian equation. To study n-Laplacian equation, we use the potential theory.

16:00-16:30, Monday, June 11

Speaker: Xiangwen Zhang (University of California, Irvine)

Title: *The anomaly flow*

Abstract: We discuss the development on geometric and analytic aspects of the Anomaly flow. Such flow naturally arises in the study of a system of equations for supersymmetric vacua of superstrings proposed independently by C. Hull and A. Strominger in 1980s. The system allows non-vanishing torsion and they incorporate terms which are quadratic in the curvature tensor. As such they are also particularly interesting from the point of view of both non-Kaehler geometry and the theory of nonlinear partial differential equations. While the complete solution of the system seems out of reach at the present time, we describe progress in developing a new general approach based on geometric flows. It turns out that the corresponding flow shares some features with the Ricci flow and preserves the conformally balanced condition of Hermitian metrics.

16:30-17:00, Monday, June 11

Speaker: Ling Xiao (University of Connecticut)

Title: *Complete translating solitons to the mean curvature flow in R^3 with nonnegative mean curvature*

Abstract: We prove that any complete immersed two-sided mean convex translating soliton $\Sigma \subset R^3$ for the mean curvature flow is convex. As a corollary it follows that an entire mean convex graphical translating soliton in R^3 is the axisymmetric "bowl soliton". We also show that if the mean curvature of Σ tends to zero at infinity, then Σ can be represented as an entire graph and so is the "bowl soliton". Finally we classify all locally strictly convex graphical translating solitons defined over strip regions.

17:00-17:30, Monday, June 11

Speaker: Tian Chong (Shanghai Polytechnic University)

Title: *Some results on CC-hamonic maps*

Abstract: We introduce a horizontal energy functional for maps from a Riemannian manifold to a pseudo-Hermitian manifold. The critical maps of this functional will be called CC-harmonic maps. In this talk, we will introduce some results on CC-harmonic maps.

14:00-14:30, Tuesday, June 12

Speaker: Meijun Zhu (The University of Oklahoma)

Title: *Nonlinear integral equations on bounded domains with negative exponents*

Abstract: In this talk, we introduce some nonlinear integral equations on bounded domains related to the sharp reversed Hardy-Littlewood-Sobolev inequality. These are integral equations with negative power nonlinear terms, thus are different to the integral equation with positive power. Existence results, as well as nonexistence results are obtained. This work joins with Jingbo Dou and Qianqiao Guo.

14:30-15:00, Tuesday, June 12

Speaker: Xiangjin Xu (Binghamton University - State University of New York)

Title: *Sharp Li-Yau type estimates and new heat kernel estimates on negative curved manifolds*

Abstract: Apply the new Li-Yau type Harnack estimates for the heat equations on manifolds with $Ric(M) \geq -K$, $K \geq 0$, which established by Junfang Li and the author [Advance in Mathematics 226(5) (2011), 4456-4491], the author proves a new upper bound estimate for the heat kernel $H(x,y,t)$ of manifolds with $Ric(M) \geq -K$,

$$H(x,y,t) \leq A_K(t)V_x^{-1/2}(\delta(t))V_y^{-1/2}(\delta(t)) \exp\left[-\frac{d^2(x,y)}{4t}+[1+d^2(x,y)]B_K(t)-\lambda_1(M)t\right],$$

where $\lambda_1(M)$ is the first eigenvalue of M, and $A_K(t), B_K(t) : [0,\infty) \to [0,\infty)$ are some known functions depended on $\delta(t)$, and $\delta(t) \sim t$ as $t \to 0$ and $\delta(t) \sim 1 or \sqrt{t}$ as $t \to \infty$. While in the seminal work of Li-Yau [Acta Math. 156 (1986) 153-201.], the heat kernel upper bound estimates had δ-loss:

$$H(x,y,t) \leq C(\delta,n)V_x^{-1/2}(\sqrt{t})V_y^{-1/2}(\sqrt{t}) \exp\left[-\frac{d^2(x,y)}{(4+\delta)t}+C_1\delta Kt\right],$$

where constant $C(\delta,n) \sim \exp\left[\frac{c_1}{\delta}\right]$ as $\delta \to 0$, due that there was non-sharp Harnack estimates on manifolds with $Ric(M) \geq -K$.

15:00-15:30, Tuesday, June 12

Speaker: Qiang Guang (University of California, Santa Barbara)

Title: *Compactness and generic finiteness for free boundary minimal hypersurfaces*

Abstract: Free boundary minimal hypersurfaces are critical points of the area functional in compact manifolds with boundary. In general, a free boundary minimal hypersurface may be improper, i.e., the interior of the hypersurface may touch the boundary of

the ambient manifold. In this talk, we will present recent work on compactness and generic finiteness results for improper free boundary minimal hypersurfaces. This is joint work with Xin Zhou.

16:00-16:30, Tuesday, June 12

Speaker: Jun Sun (Wuhan University)

Title: *Differentiable sphere theorems for submanifolds in Sasaki space form*

Abstract: In this talk, we will present some differentiable sphere theorems for submanifolds in Sasaki space forms, which generalize previous differentiable sphere theorems for submanifolds in odd-dimensional unit spheres.

16:30-17:00, Tuesday, June 12

Speaker: Bin Zhou (Peking University)

Title: *Properness of energy functionals on polarized compactifications of reductive Lie groups*

Abstract: In this talk, I will first give an introduction on Tian's properness conjecture concerning on an analytic charactarization of the existence of canonical metrics in Kahler geometry. Then I will focus on compactifications of reductive Lie groups. The main results are criterion theorems of the properness of two important functionals: Ding functional and Mabuchi's K-energy on these manifolds. In particular, the existence of Kahler-Einstein metrics, Kahler-Ricci solitons and Mabuchi's generalized Kahler-Einstein metrics on Fano compactifications of reductive Lie groups can be established.

17:00-17:30, Tuesday, June 12

Speaker: Yongjia Zhang (University of California, San Diego)

Title: *On the equivalence between bounded entropy and noncollapsing for ancient solutions to the Ricci flow*

Abstract: At the beginning of section 11 in Perelman's celebrated paper "The entropy formula for the Ricci flow and its geometric applications", he asserted the following: On an ancient solution with bounded nonnegative curvature operator, kappa-noncollapsing on all scales is equivalent to a uniform bound for the entropy, constructed using a fundamental solution to the conjugate heat equation based at any point. We give

a proof for this assertion.

14:00-14:30, Thursday, June 14

Speaker: Jingang Xiong (Beijing Normal University)

Title: *Singular solutions of conformally invariant PDEs*

Abstract: I will review some asymptotic symmetry results for solutions of partial differential equations from conformal geometry.

14:30-15:00, Thursday, June 14

Speaker: Miaomiao Zhu (Shanghai Jiao Tong University)

Title: *Existence of solutions of a boundary value problem for Dirac-harmonic maps*

Abstract: Motivated from the supersymmetric nonlinear sigma model from quantum field theory, the notion of Dirac-harmonic maps couples a harmonic map type field with a spinor field. In this talk, we shall present some recent progresses on a heat flow approach to the existence of solutions of a boundary value problem for Dirac-harmonic maps.

15:00-15:30, Thursday, June 14

Speaker: Chao Xia (Xiamen University)

Title: *Inverse anisotropic mean curvature flow*

Abstract: In this talk, we discuss the inverse anisotropic mean curvature flow (IAMCF) in R^n. Under the assumption of star-shapedness and anisotropic mean convexity, we show the flow exists for all time and converges to the Wulff shape after rescaling. We also study Huisken-Ilmanen's weak formulation for IAMCF. We use the approximation of Finsler p-laplacian for $p \to 1$ to show the existence of the weak solution. The second part of the talk is based on joint work with Della Pietra and Gavitone at Naples.

16:00-16:30, Thursday, June 14

Speaker: Li Sheng (Sichuan University)

Title: *Extremal metrics on toric manifolds and Related problem*

Abstract: In a sequence of papers, Donaldson initiated a program to study the extremal metrics on toric manifolds and solved the problem for cscK metrics on toric surfaces. For toric manifolds, the equation of extremal metrics can be reduced to a real 4th-order partial differential equation on the Delzant polytope, called the Abreu equation.

In joint papers with Li An-Min and Chen Bohui we apply the affine techniques to extend the existence result in dimension 2 to extremal metrics. In joint work with Chen Bohui, Han Qing, Li An-Min and Lian Zhao. we study generalized Abreu equations on a Delzant ploytope and use the similar method to study constant scalar curvatures on homogeneous toric bundles.

16:30-17:00, Thursday, June 14

Speaker: Ling Yang (Fudan University)

Title: *On Dirichlet problem for minimal graphs and Lawson-Osserman constructions*

Abstract: We develop the Lawson-Osserman's works on minimal graphs. Firstly, we construct a constellation of uncountably many Lawson-Osserman spheres, which are minimal in Euclidean spheres and therefore generate Lawson-Osserman cones that correspond to Lipschitz but non-differentiable solutions to the minimal surface system. Then, by the theory of autonomous systems in plane, we find for each Lawson-Osserman cone an entire minimal graph having it as tangent cone at infinity. Further, in addition to the truncated Lawson-Osserman cones, we discover infinitely many analytic solutions to the Dirichlet problem of minimal surfaces system for boundary data induced by certain Lawson-Osserman spheres. As a corollary, those Lawson-Osserman cones are non-minimizing. These behaviors are observed for the first time. This is the joint work with Prof. Xiaowei Xu and Yongsheng Zhang.

SS 11. Harmonic Analysis and Partial Differential Equations

Organizers: Hong-Quan Li & Xiaochun Li

	June 11	June 12	June 13	June 14
Chair			***Xiaochun Li***	
9:00-9:45			**Carlos Perez**	
9:45-10:30			**Shuanglin Shao**	
10:30-11:00	**Tea Break**			
Chair			***Xiaochun Li***	
11:00-11:45			**Guixiang Hong**	
12:30-14:00	**Lunch Break**			
Chair	***Yong Ding***		***Francisco Javier Duoandikoetxea***	***Carlos Pérez Moreno***
14:00-14:45	**Javier Duoandikoetxea**		**Yuan Zhou**	
14:45-15:30	**Xiangjin Xu**		**Renjin Jiang**	**Wenchang Sun**
15:30-16:00	**Tea Break**			
Chair	***Yong Ding***		***Francisco Javier Duoandikoetxea***	***Carlos Pérez Moreno***
16:00-16:45	**Zihua Guo**		**Xudong Lai**	**Liang Song**
16:45-17:30				**Loukas Grafakos**
	Reception		**Banquet** ***(by Invitation)***	

Venue: June 11th, Room 408; June 13th (morning) Room 409, (afternoon) Room 408; June 14th, Room 404, West Side Building, Guanghua Building

SS 11. Harmonic Analysis and Partial Differential Equations

14:00-14:45, Monday, June 11

Speaker: Javier Duoandikoetxea (University of the Basque Country)

Title: *Boundedness of operators on weighted Morrey spaces*

Abstract: Weighted versions of the usual Morrey spaces can be defined in different ways. For weights of Muckenhoupt type we show that many operators are well defined and bounded on different weighted Morrey spaces, sometimes restricting the parameter range in terms of the reverse Hölder condition of the weight. Moreover, we show that the weighted inequalities can be extended beyond the Muckenhoupt range and obtain sharp results in the case of power weights for some operators. The results are obtained from the boundedness properties of the operators on weighted Lebesgue spaces. This is joint work with Marcel Rosenthal.

14:45-15:30, Monday, June 11

Speaker: Xiangjin Xu (Binghamton University - State University of New York)

Title: *Gradient estimates for spectral function and Carleson measures on compact manifolds with boundary*

Abstract: On a compact Riemannian manifold (M, g) with boundary, we first study some Bernstein type inequality on the subspace of $L^2(M)$ generated by eigenfunctions of eigenvalues less than $L(> 1)$ associated to the Dirichlet (Neumann) Laplace–Beltrami operator on M. On these spaces we discuss the characterization of the Carleson measures and the Logvinenko–Sereda sets for Dirichlet (or Neumann) Laplacian on M, which generalized the corresponding results of J. Ortega-Cerda and B. Pridhnani on a compact boundaryless manifold (Forum Math. 25 (2013), DOI 10.1515 / FORM.2011.110).

16:00-16:45, Monday, June 11

Speaker: Zihua Guo (Monash University)

Title: *Generalized Strichartz estimates for Schrodinger type equations and applications*

Abstract: In this talk we survey some results on the generalized Strichartz estimates for Schrodinger type equations and their applications to the nonlinear dispersive equations. The generalized estimates include: almost sharp estimates in the radial case or

spherically averaged case, and for Schrodinger equations with potential; the applications include: Klein-Gordon equation, Zakharov system, Gross-Pitaevskii equation.

9:00-9:45, Wednesday, June 13

Speaker: Carlos Pérez (University of the Basque Country & BCAM- Basque Center for Applied Mathematics)

Title: *Degenerate Poincare-Sobolev inequalities: recent results*

Abstract: In this lecture I plan to discuss some recent results obtained with E. Rela concerning Poincaré and Poincaré-Sobolev inequalities with weights. These results improve some classical estimates due to Fabes-Kenig-Serapioni obtained in the 80's in connection with the local regularity of weak solutions of degenerate elliptic equations. One of the main results is the following.

Theorem 1. *Given $1 \leq p < n$ and $w \in A_p$ we define p^* as the "degenerate" Poincaré-Sobolev exponent defined by*

$$\frac{1}{p} - \frac{1}{p^*} = \frac{1}{n(p + \log[w]_{A_p})}. \tag{1}$$

Then the following Poincarée-Sobolev inequality holds,

$$\left(\frac{1}{w(Q)}\int_Q |f - f_Q|^{p^*}\, w\, dx\right)^{\frac{1}{p^*}} \leq c_n [w]_{A_p}^{\frac{1}{p}} \ell(Q) \left(\frac{1}{w(Q)}\int_Q |\nabla f|^p\, w\, dx\right)^{1/p}$$

I will also discuss that our method is a connected with the Keith-Zhong phenomenon using extrapolation ideas.

9:45-10:30, Wednesday, June 13

Speaker: Shuanglin Shao (University of Kansas)

Title: *On smoothness of extremizers to the Tomas-Stein inequality for S^1*

Abstract: In this talk, we discuss an aspect of the extremal problem for the Tomas-Stein inequality for the one dimensional sphere. The extremal problem usually includes whether these is an extremizer to the inequality; if they exist, what are the properties such as regularity or uniqueness? what are the exact form of extremizers? In this talk, we focus on establishing that extremizers to the Tomas-Stein inequality for one dimensional sphere are smooth. This is achieved by studying the associated generalized

Euler-Lagrange inequality, which is a 5-fold convolution equation involving the surface measure of the sphere. The first step is to show that the extremizers gain an initial regularity depending on the functions themselves. Then we bootstrap this regularity to infinity. A key ingredient in this bootstrap argument is that the 5-fold convolution of the surface measures of sphere is uniformly bounded.

11:00-11:45, Wednesday, June 13

Speaker: Guixiang Hong (Wuhan University)

Title: *Product estimates in function spaces on quantum tori and quantum Euclidean spaces*

Abstract: The theory of function spaces, including the equivalent characterizations, the embedding properties, the product estimates etc, play important role in PDEs and geometric analysis. Recently, in the noncommutative setting, on one hand, Xu-Xiong-Yin introduced Besov spaces and Sobolev spaces on quantum tori, providing several equivalent characterizations and studied some embedding properties; on the other hand, Gonzalez-Junge-Parcet introduced singular integral operators and pseudo-differential operators on quantum Euclidean spaces, studied the mapping properties and found some applications to noncommutative PDEs.

Product estimates are inevitable in dealing with nonlinear PDEs and harmonic mappings. However, in the noncommutative setting, the product estimates are a priori unavailable because of the failure of paraproduct estimates due to experts including Pisier, Volberg, Petermichl, Nazarov, Mei etc. Recently, I show that with some additional regularity on the functions, the product estimates survive in the noncommutative setting. Then together with some new observations on noncommutative function spaces such as some new embedding properties, I am able to show some product estimates in function spaces on quantum tori and quantum Euclidean spaces, which are fundamental examples in quantum field theory and noncommutative geometry.

14:00-14:45, Wednesday, June 13

Speaker: Yuan Zhou (Beihang University)

Title: *Sobolev regularity for Planar infinity harmonic functions*

Abstract: Given an arbitrary planar ∞-harmonic function u, for each $\alpha > 0$ we establish a quantitative $W^{1,2}_{\mathrm{loc}}$-estimate of $|Du|^\alpha$, which is sharp as $\alpha \to 0$. We also show that the distributional determinant of u is a Radon measure enjoying some quantitative lower and upper bounds.

14:45-15:30, Wednesday, June 13

Speaker: Renjin Jiang (Tianjin University)

Title: *Riesz transform, heat kernel and harmonic functions on non-compact manifolds*

Abstract: In this report, we will present some recent study regarding Riesz transform on non-compact manifolds. The study of Riesz transform on manifolds has a long story, among which, the theory of Auscher-Coulhon-Duong-Hofmann plays an important role in the study. We shall report recent study on characterizing boundedness of the Riesz transform via regularity of harmonic functions, and on relaxing the requirement of Poincare inequality.

16:00-16:45, Wednesday, June 13

Speaker: Xudong Lai (Harbin Institute of Technology)

Title: *On the higher order Calderón commutator*

Abstract: In this talk, we introduce some recent results about the multilinear boundedness properties of the higher (n-th) order Calderón commutator for dimension larger than two. Specially some new multilinear endpoint estimates (product Lorentz space) are established for Calderón commutator here.

14:45-15:30, Thursday, June 14

Speaker: Wenchang Sun (Nankai University)

Title: *Iterated and mixed weak norms with applications to geometric inequalities*

Abstract: We consider a new weak norm, iterated weak norm in Lebesgue spaces with mixed norms. We study properties of the mixed weak norm and the iterated weak norm and present the relationship between the two weak norms. Even for the ordinary Lebesgue spaces, the two weak norms are not equivalent and any one of them can not control the other one. We give some convergence and completeness results for the two weak norms respectively. We study the convergence in truncated norm, which is a substitution of the convergence in measure for mixed Lebesgue spaces. And we give a characterization of the convergence in truncated norm. We show that Hölder's inequality is not always true on mixed weak spaces and we give a complete characterization of indices which admit Hölder's inequality.

As applications, we establish some geometric inequalities related to fractional integrals in mixed weak spaces and in iterated weak spaces respectively, which essentially generalize the Hardy-Littlewood-Sobolev inequality.

16:00-16:45, Thursday, June 14

Speaker: Liang Song (Sun Yat-sen University)

Title: *Maximal function characterizations for Hardy spaces associated to nonnegative self-adjoint operators*

Abstract: Let X be a metric measure space with a doubling measure and L be a nonnegative self-adjoint operator acting on $L^2(X)$. Assume that L generates an analytic semigroup e^{-tL} whose kernels $p_t(x,y)$ satisfy Gaussian upper bounds but without any assumptions on the regularity of space variables x and y. In this talk we give an atomic decomposition for the Hardy spaces $H^p_{L,max}(X)$ in terms of the nontangential maximal function associated with the heat semigroup of L, and hence we establish characterizations of Hardy spaces associated to an operator L, via an atomic decomposition or the nontangential maximal function. We also obtain an equivalence of $H^p_{L,max}(X)$ in terms of the radial maximal function. This is a joint work with Prof. Lixin Yan.

16:45-17:30, Thursday, June 14

Speaker: Loukas Grafakos (University of Missouri at Columbia)

Title: *A sharp version of the Hörmander multiplier theorem*

Abstract: We discuss a version of the Hörmander multiplier theorem in which a new condition related to a Sobolev space, built on a Lorentz space, improves existing ones. The talk is based on joint work with Lenka Slavíková.

SS 12. Harmonic Maps and Related Topics

Organizers: Yuxin Dong, Ye-Lin Ou, Mei-Chi Shaw & Shihshu Walter Wei

	June 11	June 12	June 13	June 14
Chair			***Yuxin Dong***	
9:00-9:30			**Xiaochun Rong**	
9:30-10:00			**Volker Branding**	
10:00-10:30			**Yibin Ren**	
10:30-11:00	**Tea Break**			
Chair		***Yibing Sheng***		
11:00-11:30		**Jiazu Zhou**		
11:30-12:00		**Jun-Ichi Inoguchi**		
12:00-12:30		**Xiaojun Liu**		
12:30-14:00	**Lunch Break**			
Chair	***Shihshu Walter Wei***	***Eric Loubeau***		
14:00-14:30	**Wu-Yi Hsiang**	**Bobo Hua**		
14:30-15:00	**Eric Loubeau**	**Yuxiang Li**		
15:00-15:30	**Huajun Gong**	**Yongsheng Zhang**		
15:30-16:00	**Tea Break**			
Chair	***Ye-Lin Ou***	***Jun-ichi inoguchi***		
16:00-16:30	**Qiaoling Xia**	**Miaomiao Zhu**		
16:30-17:00	**Yingbo Han**	**Yong Luo**		
17:00-17:30	**Jia-Cheng Huang**	**Tian Chong**		
	Reception		**Banquet** ***(by Invitation)***	

Venue: Room 1501, East Main Tower, Guanghua Building

SS 12. Harmonic Maps and Related Topics

14:00-14:30, Monday, June 11

Speaker: Wu-Yi Hsiang (University of California)

Title: *Retrospects and prospects on equivariant differential geometry*

Abstract: In this short talk, we shall begin with a concise review on some highlights of equivariant differential geometry such as symmetry theorems on isoperimetric regions, soap bubbles, closed minimal submanifolds of spheres etc. on the one hand, and on the other hand, the construction of some outstanding new examples such as immersed soap bubbles, spherical Bernstein problems, etc. and then following with a brief overview on what kinds of natural roles it is playing in the study of various interplays between symmetries and optimalities in the intrinsic structures of the Nature.

We shall conclude with a brief discussion on its prospects of further developments, mainly by formulating some pertinent problems as well as a few new results, such as the construction of examples of Ricci flows of $O(3)$-hypersurfaces in $\mathbb{E}_4$ exhibiting the puzzling behavior of non-preservation of positive Ricci curvature everywhere.

14:30-15:00, Monday, June 11

Speaker: Eric Loubeau (Université de Bretagne Occidentale)

Title: *The harmonicity of G_2-structures*

Abstract: In this talk I will present an approach of G2-structures on seven-dimensional Riemannian manifolds, based on the theory of harmonic maps.

Harmonic maps are defined as critical points of the energy functional

$$E(\phi) = \frac{1}{2}\int_M |d\phi|^2 v_g,$$

and characterised by the vanishing of the associated Euler-Lagrange operator, the tension field, which is a system of semi-linear partial differential equations of second order. I will review some of the essential results on harmonic maps and then turn to the specific case of vector fields, viewed as maps from M to TM (equipped with the Sasaki metric) which must satisfy

$$\nabla * \nabla_\sigma = 0$$

when harmonic.

This will unfortunately lead to a blind alley but it will serve as toy-model for the more interesting but more challenging case of sections of homogeneous bundles with a particular geometrical meaning.

After a quick overlook of the unified set-up of geometrical structures, I will illustrate this with the historical example of almost complex structures and then the lesser-known case of almost contact structures.

Recently, in dimension seven, efforts have been made to apply these ideas to G_2-structures, as preparatory conditions to obtaining G_2-manifolds. These have led to a harmonic condition for G_2-structures, through their characteristic three-forms, which paves the way for the formulation of a heat flow type of problem.

15:00-15:30, Monday, June 11

Speaker: Huajun Gong (Shenzhen University)

Title: *Nonuniqueness of nematic liquid crystal flows in dimension three*

Abstract: For suitable initial and boundary data, we construct infinitely many weak solutions to the nematic liquid crystal flows in dimension three. These solutions are in the axisymmetric class with bounded energy and "backward bubbling" at a large time.

16:00-16:30, Monday, June 11

Speaker: Qiaoling Xia (Zhejiang University)

Title: *Some results on Finsler p-eigenvalue problem*

Abstract: The eigenvalue problem is one of the fundamental problems in geometric analysis. In this talk, we will introduce some recent progress on Finsler $p(>1)$-eigenvalue problem, including the upper or lower bound estimates for the first p-eigenvalue, the local and global gradient estimates for Finlser p-eigenfunctions and their applications.

16:30-17:00, Monday, June 11

Speaker: Yingbo Han (Xinyang Normal University)

Title: *On CR analogue of Yau's conjecture, the CR Poincare-Lelong equation and their applications*

Abstract: In this talk, we first derive the CR volume doubling property, CR Sobolev inequality, and mean value inequality. We then apply them to prove the CR analogue of Yau's conjecture on the space consisting of all pseudoharmonic functions of polynomial growth of degree at most d in a complete noncompact pseudohermitian (2n+1)-

manifold. Secondly we solve the so-called CR Poincare Lelong equation by solving the CR Poisson equation on a complete noncompact CR (2n+1)-manifold with nonnegative pseudohermitian bisectional curvature tensors and vanishing torsion which is an odd dimensional counterpart of Keahler geometry. With its applications plus the CR Liouville property, we study the structures of complete noncompact Sasakian manifolds.

17:00-17:30, Monday, June 11

Speaker: Jiacheng Huang (Fudan University)

Title: *Harmonic maps on Alexandrov spaces*

Abstract: In differential geometry, the Alexandrov spaces form a generalization of Riemannian manifolds with sectional curvature bounded below, and were studied very extensively. In this talk, we are going to discuss the harmonic maps on Alexandrov spaces. Harmonic maps are defined as the minimizers of the energy functional on Alexandrov spaces. We will discuss the existence, regularity and Liouville type theorem for such harmonic maps.

11:00-11:30, Tuesday, June 12

Speaker: Jiazu Zhou (Southwest University)

Title: *The sharp convex mixed Lorentz-Sobolev Inequality*

Abstract: New sharp convex mixed Lorentz-Sobolev inequality is obtained by convexifying level sets in Lorentz integrals. An L_p Minkowski inequality for L_p-mixed volume of convex body K and the projection body $\Pi_p Q$ of convex body Q is proved. The sharp convex mixed Lorentz-Sobolev inequality obtained is equivalent to the L_p Minkowski inequality for L_p-mixed volume of K and $\Pi_p Q$.

11:30-12:00, Tuesday, June 12

Speaker: Jun-ichi Inoguchi (University of Tsukuba)

Title: *Harmonic maps into Lie groups, revisited*

Abstract: Uhlenbeck established a fundamental theory of harmonic maps into the unitary group. Segal showed that harmonic maps into unitary groups are obtained by holomorphic curve into the based loop group. Uhlenbeck-Segal theory actually works for any compact Lie groups. Dorfmeister, Pedit and Wu generalized the Uhlenbeck-Segal

theory to harmonic maps into compact Riemannian symmetric spaces, now referred to as the generalized Weierstrass type representation or DPW-method. Since the generalized Weierstrass type representation for harmonic maps usually requires a bi-invariant metric on some related Lie group, we can not expect this scheme to work unchanged for harmonic maps into Lie groups, if these Lie groups carry only a left-invariant metric. In fact, harmonic maps into general Lie groups do not even admit a zero-curvature representation in general.

In this talk we develop a loop group theory for harmonic maps into Lie groups which are equipped with a bi-invariant affine connection. This is a joint work with Josef F. Dorfmeister and Shimpei Kobayashi.

12:00-12:30, Tuesday, June 12

Speaker: Xiaojun Liu (University of Shanghai for Science and Technology)

Title: *Normal family theory and Gauss curvature estimate of minimal surfaces in* R_m

Abstract: In this paper, we first extend Zalcman's principle of normality to the families of holomorphic mappings from Riemann surfaces to a compact Hermitian manifold. We then use this principle to derive an estimate for Gauss curvatures of the minimal surfaces in Rm whose Gauss maps satisfy some property P, in the spirit of Bloch's heuristic principle in complex analysis. Consequently, we recover and simplify the known results about value distribution properties of the Gauss map of minimal surfaces in R^m.

14:00-14:30, Tuesday, June 12

Speaker: Bobo Hua (Fudan University)

Title: *Discrete harmonic functions on graphs*

Abstract: Analogous to Riemannian manifolds, on any graph it associates with a discrete Laplace operator. Discrete harmonic functions are in the kernel of the Laplace operator. We report some results on discrete harmonic functions under Bakry-Emery curvature conditions on graphs.

14:30-15:00, Tuesday, June 12

Speaker: Yuxiang Li (Tsinghua University)

Title: *energy identities for a Sacks-Uhlenbeck* α*-harmonic map sequence*

Abstract: I will give a survey on the convergence behavior of an α-harmonic maps with uniform bounded energy as $\alpha \to 1$.

15:00-15:30, Tuesday, June 12

Speaker: Yongsheng Zhang (Northeast Normal University)

Title: *On Lawson-Osserman constructions*

Abstract: We make systematic developments on Lawson-Osserman constructions relating to the Dirichlet problem (over unit disks) for minimal surfaces of high codimension in their 1977' Acta paper. In particular, we show the existence of boundary functions for which infinitely many analytic solutions and at least one nonsmooth Lipschitz solution exist simultaneously. This newly-discovered amusing phenomenon enriches the understanding on the Lawson-Osserman philosophy.

16:00-16:30, Tuesday, June 12

Speaker: Miaomiao Zhu (Shanghai Jiao Tong University)

Title: *Pohozaev type constants and applications in geometric analysis*

Abstract: In this talk, we shall discuss the notion of Pohozaev type constants for solutions of some nonlinear elliptic systems in dimension two and explore their applications in the study of harmonic type systems and Liouville type systems.

16:30-17:00, Tuesday, June 12

Speaker: Yong Luo (Wuhan University)

Title: *The geometry of biharmonic maps in nonpositively curved manifolds*

Abstract: Let $u : (M, g) \to (N, h)$ be a map, the bienergy of u is defined by

$$\tau_2(u) = \frac{1}{2} \int_M |\tau(u)^2| d\mu_g$$

where $\tau(u)$ is the tension field of u. Critical points of the bienergy functional are called biharmonic maps and isometric biharmonic maps are called biharmonic submanifolds, which are natural generalizations of harmonic maps and minimal submanifolds respectively. In this talk we will discuss non-existence results of proper biharmonic maps(that

biharmonic maps which are not harmonic) when the target manifold is nonpositively curved.

17:00-17:30, Tuesday, June 12

Speaker: Tian Chong (Shanghai Polytechnic University)

Title: *Some results on CC-harmonic maps*

Abstract: We introduce a horizontal energy functional for maps from a Riemannian manifold to a pseudo-Hermitian manifold. The critical maps of this functional will be called CC-harmonic maps. In this talk, we will introduce some results on CC-harmonic maps.

9:00-9:30, Wednesday, June 13

Speaker: Xiaochun Rong (Rutgers University)

Title: *A geometric approach to the modified Milnor problem*

Abstract: In the theory of group growth, the Milnor Problem (modified) asks whether any finite presented group of vanishing algebraic entropy has at most polynomial growth. We show that a positive answer to the modified Milnor Problem is equivalent to the Nilpotency Conjecture in Riemannian geometry: given $n, d > 0$, there exists a constant $\epsilon(n, d) > 0$ such that if a compact Riemannian n-manifold M satisfies that Ricci curvature $Ric_M \geq -(n-1)$, diameter $d \geq diam(M)$ and volume entropy $h(M) < \epsilon(n, d)$, then the fundamental group $\pi_1(M)$ is virtually nilpotent. We will verify the Nilpotency Conjecture in some cases, and we will verify the vanishing gap phenomena for more cases i.e., if $h(M) < \epsilon(n, d)$, then $h(M) = 0$. This is a join work with Lina Chen and Shicheng Xu

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9:30-10:00, Wednesday, June 13

Speaker: Volker Branding (Vienna University)

Title: *On semi-biharmonic maps between Riemannian manifolds*

Abstract: We study an action functional for maps between Riemannian manifolds that interpolates between the actions for harmonic and biharmonic maps. Critical points of this functional will be called semi-biharmonic maps. We will report on the basic properties of semi-biharmonic maps and present several existence and non-existence

results.

10:00-10:30, Wednesday, June 13

Speaker: Yibin Ren (Zhejiang Normal University)

Title: *Pseudo-Harmonic maps on complete noncompact Pseudo-Hermitian manifolds*

Abstract: In this talk, we give an estimate of sub-Laplacian of Riemannian distance functions in pseudo-Hermitian manifolds which plays a similar role as Laplacian comparison theorem, and deduce a prior horizontal gradient estimate of pseudo-harmonic maps from pseudo-Hermitian manifolds to regular balls of Riemannian manifolds. As an application, Liouville theorem will be established under the conditions of nonnegative pseudo-Hermitian Ricci curvature and vanishing pseudo-Hermitian torsion. Moreover, we obtain the existence of pseudo-harmonic maps from complete noncompact pseudo-Hermitian manifolds to regular balls of Riemannian manifolds. We will also discuss the gradient estimate of pseudo-harmonic functions on complete noncompact pseudo-Hermitian manifolds.

SS 13. Inverse Problems

Organizers: Gang Bao, Shuai Lu & Hongkai Zhao

	June 11	June 12	June 13	June 14
Chair			***Jijun Liu***	
9:00-9:30			**Jianwei Ma**	
9:30-10:00			**Jingzhi Li**	
10:00-10:30			**Xiang Xu**	
10:30-11:00	**Tea Break**			
Chair		***Peijun Li***	***Jijun Liu***	
11:00-11:30		**Bo Zhang**	**Shingyu Leung**	
11:30-12:00		**Ting Zhou**	**Wangtao Lu**	
12:00--12:30		**Haibing Wang**	**Yuliang Wang**	
12:30-14:00	**Lunch Break**			
Chair	***Gang Bao***	***Bo Zhang***	***Jijun Liu***	
14:00-14:30	**Gunther Uhlmann**	**Jijun Liu**	**Jiguang Sun**	
14:30-15:00	**Junshan Lin**	**Ricardo Delgadillo**	**Shuai Lu**	
15:00-15:30	**Jun Lai**	**Xiaodong Liu**		
15:30-16:00	**Tea Break**			
Chair	***Gang Bao***	***Bo Zhang***		
16:00-16:30	**Jin Cheng**	**Peijun Li**		
16:30-17:00	**Alexandre Boukhgueim**	**Ting Wei**		
17:00-17:30	**Wenjia Jing**	**Tao Yin**		
	Reception		**Banquet** ***(by Invitation)***	

Venue: Conference Room No.7, Fuxuan Hotel

SS 13. Inverse Problems

14:00-14:30, Monday, June 11

Speaker: Gunther Uhlmann (University of Washington)

Title: *Seeing through Sace Time*

Abstract: We address the inverse problem of whether one can determine the structure of space time by making observations near an observer. We also consider inverse problems for several non-linear wave equations besides Einstein equations like non-linear elasticity. We use in a fundamental wave the non-linearity of the equation. The intereaction of several waves produce new waves that are used to solve the inverse problems.

14:30-15:00, Monday, June 11

Speaker: Junshan Lin (Auburn University)

Title: *Computational optimal design of random surface textures in thin-film solar cells*

Abstract: In this talk, I will present an optimal design problem arising in thin-film solar cells, where one seeks to design random textures so as to increase light absorption and enhance the performance of photovoltaics structures. Two algorithms are employed to solve the optimal design problem. One is based on the full gradient descent method, and the other is based on the stochastic gradient descent method. I will discuss the performance of two algorithms and the absorption enhancement of solar cells when the optimal random surface profile is implemented.

15:00-15:30, Monday, June 11

Speaker: Jun Lai (Zhejiang University)

Title: *Forward and inverse electromagnetic scattering of three dimensional axis-symmetric objects*

Abstract: Fast algorithm for the electromagnetic scattering of axis-symmetric objects is of great importance in optics, biomedical imaging and inverse scattering. In this talk, we apply a second kind integral formulation to the three dimensional scattering problem of axis-symmetric objects. The resulted surface integral equation is reduced to a sequence of line integral equations by Fourier transform along the azimuthal direction. These equations are decoupled from each other and a high order kernel splitting technique is applied to the evaluation of singular integrals. The algorithm is efficient

and high order even for the scattering of non-smooth objects by employing generalized Gaussian quadrature. Numerical experiments are presented to demonstrate the efficiency of the algorithm. Inverse scattering for axis-symmetric objects will be also discussed.

16:00-16:30, Monday, June 11

Speaker: Jin Cheng (Fudan University)

Title: *A new unique continuation for the Lame equation*

Abstract: The unique continuation property means that the solution of the partial differential equations on the small domain can determine the solution on the large connected domain. This is useful for study of inverse problems for partial differential equations. In this talk, we discuss the problems of determining the solutions of the Lame equation from the partial information of the solution on the small domain.

16:30-17:00, Monday, June 11

Speaker: Alexandre Boukhgueim (Wichita State University)

Title: *Inverse problems for the two-dimensional transport equation with weight and attenuation*

Abstract: We study the problem of recovering the right-hand side of a two-dimensional transport equation

$$< \omega, \nabla_x u(x,\omega) > +\mu(x)u(x,\omega) = \rho(x,\omega)h(x,\omega)$$

where $x \in \Omega \subset \mathbb{R}^2, \omega \in S^1 = \{\omega \in \mathbb{R}^2 : |\omega| = 1\}$, μ is a given attenuation, $\rho(x,\omega)$ is a given even trigonometric polynomial with respect to ω and the unknown function h has the form $h(x,\omega) = a(x)$ in the scalar tomography case or $h(x,\omega) =< \omega, v >$,$v = (v_1(x), v_2(x))$ in the vector tomography case. We assume that the trace of the function u on $\partial\Omega x S$ is known. We investigate the uniqueness and stability of these inverse problems.

17:00-17:30, Monday, June 11

Speaker: Wenjia Jing (Tsinghua University)

Title: *A backscattering model based on corrector theory of homogenization for the random Helmholtz equation*

Abstract: This work concerns the analysis of wave propagation in random media. Our medium of interest is sea ice, which is a composite of a pure ice background and randomly located inclusions of brine and air. From a pulse emitted by a source above the sea ice layer, the main objective of this work is to derive a model for the backscattered signal measured at the source/detector location. The problem is difficult in that, in the practical configuration we consider, the wave impinges on the layer with a non-normal incidence. Since the sea ice is seen by the pulse as an effective (homogenized) medium, the energy is specularly reflected and the backscattered signal vanishes in a first order approximation. What is measured at the detector consists therefore of corrections to leading order terms, and we focus in this work on the homogenization corrector. We describe the propagation by a random Helmholtz equation, and derive an expression of the corrector in this layered framework. We moreover obtain a transport model for quadratic quantities in the random wavefield in a high frequency limit.

11:00-11:30, Tuesday, June 12

Speaker: Bo Zhang (AMSS, Chinese Academy of Sciences)

Title: *Direct imaging methods for inverse scattering by unbounded rough surfaces*

Abstract: In this talk, we consider inverse scattering by unbounded rough surfaces which is to reconstruct the scattering surface from the scattered field measured on a horizontal straight line segment at a finite distance above the rough surface. An unbounded rough surface means a nonlocal perturbation of an infinite plane surface such that the whole surface lies within a finite distance of the original plane. We propose a direct imaging method to reconstruct the rough surface from the scattered near-field Cauchy data generated by acoustic point sources. A theoretical analysis is also provided for the imaging function. Numerical experiments are presented to show that the direct imaging algorithm is fast, accurate and very robust with respect to noise in the data. We will extend the results to both the case of inverse elastic scattering by an unbounded rigid rough surface and the plane wave incidence case. In the latter case with incident plane waves, we use the measured scattered near-field data instead of the Cauchy data. This talk is based on joint works with Xiaoli Liu and Haiwen Zhang.

11:30-12:00, Tuesday, June 12

Speaker: Ting Zhou (Northeastern University)

Title: *Direct and inverse problems for the nonlinear time-harmonic Maxwell equations in kerr-type media*

Abstract: In this work, we consider an inverse boundary value problem of electromagnetism in a nonlinear Kerr medium. We show the unique determination of the electromagnetic material parameters and the nonlinear susceptibility parameters of the medium by making electromagnetic measurements on the boundary. We are interested in the case of the time-harmonic Maxwell equations. This is a joint work with Dr. Yernat M. Assylbekov.

12:00-12:30, Tuesday, June 12

Speaker: Haibing Wang (Southeast University)

Title: *Reconstruction of unknown inclusions based on the diffusion model*

Abstract: Consider the problem of reconstructing unknown inclusions inside a diffusive medium from boundary measurements, which arises from active thermography and diffuse optical tomography. It is formulated as an inverse boundary value problem for the diffusion equation. We introduce two non-iterative methods for reconstructing the boundary of the unknown inclusion. One is a sampling-type method, which is based on the characterization of the solution to the so-called Neumann-to-Dirichlet map gap equation. The second is a direct algorithm for locating small inclusions, which is based on the asymptotic expansion for the weighted boundary measurement. Some close relations between them are discussed. Numerical results are also presented to show the efficiency and stability of the proposed methods.

14:00-14:30, Tuesday, June 12

Speaker: Jijun Liu (Southeast University)

Title: *On fluorescence imaging by diffusion process: model and algorithm*

Abstract: Fluorescence imaging is a type of wave spectroscopy that extracts the quantitative property of fluorescence from some measurable data of the sample. This process in the randomly inhomogeneous medium is governed by the radiative transfer equation for excitation and emission fields. By introducing the average of angularly reserved wave energy density, we derive an imaging model by a coupled diffusion system for the average fields. This nonlinear inverse problem is linearized with an error estimate on the excitation field indicating the model approximation. Then we give the explicit expression for emission fields, which provide the fundamentals for the efficient realizations for fluorescence imaging by the iterative schemes. Finally, in terms of the representations of the solution to the diffusion equation, the imaging of fluorophore is implemented by solving a linear integral equation of the first kind. The uniqueness and

non-uniqueness of this inverse problem are rigorously analyzed for boundary measurement data, which reveals the essence of the imaging model. An iteration algorithm is proposed for recovering the unknown fluorescence density.

14:30-15:00, Tuesday, June 12

Speaker: Ricardo Delgadillo (Michigan State University)

Title: *Gaussian Beam based algorithm for the time-dependent Kohn-Sham equations*

Abstract: In this paper, we develop a numerical scheme for solving the time-dependent Kohn-Sham (TDKS) equations asymptotically. Our strategy will be to use a single-step predictor-corrector algorithm to solve the TDKS equations. The novelty introduced in our algorithm is that it makes use of the Gaussian beam (GB) method to solve the time-dependent Shrödinger equation asymptotically. The GB method was developed to efficiently compute an approximate solution to the Shrödinger by using asymptotic analysis similar to the WKB method. The analysis shows that the GB method is a great approximation for systems in the semi-classical regime. This will enable us to study systems in Time-dependent density functional theory (TDDFT) in the limit $\hbar \to 0$ equivalently, in the limit as $N \to \infty$, where N is the number of particles in the system.

15:00-15:30, Tuesday, June 12

Speaker: Xiaodong Liu (AMSS, Chinese Academy of Sciences)

Title: *Data recovery: from limited-aperture to full-aperture*

Abstract: Many methods have been proposed for inverse scattering problems in the past thirty years. Most of them use full-aperture data, i.e., data of all the observation directions due to all incident directions. However, in many cases of practical interest, it is not possible to measure the full-aperture data. Consequently, only limited-aperture data over a range of angles are available. Various reconstruction algorithms using limited-aperture data have been developed. However, the quality of the reconstructions are not satisfactory. Other than developing methods using limited-aperture data, we take some alternative approaches to recover the data that can not be measured directly[2,3]. Based on these data, using a recent proposed direct sampling method [1], the quality of the shape and location reconstructions will be greatly improved[2,3].

References

[1] X. Liu A novel sampling method for multiple multiscale targets from scattering amplitudes at a fixed frequency, $Inverse\ Problems$ 33 (2017), 085011.

[2] X. Liu and J. Sun, Data recovery: from limited-aperture to full-aperture, arX-

iv:1708.03029: 2017
[3] H. Liu, X. Liu and Y. Wang, A joint reconstruction scheme for inverse shape problems with limited-aperture data, preprint, 2018

16:00-16:30, Tuesday, June 12

Speaker: Peijun Li (Purdue University)

Title: *Inverse random source problems for time-harmonic wave equations*

Abstract: This talk concerns the inverse source scattering problems for time-harmonic acoustic, elastic, and electromagnetic waves. The external sources are assumed to be microlocally isotropic Gaussian random functions such that their covariance operators are classical pseudo-differential operators. We intend to address the uniqueness of the problems, i.e., how the amplitude of the scattering field averaged over the frequency band, obtained from a single realization of the random source, may determine uniquely the principle symbol of the covariance operators for these wave equations.

16:30-17:00, Tuesday, June 12

Speaker: Ting Wei (Lanzhou University)

Title: *Identifying a diffusion coefficient in a time-fractional diffusion equation*

Abstract: In this paper, we propose a conjugate gradient algorithm for identifying a space-dependent diffusion coefficient in a time-fractional diffusion equation from the boundary Cauchy data in one-dimensional case. The existence and uniqueness of the solution for a weak form of the direct problem are obtained. The identification of diffusion coefficient is formulated into a variational problem by the Tikhonov-type regularization. The existence, stability and convergence of a minimizer for the variational problem approach to the exact diffusion coefficient are provided. We use a conjugate gradient method to solve the variational problem based on the deductions of a sensitive problem and an adjoint problem. We test three numerical examples and show the effectiveness of the proposed method.

17:00-17:30, Tuesday, June 12

Speaker: Tao Yin (Université Grenoble Alpes)

Title: *Inverse conductivity problem with internal data*

Abstract: In this talk, we consider the reconstruction of strictly positive condictivity from internal measurements. The square root of conductivity satisfies a transport equation which does not fall within the classical variational framework to prove the existence, uniqueness of solutions. To overcome this, we introduce an auxiliary Helmholtz problem indexed by a small enough parameter to obtain a regularization of the internal data and a regularized system for the conductivity. The existence and uniqueness of solutions of the regularized transport equation is proved and a stability estimate in an appropriate norm is given. Then we apply a discontinuous Galerkin method for solving the regularized transport equation and derive an error estimate including the effects of meshsize and the regularized parameter. Numerical examples are presented to verify the theoritical results. This is a joint work with F. Triki at UGA.

9:00-9:30, Wednesday, June 13

Speaker: Jianwei Ma (Harbin Institute of Technology)

Title: *Deep learning for seismic data processing and inversion*

Abstract: To be announced.

9:30-10:00, Wednesday, June 13

Speaker: Jingzhi Li (Southern University of Science and Technology)

Title: *Shape derivatives—new perspective and applications in scattering*

Abstract: This talk presents the "derivative" of solutions of second-order boundary value problems with respect to the shape of the domain. A rigorous approach relies on encoding shape variation by means of deformation vector fields, which will supply the directions for taking shape derivatives. These derivatives and methods to compute them numerically are key tools for studying shape sensitivity, performing gradient based shape optimization, and small-variation shape uncertainty quantification. A unifying view of second-order elliptic boundary value problems recasts them in the language of differential forms (exterior calculus). Fittingly, the shape deformation through vector fields matches the concept of Lie derivative in exterior calculus. This paves the way for a unified treatment of shape differentiation in the framework of exterior calculus. Applications in scattering problems reveals the extraordinary power of the machinery.

10:00-10:30, Wednesday, June 13

Speaker: Xiang Xu (Zhejiang University)

Title: *Wellposedness and numerical analysis for quasi-static piezotronic equation in P-N junction*

Abstract: In this talk, a quasi-static piezotronic equation in p-n junction is investigated, which describes the behaviour of carriers, i.e., electrons and holes in semiconductors when subjected to external force. Galerkin method is utilized to show the existence and uniqueness of the solution of the piezotronic equation. Moreover, optimal error estimates are obtained for both semi-discrete and fully discrete Galerkin schemes. Numerical examples are presented to illustrate the validity and effectiveness of the proposed numerical schemes.

11:00-11:30, Wednesday, June 13

Speaker: Shingyu Leung (The Hong Kong University of Science and Technology)

Title: *Adjoint state methods for inverse problems from seismology*

Abstract: We discuss various applications of the adjoint state method for obtaining the numerical solutions to various inverse problems originated from traveltime tomography. We first formulate these inverse problems in variational formulations. To minimize the energy in the variational formulation, we derive the gradient of the nonlinear functional which can be efficiently computed using the adjoint state method. We will also show various numerical examples to demonstrate the feasibility and the robustness of these new formulations.

11:30-12:00, Wednesday, June 13

Speaker: Wangtao Lu (Zhejiang University)

Title: *A numerical mode matching method for wave scattering in a layered medium with a stratified inhomogeneity*

Abstract: Numerical mode matching (NMM) methods are widely used for analyzing wave propagation and scattering in structures that are piece-wise uniform along one spatial direction. For open structures that are unbounded in transverse directions (perpendicular to the uniform direction), the NMM methods use the perfectly matched layer (PML) technique to truncate the transverse variables. When incident waves are specified in homogeneous media surrounding the main structure, the total field is not always outgoing, and the NMM methods rely on reference solutions for each uniform segment. Existing NMM methods have difficulty handing gracing incident waves and

special incident waves related to the onset of total internal reflection, and are not very efficient at computing reference solutions for non-plane incident waves. In this paper, a new NMM method is developed to overcome these limitations. A Robin-type boundary condition is proposed to ensure that non-propagating and non-decaying wave field components are not reflected by truncated PMLs. Exponential convergence of the PML solutions based on the hybrid Dirichlet-Robin boundary condition is established theoretically. A fast method is developed for computing reference solutions for cylindrical incident waves. The new NMM is implemented for two-dimensional structures and polarized electromagnetic waves. Numerical experiments are carried out to validate the new NMM method and to demonstrate its performance.

12:00-12:30, Wednesday, June 13

Speaker: Yuliang Wang (Hong Kong Baptist University)

Title: *Vanishing and localizing of transmission eigenfunctions near corners/edges*

Abstract: In this talk I will present our recent finding on the intrinsic geometric structure of interior transmission eigenfunctions arising in wave scattering theory. We numerically show that the aforementioned geometric structure can be very delicate and intriguing. The major findings can be roughly summarized as follows. If there is a cusp, i.e. a discontinuity of the surface tangent on the support of the underlying potential function, then the interior transmission eigenfunction vanishes near the cusp if its interior angle is less than Pi, whereas the interior transmission eigenfunction localizes near the cusp if its interior angle is bigger than Pi. Furthermore, we show that the vanishing and blowup orders are inversely proportional to the interior angle of the cusp: the sharper the corner, the higher the convergence order.

14:00-14:30, Wednesday, June 13

Speaker: Jiguang Sun (Michigan Technological University & University of Electronic Science and Technology of China)

Title: *A Bayesian approach for the inverse medium problem using Steklov eigenvalues*

Abstract: We present a new integral equation for the estimation of the Steklov eigenvalues from Cauchy data. Then using reconstructed Steklov eigenvalues, we propose a Bayesian formulation to estimate the refractive index. Numerical experiments show that the estimation of Steklov eigenvalues and refractive index are both satisfactory and effective.

14:30-15:00, Wednesday, June 13

Speaker: Shuai Lu (Fudan University)

Title: *Multifrequency inverse source problems for Helmholtz equations*

Abstract: In this talk, we investigate an interior Helmholtz inverse source problem with multiple frequencies. By implementing sharp uniqueness of the continuation results and exact observability bounds for the wave equation, a (nearly Lipschitz) increasing stability estimate is explicitly obtained for Cauchy measurements in a non-empty wave-number interval. With a specific geometric domain, an iterative/recursive reconstruction algorithm is proposed aiming at recovering unknown sources by the multifrequency boundary measurement. Both convergence and error estimates are derived to guarantee its reliability. Numerical examples verify the efficiency of our proposed algorithm. These results are joint works with Gang Bao (Zhejiang U), Jin Cheng (Fudan U), Victor Isakov (Wichita State U) and William Rundell (TAMU).

SS 14. Mathematics of Planet Earth: Natural Systems and Models

Organizers: Daniel Helman & Huaiping Zhu

	June 11	June 12	June 13	June 14
9:00-10:30				
10:30-11:00	Tea Break			
Chair			*Huaiping Zhu*	*Daniel Helman*
11:00-11:30			Kenneth M. Golden	Zhenqing Li
11:30-12:00			Quan-Xing Liu	Jinbao Liao
12:00--12:30			Ling Yang	Ming Zhong
12:30-14:00	Lunch Break			
Chair			*Daniel Helman*	*Huaiping Zhu*
14:00-14:30			Martin Walter	Lai Zhang
14:30-15:00			Haitao Song	Congbo Xie
15:00-15:30			Haixia Lu	Hui Wan
15:30-16:00	Tea Break			
Chair			*Huaiping Zhu*	*Daniel Helman*
16:00-16:30			Jingli Ren	Guihong Fan
16:30-17:00			Guiquan Sun	Weiming Wang
17:00-17:30			Daniel Helman	Shujing Gao
	Reception		Banquet *(by Invitation)*	

Venue: Room 801, East Main Tower, Guanghua Building

SS 14. Mathematics of Planet Earth: Natural Systems and Models

11:00-11:30, Wednesday, June 13

Speaker: Kenneth M. Golden (University of Utah)

Title: *Linking scales in the sea ice system*

Abstract: "Polar sea ice is a key component of the Earth's climate system. It exhibits complex composite structure on length scales ranging from microns to tens of kilometers. I will give an overview of how we are using theories of composite materials and statistical physics to link behavior on various scales in the sea ice system. In particular, we address fundamental questions in sea ice homogenization, where information on smaller scales is incorporated into rigorous representations of effective large scale behavior. We also consider the inverse problem where small scale structure is inferred from larger scale effective properties. Examples include fluid flow through the porous brine microstructure, wave propagation in the marginal ice zone, convection enhanced thermal conduction, remote sensing, and the evolution of melt ponds on Arctic sea ice. This work is helping to advance how sea ice is represented in climate models, and to improve projections of climate change and the response of polar ecosystems."

11:30-12:00, Wednesday, June 13

Speaker: Quanxing Liu (East China Normal University)

Title: *A multidisciplinary approach to pattern formation in ecology: from individual to ecosystems*

Abstract: Many ecosystems develop strikingly regular spatial patterns because of small-scale interactions between organisms, a process generally referred to as spatial self-organization. Self-organized spatial patterns are important determinants of the functioning of ecosystems, promoting the growth and survival of the involved organisms, and affecting the capacity of the organisms to cope with changing environmental conditions. The predominant explanation for self-organized pattern formation is spatial heterogeneity in establishment, growth and mortality, resulting from the self-organization processes. A number of recent studies, however, have revealed that movement of organisms can be an important driving process creating extensive spatial patterning in many ecosystems. Here, I review studies that detail movement-based pattern formation in contrasting ecological settings. My talk highlights that a common principle, where movement of organisms is density-dependent, explains observed spatial regular patterns in all of these studies. This principle, well known to physics as the Cahn-Hilliard principle of phase separation, has so-far remained unrecognized as a general mechanism for self-organized complexity in ecology. In this talk, I show how

this movement principle can be discerned in ecological settings, and clarify how to test this mechanism experimentally.

12:00-12:30, Wednesday, June 13

Speaker: Ling Yang (Suzhou University)

Title: *Mathematical model of mammalian circadian clock based on the regulatory rules of cis-elements*

Abstract: With sunrise and sunset, most organisms on the earth have evolved to exhibit regular behaviors with a period of 24h. The fundamental mechanism which orchestrates the daily rhythms is not only the sunlight, but also an endogenous system, "circadian clock". To investigate the underlying dynamics, we built a mathematical model of mammalian circadian clock, which is based on the regulatory rules of cis-elements. By using a combined mathematical-experimental approach, we revealed an unexpected rule: the intensity ratio of the primary loop to the auxiliary positive loop is inversely related to the period length. Additionally, our simulation and the experimental results in human osteosarcoma cells suggest that a coupling effect between the numerator and denominator of this intensity ratio ensures the robustness of circadian period. Furthermore, we simplified the model into a differential equation with two time delays. Through analytical studies and extensive simulations, we found that the positive auxiliary feedback loop may provide a trade-off mechanism, to use the small loss in the robustness of oscillation in exchange for adaptable flexibility in mammalian circadian clock. Our mathematical model highlights the role of cis-elements in circadian clocks and provide a more realistic tool to explore the dynamics of circadian clocks.

14:00-14:30, Wednesday, June 13

Speaker: Martin Walter (University of Colorado, Boulder)

Title: *Climate change versus climate crisis*

Abstract: Starting with J. Fourier, climate science/global warming models have become progressively more detailed for the past two centuries. The history of our planet/geology, classical and nuclear chemistry, atmospheric physics, and quantum mechanics have all helped deepen our understanding. For the past few decades a well-funded effort has promoted confusion and falsehoods about climate science. One consequence of this disinformation is a lessened sense of urgency. This may prove to be very unfortunate, even catastrophic, since relatively recently understood consequences of global warming will lead to the end of civilization as we have known it unless humans act with

sufficient alacrity.

14:30-15:00, Wednesday, June 13

Speaker: Haitao Song (Shanxi University)

Title: *Is there a risk of Chikungunya outbreak with local transmission in Ontario, Canada?*

Abstract: Chikungunya is a mosquito-borne disease that is transmitted by Aedes mosquitoes. In 2014, Chikungunya spread across Caribbean, Central America and South America with an obvious trend to move north of the globe. Adult Aedes aegypti and Aedes albopictus mosquitoes were captured in Windsor, Ontario, in summer of 2016 and 2017, which suggests that the Aedes of mosquito species may be becoming established in Canada in the future when it is getting warmer. To assess the risk of a Chikungunya outbreak with autochthonous transmission in Canada, we developed a transmission model for Chikungunya virus that incorporates maturation delay for mosquito reproduction, extrinsic incubation delay and intrinsic incubation delay due to the impact of temperature. The basic reproduction number was computed to evaluate the effect of temperature on the risk of Chikungunya transmission in Canada. Dynamical analysis shows that maturation delay may destabilize the infected steady state through a Hopf bifurcation. However, extrinsic incubation delay and intrinsic incubation delay do not affect the stability of the infected steady state but rather alter the peaking time and number of infected humans. The temperature-derived risk classes for Chikungunya transmission in Canada were created based on the effect of temperature on maturation period and extrinsic incubation period. Using our model and basic reproduction number, we generated the risk map of Chikungunya with temperature and found that there is an increasing risk of the virus in the areas further north and west of Ontario if global warming continues. These findings suggest that, through its effect on mosquitoes reproduction and Chikungunya virus transmission, climate change will broaden the range of risk in Canada.

15:00-15:30, Wednesday, June 13

Speaker: Haixia Lu (Suqian College)

Title: *Hyphantria cunea with delay and seasonality*

Abstract: Hyphantria cunea Drury (H.cunea), commonly called fall webworm, is a kind of defoliator native to North America. Since 1979 first discovered in Dandong, it has spread across the country and now it became established in China feeding on

over 100 species of trees and causes significant damages. In this talk, I will present a basic stage-structured model for the population of H.cunea, a delay differential equation model and model incorporating the resource and seasonality. By introducing the population reproduction number R_0, I will show that R_0 acts as a threshold parameter for the existence and stability of equilibria. The trivial equilibria of the above models are all globally asymptotically stable when $R_0 < 1$; the basic model and the delay-differential model have a unique positive equilibrium respectively, and they are both locally asymptotically stable when $R_0 > 1$; the model with periodic season is uniformly persistent and admits a positive periodic solution if $R_0 > 1$. Numerical simulations are carried out to illustrate the theoretical results. In addition, we consider the effect of temperature and season on the population of H.cunea.

16:00-16:30, Wednesday, June 13

Speaker: Jingli Ren (Zhengzhou University)

Title: *On a reaction-advection-diffusion equation with double free boundaries and mth-order Fisher nonlinearity*

Abstract: A reaction-advection-diffusion equation is investigated with double free boundaries and mth-order Fisher nonlinearity. The main purpose is to study the influence of the advection term on the dynamics of this problem. We obtain a rather complete description, that is, a spreading-transition-vanishing trichotomy with small advection, a virtual spreading-transition-vanishing trichotomy with medium-sized advection, and vanishing happens with large advection. Moreover, when spreading happens, we prove that the leftward and rightward asymptotic spreading speeds are strictly decreasing with respect to m and find that the spreading solution converges to a semi-wave as t tends to infinite. Numerical simulation is also given to illustrate the impacts of the advection and the initial value on the free boundaries.

16:30-17:00, Wednesday, June 13

Speaker: Guiquan Sun (Shanxi University)

Title: *Pattern transitions in spatial epidemics: mechanisms and emergent properties*

Abstract: Infectious diseases are a threat to human health and a hindrance to societal development. Consequently, the spread of diseases in both time and space has been widely studied, revealing the different types of spatial patterns. Transitions between patterns are an emergent property in spatial epidemics that can serve as a potential trend indicator of disease spread. Despite the usefulness of such an indicator, attempt-

s to systematize the topic of pattern transitions have been few and far between. We present a mini-review on pattern transitions in spatial epidemics, describing the types of transitions and their underlying mechanisms. We show that pattern transitions relate to the complexity of spatial epidemics by, for example, being accompanied with phenomena such as coherence resonance and cyclic evolution. The results presented herein provide valuable insights into disease prevention and control, and may even be applicable outside epidemiology, including other branches of medical science, ecology, quantitative finance, and elsewhere.

17:00-17:30, Wednesday, June 13

Speaker: Daniel Helman (Ton Duc Thang University)

Title: *Mathematics of the Geodynamo: solid inner core versus high-density plasma core models*

Abstract: The existence of Earth's solid inner core is well-known from the seismological observations of Inge Lehmann in the early part of the 20th century. Yet if the Earth's inner core were a high-density plasma-acting as a non-Newtonian fluid-it is hypothesized to likewise transmit transverse seismic waves as solid materials do. These two alternative hypotheses-solid inner core versus high-density plasma inner core-ought to be treated differently when constructing a model of the Earth's magnetic field. Current geodynamo models are reviewed and contrasted with magnetohydrodynamic models typically used in stellar magnetic field studies to gain insight into model fitness and suitability. Magnetic reversals are highlighted, with an aim to make a testable hypothesis related to the state of Earth's inner core based on the mathematics involved.

11:00-11:30, Thursday, June 14

Speaker: Zhenqing Li (Institute of Botany, Chinese Academy of Sciences)

Title: *Modelling tree-grass coexistence in water-limited ecosystems*

Abstract: Tree-grass coexistence is commonly observed in arid and semi-arid ecosystems. Many ecosystems are undergoing a shift from grassland to tree dominance or the opposite, and therefore exploring the mechanism of tree-grass coexistence and studying how ecosystems respond to environmental change are critical to understanding such shift. We construct a tree-grass-water model by considering the Walter's two layer hypothesis, i.e., the grass species only access to the shallow soil water, while the tree can uptake both the shallow and deep soil water. We find that the tree-grass coexistence region increases with their niche separation, and thus the vertical niche

separation between trees and grass with respect to limiting water resources might be one of mechanisms for tree-grass coexistence. Besides, both tree and grass display positive responses to precipitation, but surprisingly, there exists a catastrophe that the mean vegetation density first rapidly increases but then quickly decreases as precipitation increases in the tree-grass-water model with infiltration feedback. Most likely, this catastrophe is due primarily to the periodical fluctuation of vegetation density and water, caused by its intrinsic infiltration feedback. Overall, our study provides new insights into the dynamics of tree-grass in arid and semi-arid ecosystems.

11:30-12:00, Thursday, June 14

Speaker: Jinbao Liao (Jiangxi Normal University)

Title: *Food web persistence in fragmented landscapes*

Abstract: Habitat destruction, characterized by patch loss and fragmentation, is a key driver of biodiversity loss. There has been some progress in the theory of spatial food webs, however to date practically nothing is known about how patch configurational fragmentation influences multi-trophic food web dynamics. We develop a spatially extended patch-dynamic model for different food webs by linking patch connectivity with trophic-dependent dispersal (i.e. higher trophic levels displaying longer-range dispersal). Using this model, we find that species display different sensitivities to patch loss and fragmentation, depending on their trophic position and the overall food web structure. Relative to other food webs, omnivory structure significantly increases system robustness to habitat destruction, as feeding on different trophic levels increases the omnivore's persistence. Additionally, in food webs with a dispersal-competition tradeoff between species, intermediate levels of habitat destruction can enhance biodiversity by creating refuges for the weaker competitor. This demonstrates that maximizing patch connectivity is not always effective for biodiversity maintenance, as in food webs containing indirect competition doing so may lead to further species loss.

12:00-12:30, Thursday, June 14

Speaker: Ming Zhong (Whiting School of Engineering, Johns Hopkins University)

Title: *Discovering governing laws of interaction in heterogeneous agents dynamics from observation*

Abstract: Inferring the laws of interaction of particles and agents in complex dynamical systems from observational data is a fundamental challenge in a wide variety of disciplines. We start from data consisting of trajectories of interacting agents, which

is in many cases abundant, and propose a non-parametric statistical learning approach to extract the governing laws of interaction. We demonstrate the effectiveness of our learning approach both by providing theoretical guarantees, and by testing the approach on a variety of prototypical systems in various disciplines, with homogeneous and heterogeneous agents systems, ranging from fundamental physical interactions between particles to systems-level interactions, with such as social influence on people's opinion, prey-predator dynamics, flocking and swarming, and cell dynamics.

14:00-14:30, Thursday, June 14

Speaker: Lai Zhang (Yangzhou University)

Title: *Biodiversity loss through speciation collapse: mechanisms, warning signals, and possible rescue*

Abstract: Speciation is the process that generates species diversity. While this process normally adds species to the global species pool, recent empirical findings show that it can also work backwards, leading to the collapse of two species into one. Here, we elucidate the mechanisms behind speciation collapse using a stochastic individual-based model with explicit genetics. We investigate the impact of two types of environmental disturbance: deteriorated visual conditions, which reduce foraging ability as well as impede mate choice, and environmental homogenization, which restructures ecological niches. We find: (1) Species pairs can collapse into a variety of forms including a hybrid swarm, monomorphic or polymorphic generalists, or single specialists. Notably, a hybrid swarm may be a transient stage to a monomorphic population; (2) Environmental restoration enable species pairs to re-emerge from single generalist forms, but not from single specialist forms; (3) Speciation collapse is up to four orders of magnitude faster than speciation, while the re-emergence of species pairs can be as slow as de novo speciation; (4) While speciation collapse can be predicted from either demographic, phenotypic, or genetic signals, observations of phenotypic changes allow the most general and robust warning signal of speciation collapse. Linking these findings to ecosystems, we conclude that factors altering ecological niches can reduce species diversity by fundamentally reshaping the ecosystem's evolutionary attractors.

14:30-15:00, Thursday, June 14

Speaker: Congbo Xie (Dalian MinZu University)

Title: *Dynamic model for life history of scyphozoa*

Abstract: A two-state life history model governed by ODEs is formulated to elucidate

the population dynamics of jellyfish and to illuminate the triggering mechanism of its blooms. The polyp-medusa model admits trichotomous global dynamic scenarios: extinction, polyps survival only, and both survival. The population dynamics sensitively depend on several biotic and abiotic limiting factors such as substrate, temperature, and predation. The combination of temperature increase, substrate expansion, and predator diminishment acts synergistically to create a habitat that is more favorable for jellyfishes. Reducing artificial marine constructions, aiding predator populations, and directly controlling the jellyfish population would help to manage the jellyfish blooms. The theoretical analyses and numerical experiments yield several insights into the nature underlying the model and shed some new light on the general control strategy for jellyfish.

15:00-15:30, Thursday, June 14

Speaker: Hui Wan (Nanjing Normal University)

Title: *The impact of control measures and limited resource on dengue transmission dynamics*

Abstract: In order to study the impact of control measures and limited resource on dengue transmission dynamics, we formulate a stage-structured dengue model. The basic investigation of the model, such as the existence of equilibria and their stability, have been proved. It is also shown that this model may undergo backward bifurcation, where the stable disease-free equilibrium co-exists with an endemic equilibrium. The backward bifurcation property can be removed by ignoring the disease-induced death in human population and the global stability of the unique endemic equilibrium has been proved. Sensitivity analysis with respect to R_0 has been carried out to explore the impact of model parameters. In addition, numerical analysis manifests that the more intensive control measures in targeting immature and adult mosquitoes are both effective in preventing dengue outbreaks. It is also shown that the earlier the control intervention begins, the less people would be infected and the earlier dengue would be eradicated. Even later epidemic prevention and control can also effectively reduce the severity of pandemic. Moreover, comprehensive control measures aremore effective than a single measure.

16:00-16:30, Thursday, June 14

Speaker: Guihong Fan (Columbus State University)

Title: *The impact of avian species diversity on the transmission dynamics of West Nile*

virus

Abstract: There are many compartmental models in literature about West Nile virus (WNv), but most of them ignore the impact of bird species diversity. In this work, we formulate a system of delay differential equations to model the transmission of WNv with an emphasis on the impact of bird species diversity. We classify birds into n species and for each species, we define a competent index $D(R_j)$ which is a function of species specific basic reproduction number R_j . We also find the basic reproduction number R_0 for the model with n species of birds. Study shows that if one more species of birds with the lowest competent index $D(R_j)$ is added to the model, then the basic reproduction number R_0 decreases. This is consistent with the field study by biologists from Washington University showing that the more diverse a bird population is in an area, the less chance humans have of exposure to WNv.

16:30-17:00, Thursday, June 14

Speaker: Weiming Wang (Huaiyin Normal University)

Title: *The effect of the environmental variability on the disease spreading*

Abstract: In this talk, I will introduce a new stochastic SIS model incorporating mean-reverting Ornstein-Uhlenbeck process based on the results of Gray et al [SIAM J. Appl. Math., 2011], and show that the stochastic basic reproduction number R_0^s can be used to identify the stochastic extinction and persistence for the SDE mode: if $R_0^s < 1$, the disease will be extinct a.s., while if $R_0^s > 1$, the disease will persist a.s. Epidemiologically, we find that smaller speed of reversion or bigger intensity of volatility can suppress the disease outbreak, while bigger speed of reversion or smaller intensity of volatility can benefit the disease outbreak. Thus, in order to control the spread of the disease, we must increase the intensity of volatility or decrease the speed of reversion. This is a joint work with Dr. Yongli Cai.

17:00-17:30, Thursday, June 14

Speaker: Shujing Gao (Gannan Normal University)

Title: *Citrus Huanglongbing in Gannan: mathematical models and its control*

Abstract: Citrus Huanglongbing (HLB) is one of the most destructive diseases of citrus worldwide, which affects all varieties of citrus. In this talk, I will first briefly introduce the situation of HLB in Gannan Region, and recall mathematical models on HLB. And then, I will introduce two Huanglongbing models with control strategies,

including spraying pesticides to kill psyllids, removing infected tree and cross protection. The dynamic behaviors of the models will be presented. In the end, I will discuss the challenges in modeling HLB when local environmental factors are considered.

SS 15. Noncommutative Algebra and Related Topics

Organizers: Quanshui Wu & Milen Yakimov

	June 11	June 12	June 13	June 14
Chair				
9:00-9:45			**Susan Sierra**	
9:45-10:30			**Hongdi Huang**	
10:30-11:00	**Tea Break**			
Chair				
11:00-11:45			**Jie Xiao**	
11:45-12:30			**Xiaojun Chen**	
12:30-14:00	**Lunch Break**			
Chair				
14:00-14:45	**Pu Zhang**		**Jianghua Lu**	**Zongzhu Lin**
14:45-15:30	**Can Zhu**		**William Casper**	**Zhengfang Wang**
15:30-16:00	**Tea Break**			
Chair				
16:00-16:45	**Peter Jorgensen**		**Guodong Zhou**	**Bin Zhu** (16:00-16:30) **Shengqiang Wang** (16:00-17:00) **Milen Yakimov** (17:00-17:30)
16:45-17:30	**Liping Li**		**Jiwei He**	
	Reception		**Banquet** ***(by Invitation)***	

Venue: Room 212, Center for American Studies

SS 15. Noncommutative Algebra and Related Topics

14:00-14:50, Monday, June 11

Speaker: Pu Zhang (Shanghai Jiao Tong University)

Title: *Frobenius subcategories and RSS equivalence*

Abstract: The aim of this talk is to introduce and show the existence of the Ringel-Schmidmeier-Simson equivalence, between the separated monomorphism category s-mon $(Q, I, \mathscr{X})$ and its dual sepi$(Q, I, \mathscr{X})$, where Q is an arbitrary acyclic quiver, I an admissible ideal of the path algebra kQ generated by monomial relations, and $\mathscr{X}$ is an additive full subcategory of A-mod. This was first considered by C. M. Ringel and M. Schmidmeier, and D. Simson for the case of a chain Q with $I = 0$ and $X = A$-mod. This separated monomorphism category smon$(Q, I, \mathscr{X})$ is introduced combinatorially, but it admits a nice homological interpretation, and enjoys a reciprocity smon$(Q, I, {}^{\perp}T) = {}^{\perp}(T \otimes kQ/I)$ for a cotilting A-module T . It describes Gorenstein-projective Λ-modules as $\mathcal{GP}(\Lambda) =$ smon$(Q, I, \mathcal{GP}(A))$, where $\Lambda := A \otimes_k kQ/I$. As an application, smon$(Q, I, \mathscr{X})$ is an extension-closed Frobenius subcategory if and only if so is $\mathscr{X}$. This gives a "new" construction of Frobenius subcategories in the sense that they may be not $\mathcal{GP}(\Lambda)$.

15:00-15:30, Monday, June 11

Speaker: Can Zhu (University of Shanghai for Science and Technology)

Title: *Trivial extension of Poisson algebra and its Poisson cohomology*

Abstract: Let A be a Poisson algebra and M be a left Poisson module. We construct a Poisson structure on the trivial extension algebra $A \ltimes M$. We investigate in details Poisson derivations and Hamiltonian derivation on $A \ltimes M$. As a consequence we characterize the first Poisson cohomology group of $A \ltimes M$ in terms of the ones of A and M. In the case of that A is finite dimensional and $M = A^*$, we show that $\mathrm{HP}^1(A)$ is a summand of $\mathrm{HP}^1(A \ltimes M)$. There is a map from $\mathrm{HP}^*(A \ltimes M)$ to $\mathrm{HP}^*(A)$ and the properties of this map are also studied. These are generalization of the results on the derivation and the first Hochschild cohomology group of trivial extension algebras to Poisson framework.

16:00-16:50, Monday, June 11

Speaker: Peter Jørgensen (Newcastle University)

Title: *The index in higher homological algebra and an application to higher tropical friezes*

Abstract: The notion of higher tropical friezes was introduced by Oppermann and Thomas as a higher-dimensional generalisation of the tropical friezes defined by Propp and studied by Guo. We will provide a simple example of a higher tropical frieze, and show how it arises from the natural generalisation of the notion of index to (d+2)-angulated categories.

17:00-17:30, Monday, June 11

Speaker: Liping Li (Hunan Normal University)

Title: *A local cohomology theory of FI-modules*

Abstract: The category FI of finite sets and injections provides an important categorification method for representation stability theory, which investigates asymptotic behavior of (co)homology groups of a sequence of topological spaces. In this talk we describe a machinery for homological calculations of FI-modules, and use it to develop a local cohomology theory over any commutative ring. As an application, we obtain upper bounds of a few important invariants of FI-modules, including Castelnuovo-Mumford regularity, stable range, and etc. This is joint work with Eric Ramos.

9:00-9:50, Wednesday, June 13

Speaker: Susan Sierra (University of Edinburgh)

Title: *Ideals in the enveloping algebra of the Witt algebra*

Abstract: The Witt algebra W is the Lie algebra of vector fields on the complex torus. In 2013 Sierra and Walton answered a long-standing question by showing that the enveloping algebras of the Witt algebra and of its positive part are neither left or right noetherian, using techniques of noncommutative algebraic geometry. In particular, the kernel of the natural map to the (localised) Weyl algebra is not finitely generated as a left or right ideal, although as a two-sided ideal it is principal. Furthermore, U(W) has infinite Gelfand-Kirillov dimension, whereas subalgebras of the Weyl algebra have polynomial growth.

This suggests two conjectures: that these enveloping algebras satisfy the ascending chain condition on two-sided ideals, and that any proper factor algebra has finite GK-dimension. We present work in progress on both conjectures. We further discuss work in progress on the classification of primitive ideals in U(W). This is joint work with

Alexey Petukhov.

10:00-10:30, Wednesday, June 13

Speaker: Hongdi Huang (University of Waterloo)

Title: *Hopf Ore extension*

Abstract: Panov asked the question: Given a field k and a k-Hopf Algebra R, for which algebra automorphism σ and σ-derivation δ can make the ore extension $T = R[x, \sigma, \delta]$ have the structure of Hopf Algebra extending the given structure on R? Panov answered this question under this hypothesis that x is a skew primitive element of T. Typically this is not vaild. After that K. Brown et al. provided an answer after extending the hypothesis as $\Delta(x) = s \otimes x + x \otimes t + v(x \otimes x) + w$, where $s, t \in R$ and $v, w \in R \otimes R$. In the talk, we will show that $\Delta(x) = 1 \otimes x + x \otimes t + w$ where $w \in R \otimes R$ and $t \in R$ is a group-like element, if $R \otimes R$ is a domain. In the case, we can remove the hypothesis of the coproduct of x in T.

11:00-11:50, Wednesday, June 13

Speaker: Jie Xiao (Tsinghua University)

Title: *On purity theorem of Lusztig's perverse sheaves*

Abstract: In this talk, we prove that the simple perverse sheaves which provide the canonical basis of a quantum group has the strong purity property. As an application, the existence of a class of Hall polynomials will be proved. A joint work with F.Xu and M.Zhao.

12:00-12:30, Wednesday, June 13

Speaker: Xiaojun Chen (Sichuan University)

Title: *Calabi-Yau algebras and the shifted noncommutative symplectic structure*

Abstract: The notion of Calabi-Yau algebras was introduced by Ginzburg in 2007 and has widely been studied since then. In this talk, we show that for a Koszul Calabi-Yau algebra, there is a shifted bi-symplectic structure on the cobar construction of its co-unitalized Koszul dual coalgebra, and hence its DG representation scheme have a shifted symplectic structure. Joint with F. Eshmatov.

14:00-14:50, Wednesday, June 13

Speaker: Jianghua Lu (The University of Hong Kong)

Title: *Standard Poisson structure on generalized Bruhat cells*

Abstract: K. Goodearl and M. Yakimov have recently introduced a remarkable class of polynomial Poisson algebras called symmetric Poisson CGL extensions which naturally admit cluster algebra structures. In this talk we give a class of such Poisson algebras associated to complex semi-simple Lie groups and we give some applications.

15:00-15:30, Wednesday, June 13

Speaker: William Casper (Louisiana State University)

Title: *Representation theory and the Matrix Bochner Problem*

Abstract: The Matrix Bochner Problem is to classify all sequences of orthogonal matrix polynomials which are eigenfunctions of a second-order matrix differential operator. For certain special rank 1 symmetric pairs (G,K), each irreducible representation of K gives rise to such a sequence of polynomials. In this talk, we will recall a representation-theoretic construction of orthogonal matrix polynomials and discuss various properties the associated differential operators and matrix weights are known to possess. Next, we will discuss recent work (joint with Milen Yakimov) where structural results for low dimensional, semiprime PI rings are used to prove under mild hypotheses that every sequence of orthogonal matrix polynomials which are eigenfunctions of a matrix differential operator arises as a noncommutative bispectral Darboux transformation of a direct sum of classical orthogonal polynomials. We will also demonstrate how our classification explains various properties observed in the representation-theoretic construction.

16:00-16:50, Wednesday, June 13

Speaker: Guodong Zhou (East China Normal University)

Title: *GAGA type results for singularity categories and Poisson Cohomology*

Abstract: We present several GAGA type results for singularity categories and Poisson Cohomology in dimension two.

Firstly, for a complex projective variety, we show that its (bounded) singularity category is naturally equivalent to that of its analytificaton. Secondly, we define the torsion singularity category of a formal scheme, and then show that under Orlov's condition (ELF), for the formal completion of a Noetherian scheme along a closed subset, its

torsion singularity category is equivalent to the singularity of the original scheme with support in the closed subset. Lastly, using Artin Approximation Theorem, we prove that for a Noetherian local ring with isolated singularity, its singularity category is equivalent, up to direct summands, to the singularity category of its Henselisation, while the latter is equivalent to the singularity category of its completion.

We show that for certain Poisson structures with isolated singularities over the complex plane, Poisson cohomology groups are isomorphic as Gerstenhaber algebras for formal series, holomorphic functions and polynomial functions. We also compute the Gerstenhaber algebra structure over the Poisson cohomology for simple singularities.

17:00-17:30, Wednesday, June 13

Speaker: Bin Zhu (Tsinghua University)

Title: *Cluster subalgebras and cotorsion pairs*

Abstract: Nakaoka and Palu introduced the notion of extriangulated categories by extracting the similarities between exact categories and triangulated categories. In this work, we study cotorsion pairs in a Frobenius extriangulated category $\mathscr{C}$. Especially, for a 2-Calabi-Yau extriangulated category $\mathscr{C}$ with a cluster structure, we describe the cluster substructure in the cotorsion pairs. For a cluster algebra arising from $\mathscr{C}$ with cluster tilting objects, we give a one-to-one correspondence between cotorsion pairs in $\mathscr{C}$ and certain pairs of their cluster subalgebras which we call complete pairs. This is a joint work with Wen Chang and Panyue Zhou.

14:00-14:50, Thursday, June 14

Speaker: Zongzhu Lin (Kansas State University)

Title: *Algebras of differential operators on quantum projective spaces in tensor categories and deformation theory*

Abstract: Lunts and Rosenberg defined algebras of differentia operators of non-commutative algebras. Bischoff and Lee defined quantum differential operators and their D-modules on quantum projective spaces. In this talk, I continue the investigation by defining algebras of differential operators of algebra object in a braided abelian tensor category. I will discuss the connections of D-modules on non-commutative spaces and deformation theory in terms of changing the braiding structures on tensor categories. In same way many differential geometric objects can be identified.

15:00-15:30, Thursday, June 14

Speaker: Zhengfang Wang (Peking University)

Title: *Tate-Hochschild cohomology*

Abstract: The Tate-Hochschild cohomology of a singular space X is defined as the graded endomorphism ring of the diagonal inside the singularity category of X x X. Singularity categories are introduced by Buchweitz and independently by Orlov, which have played a central role in noncommutative geometry and homological mirror symmetry.

In this talk, we construct an explicit complex to compute the Tate-Hochschild cohomology. We prove that this complex is an algebra over the little 2-discs operad, namely, the Deligne conjecture for this complex holds. We will also talk about a joint work with M. Rivera that the Tate-Hochschild cohomology of a simply-connected closed manifold recovers the Rabinowitz-Floer homology of the unit disc cotangent bundle.

16:00-16:30, Thursday, June 14

Speaker: Jiwei He (Hangzhou Normal University)

Title: *Noncommutative Auslander theorem and BGG correspondence*

Abstract: Associated to a group action on an algebra A, there is an ideal I of A. We call the ideal I the radical of the group action. This leads to an invariant, called pertinency, of group actions on Noetherian algebras with finite Gelfand-Kirillov dimensions. Let G be a finite group, and let A be a Noetherian left G-module algebra. We proved certain noncommutative Auslander theorem, namely $End_{A^G}A \cong A * G$, by means of the pertinency of the finite group action. The pertinency was also applies to establish a more general version of Bernstein-Gelfand-Gelfand correspondence on Koszul Artin-Scheter regular algebras. This is a Joint work with Y.-H. Bao and J. J. Zhang.

16:30-17:00, Thursday, June 14

Speaker: Shengqiang Wang (East China University of Science and Technology)

Title: *Homological theory for Poisson algebras*

Abstract: In this talk, we will focus on the Poisson (co)homology theory for Poisson algebras, especially for those which are smooth or Frobenius. First, we give explicit forms of the twisted Poincaré duality between Poisson cohomologies and homologies. Second, we investigate the Batalin-Vilkovisky structures on Poisson cohomology groups. Finally, some results are illuminated by examples.

17:00-17:30, Thursday, June 14

Speaker: Milen Yakimov (Lousiana State University)

Title: *Prime spectra of abelian 2-categories and categorification of open Richardson varieties*

Abstract: We will describe a general theory of prime, completely prime, semiprime, and primitive ideals of abelian monoidal categories, and more generally of abelian 2-categories. These notions extend Balmer's theory of prime spectra of tensor triangulated categories, which deals with the symmetric/braided case. The notions provide a bridge between prime spectra of noncommutative rings and total positivity. As an application we obtain categorications of the coordinate rings of Richardson varieties for arbitrary symmetric Kac-Moody algebras.

SS 16. Nonlinear Analysis and Numerical Simulations

Organizers: Jifeng Chu, Zhaosheng Feng & Juntao Sun

	June 11	June 12	June 13	June 14
Chair				
9:00-9:30			**Jifeng Chu**	
9:30-10:00			**Chi-Jen Wang**	
10:00-10:30			**Kai Tao**	
10:30-11:00	**Tea Break**			
Chair				
11:00-11:30			**Jing Tian**	
11:30-12:00			**Hasi Bagan**	
12:00-12:30			**Zhaosheng Feng**	
12:30-14:00	**Lunch Break**			
14:00-15:30				
15:30-16:00	**Tea Break**			
16:00-17:30				
	Reception		**Banquet** *(by Invitation)*	

Venue: Conference Room No.5, Fuxuan Hotel

SS 16. Nonlinear Analysis and Numerical Simulations

9:00-9:30, Wednesday, June 13

Speaker: Jifeng Chu (Shanghai Normal University)

Title: *Exact solution and instability for geophysical trapped waves at arbitrary latitude*

Abstract: We present an exact solution to the nonlinear governing equations in the β-plane approximation for geophysical trapped waves propagating at arbitrary latitude on a zonal current. Such an exact solution is explicit in the Lagrangian framework and represents three-dimensional, nonlinear oceanic wave-current interactions. Based on the short-wavelength instability approach, we prove criteria for the hydrodynamical instability of such trapped waves.

9:30-10:00, Wednesday, June 13

Speaker: Chi-Jen Wang (National Chung Cheng University)

Title: *Critical droplet solutions for non-equilibrium phase transitions in crystal lattice systems*

Abstract: Discontinuous phase transitions are common in the steady states of diverse non-equilibrium systems describing catalytic reaction-diffusion processes, biological transport, spatial epidemics, etc. These transitions are usually associated with equistability of two stable states, as can be determined by stationarity of a planar interface separating these states. For equilibrium systems, this criterion is equivalent to the Maxwell construction determining coexistence of two states at a unique equistability point. Analyses of nucleation phenomena near such transitions aims in part to characterize critical droplets of the more stable state embedded in the less stable metastable state, where these droplets correspond to stationary curved interfaces between the two states. There is a range of critical droplets and their critical sizes are expected to diverge when approaching the transition. The critical curvature which arrests propagation should vanish linearly approaching the transition. However, the analysis of discontinuous transitions in spatially discrete non-equilibrium systems also reveals an interface propagation failure. As a non-equilibrium counterpart to the classic Ising model, we consider stochastic lattice-versions of Schloegl's 2nd model involving spontaneous annihilation $X \to \varphi$ and autocatalytic creation$\varphi + 2X \leftrightarrow 3X$.

10:00-10:30, Wednesday, June 13

Speaker: Kai Tao (Hohai University)

Title: *TaiNon-perturbation of discrete analytic Schrodinger operators with skew-shift*

Abstract: We study the discrete analytic Schrodinger operators with the skew-shift mapping. We prove that if the coupling number is large, then the Lyapunov exponent is positive and week Holder continuous, and the spectrum satisfies Anderson Localization and contains large intervals. Moreover, all of these conclusions are non-perturbative.

11:00-11:30, Wednesday, June 13

Speaker: Jing Tian (Towson University)

Title: *On the mathematical modelling of turbulent flow*

Abstract: Turbulence is a pervasive, complex family of phenomena observed in nature, and has been a great challenge to mathematicians, physicists, engineers and computational scientists. It is widely accepted by the scientific community that turbulent flows are governed by the Navier-Stokes equations, for large values of the Reynolds numbers. In this talk, we will begin with a brief introduction to turbulence, Navier-Stokes equations and the existence and smoothness problem. We then discuss a turbulence modelling method, the Navier-Stokes-alpha model. With the hypothesis that the turbulence described by the Navier-Stokes-alpha model partly due to the roughness of the walls, we present the transition from the Navier-Stokes equations into the Navier-Stokes-alpha model by introducing a Reynolds type averaging.

11:30-12:00, Wednesday, June 13

Speaker: Hasi Bagan (Shanghai Normal University)

Title: *Combining rough sets and kernel subspace methods for remote sensing data classification*

Abstract: Multi-source remote sensing data provide complementary information, and their combination often leads to increased land cover classification accuracy. The quality of supervised classification map depends on the ground reference data and classification methods. However, training samples from urban multi-source remote sensing data are often mixed with noise, and classification of fused multi-source data requires classification methods of good generalization capability. Thisstudy purpose combine tolerance rough sets and kernel learning subspace methods for urban land cover classification using fused multi-source remote sensing data. Firstly, we develop a tolerance rough sets algorithm for effectively identifying and eliminating mislabeled training samples. Secondly, we propose a kernel principle component analysis for creating

basis vectors for class subspaces. Finally, we evaluate the classification accuracy and generalization ability of the combined tolerance rough sets and kernel learning subspace methods based on fused multi-source remote sensing data at high and medium spatial resolution, respectively. The research has potential to expand the roughsets and kernel methods for multi-source remote sensing data based urban land cover classification. The outcome of this study can effectively promote the application of multi-source remote sensing data in urban areas, which has both theoretical and practical significance.

12:00-12:30, Wednesday, June 13

Speaker: Zhaosheng Feng (University of Texas)

Title: *Dynamical behaviors to the KdV-Burgers-Kuramoto equation*

Abstract: In this talk, we consider the KdV-Burgers-Kuramoto equation, a partial differential equation that occupies a prominent position in describing some physical processes in motion of turbulence and other unstable process systems. Equivalence transformations are applied for exploring the principal Lie algebra. By means of the associated equivalence algebra we convert partial differential equations into a system of ordinary differential equations from which we can derive some explicit and implicit solutions.

SS 17. Nonlinear Dispersive Equations

Organizers: Marius Beceanu & Chengbo Wang

	June 11	June 12	June 13	June 14
Chair			***Yi Zhou***	
9:00-9:30			**Yu Deng**	
9:30-10:00			**Hao Jia**	
10:00-10:30			**Baoping Liu**	
10:30-11:00	**Tea Break**			
Chair		***Avy Soffer***		
11:00-11:30		**Yi Zhou**		
11:30-12:00		**Zhiwu Lin**		
12:00--12:30		**Dongbing Zha**		
12:30-14:00	**Lunch Break**			
Chair	***Marius Beceanu***	***Zhiwu Lin***		
14:00-14:30	**Avy Soffer**	**Shuanglin Shao**		
14:30-15:00	**Guixiang Xu**	**Xuecheng Wang**		
15:00-15:30	**Gong Chen**	**Junyong Zhang**		
15:30-16:00	**Tea Break**			
Chair	***Guixiang Xu***	***Chengbo Wang***		
16:00-17:30	**Shijun Zheng** (16:00-16:30)	**Ze Li** (6:00-16:30)		
	Qidi Zhang (16:30-17:00)	**Hua Wang** (16:30-17:00)		
	Reception		**Banquet** ***(by Invitation)***	

Venue: June 11th & 13th, Room 302; June 12th, Room 303, West Side Building, Guanghua Building

SS 17. Nonlinear Dispersive Equations

14:00-14:30, Monday, June 11

Speaker: Avy Soffer (Rutgers University)

Title: *Large time behavior of two-dimensional Euler and Navier-Stokes equations*

Abstract: We study the large time behavior of solutions to two-dimensional Euler and Navier-Stokes equations linearized about shear flows of the mixing layer type in the unbounded channel $T \times R$. Under a simple spectral stability assumption on a self-adjoint operator, we prove a local form of the linear inviscid damping that is uniform with respect to small viscosity. We also prove a local form of the enhanced viscous dissipation that takes place at times of order $\nu^{-\frac{1}{3}}$, ν being the small viscosity. To prove these results, we use a Hamiltonian approach, following the conjugate operator method developed in the study of Schrödinger operators, combined with a hypocoercivity argument to handle the viscous case.

14:30-15:00, Monday, June 11

Speaker: Guixiang Xu (Institute of Applied Physics and Computational Mathematics)

Title: *Long time dynamics of the solitary waves for the (generalized) derivative Schrödinger equations*

Abstract: We firstly show the existence/nonexistence of traveling waves for NLS with derivative (DNLS) by the structure analysis, ODE argument and the variational argument. Secondly, we consider the orbital stability of the (two)-solitary waves for the derivative Schrödinger equation in the energy space. Last, we will show the orbital instability of the solitary waves for the generalized derivative Schrodinger equation in the degenerate case. Our argument is based on the modulation analysis, the perturbation argument and the monotonicity formulas. These results are joint works with Prof. Changxing Miao and Xingdong Tang.

15:00-15:30, Monday, June 11

Speaker: Gong Chen (University of Toronto)

Title: *Strichartz estimates for wave and Klein-Gordon equations with potentials*

Abstract: I will briefly discuss some directed and reversed Strichartz estimates for wave and Klein-Gordon equations with potentials. Some of these results are joint work with Marius Beceanu.

16:00-16:30, Monday, June 11

Speaker: Shijun Zheng (Georgia Southern University)

Title: *Orbital stability for a class of nonlocal dispersive models*

Abstract: I will discuss the orbital stability and dynamics for some dispersive models including the nonlinear magnetic and fractional Schroedinger type equations with unbounded potentials. This study is motivated by related open questions in the field in order to understand the asymptotic behavior of wave functions for superfluidity as well as relativistic boson stars.

16:30-17:00, Monday, June 11

Speaker: Qidi Zhang (East China University of Science and Technology)

Title: *Almost global existence for the semi-linear Klein-Gordon equation on the circle*

Abstract: I will talk about long time existence for the semi-linear Klein-Gordon equation on the circle. We shall use the normal form method to show that the small solution for some type of this equation exists almost globally for almost every positive mass. This is a joint work with D.Y. Fang and Z. Han.

11:00-11:30, Tuesday, June 12

Speaker: Yi Zhou (Fudan University)

Title: *Uniqueness and stability of traveling waves to the time-like extremal hypersurface in Minkowski space*

Abstract: In this paper we will concern with the uniqueness and stability of traveling waves to the time-like extremal hypersurface in Minkowski space. For the existence and uniqueness of traveling wave solutions for timelike extremal surface in Minkowski space $R^{1+(n+1)}$, it can be considered the generalized Bernstein theorem. Furthermore, we also get the global stability for a class of traveling wave solutions to timelike extremal surface in (1+3) dimensional Minkowski space.

11:30-12:00, Tuesday, June 12

Speaker: Zhiwu Lin (Georgia Institute of Technology)

Title: *Dynamics near the solitary waves of the supercritical gKDV Equations*

Abstract: In this talk, we consider the dynamics of the supercritical gKDV equations near solitary waves in the energy space H^1. We construct smooth local center-stable, center-unstable and center manifolds near the manifold of solitary waves and give a detailed description of the local dynamics near solitary waves. In particular, the instability is characterized as following: any forward flow not starting from the center-stable manifold will leave a neighborhood of the manifold of solitary waves exponentially fast. Moreover, orbital stability is proved on the center manifold, which implies the uniqueness of the center manifold and the global existence of solutions on it. This is joint work with Jiayin Jin and Chongchun Zeng.

12:00-12:30, Tuesday, June 12

Speaker: Dongbing Zha (Donghua University)

Title: *Space-time L^2 estimates, regularity and almost global existence for elastic waves*

Abstract: We prove some new space-time L^2 estimates for perturbed linear elastic waves. By using it, we give the almost global existence for classical solutions with small weighted $H^4 \times H^3$ norm, which refines classical results due to John, Klainerman and Sideris. The radially symmetric case is also considered.

14:00-14:30, Tuesday, June 12

Speaker: Shuanglin Shao (University of Kansas)

Title: *On characterization of the sharp Strichartz inequality for the Schrödinger equation*

Abstract: In this talk, we discuss the extremal problem for the Strichartz inequality for the Schrödinger equation on R^3. We provide a new proof to the characterization of the extremal functions. The only extremal functions are Gaussian functions up to the natural symmetries of the Strichartz inequality, which was investigated previously by Foschi and Hundertmark-Zharnitsky. This is a joint work with Jin-Cheng Jiang.

14:30-15:00, Tuesday, June 12

Speaker: Xuecheng Wang (Tsinghua University)

Title: *Propagation of regularity for the 3D massive relativistic transport equations*

Abstract: We will talk about the propagation of regularity and the long time behavior of the 3D massive relativistic Vlasov-Wave type coupled systems for small localized initial data. In particular, we don't impose any compact support assumptions on the initial data.

15:00-15:30, Tuesday, June 12

Speaker: Junyong Zhang (Beijing Institute of Technology)

Title: *Strichartz estimates in conic singular spaces*

Abstract: We will consider a Schrödinger operator in conic singular space and discuss the Strichartz estimate for the dispersive equation associated with this operator. The main techniques are the microlocal analysis method and spectral analysis argument. This is a joint work with Jiqiang Zheng (Nice University, France).

16:00-16:30, Tuesday, June 12

Speaker: Ze Li (Institute of Mathematics, Academy of Mathematics and Systems Science)

Title: *Dynamic behaviors of geometric flows on hyperbolic planes*

Abstract: In this talk, we will introduce some of our recent works on dynamic behaviors of geometric flows especially on Landau-Lifshitz flows and wave maps on hyperbolic planes. In the first part, we talk about dynamics of 2 dimensional Landau-Lifshitz flows between hyperbolic planes. In fact, we prove that suitable initial data which may be seen as an arbitrary large perturbation of the harmonic maps will evolve into a global solution and converge to the perturbed harmonic map. The new idea is to construct caloric gauge in the case where nontrivial harmonic map exists and apply it to prove asymptotic behaviors beyond scattering. In the second part, we talk about the asymptotic stability of harmonic maps under the wave map equations between hyperbolic planes. The new idea is to use caloric gauge as a geometric linearization rather than directly linearizing the equation around the harmonic map.

16:30-17:00, Tuesday, June 12

Speaker: Hua Wang (Central Normal University of China)

Title: *Scattering and blow-up criteria for INLS with a potential*

Abstract: In this talk, we consider the 3d cubic focusing inhomogeneous nonlinear Schrödinger equation with a potential

$$iu_t + \Delta u - Vu + |x|^{-b}|u|^2u = 0, \quad (t,x) \in \mathbf{R} \times \mathbf{R}^3,$$

where $0 < b < 1$. We first establish global well-posedness and scattering for the radial initial data u_0 in $H^1(\mathbf{R}^3)$ satisfying $M(u_0)^{1-s_c}E(u_0)^{s_c} < \mathcal{E}$ and $\|u_0\|_{L^2}^{2(1-s_c)}\|H^{\frac{1}{2}}u_0\|_{L^2}^{2s_c} < \mathcal{K}$ provided that V is repulsive, where $\mathcal{E}$ and $\mathcal{K}$ are the mass-energy and mass-kinetic of the ground states, respectively. Our result extends the results of Hong (2016) and Farah-Guzmán (2016) with $b \in (0, \frac{1}{2})$ to the case $0 < b < 1$. We then obtain a blow-up result for initial data u_0 in $H^1(\mathbf{R}^3)$ satisfying $M(u_0)^{1-s_c}E(u_0)^{s_c} < \mathcal{E}$ and $\|u_0\|_{L^2}^{2(1-s_c)}\|H^{\frac{1}{2}}u_0\|_{L^2}^{2s_c} > \mathcal{K}$ if V satisfies some additional assumptions. This is a joint work with Qing Guo and Xiaohua Yao.

9:00-9:30, Wednesday, June 13

Speaker: Yu Deng (Courant Institute of Mathematical Sciences)

Title: *The linear Schrodinger equation on generic irrational tori*

Abstract: We prove long-time Strichartz estimates for solutions to the linear Schrodinger equation on generic irrational tori. This improves the recent work of Bourgain and Demeter. As an application, we also establish polynomial bounds for Sobolev norm of solutions to the energy critical nonlinear Schrodinger equation in 3D. Part of this work is joint with P. Germain, L. Guth and S. Myerson.

9:30-10:00, Wednesday, June 13

Speaker: Hao Jia (University of Minnesota)

Title: *Channel of energy for outgoing waves and application to wave maps*

Abstract: Channel of energy type inequalities, introduced by Duyckaerts-Kenig-Merle, have played an important role in understanding the dynamics of nonlinear wave equations. However these inequalities are mostly restricted to the radial setting and are sensitive to dimensions. Recently, a version for outgoing waves have been discovered which work for non-radial solutions in all dimensions. We will give an application of this inequality to energy critical wave maps, ruling out the so called null concentration of energy.

10:00-10:30, Wednesday, June 13

Speaker: Baoping Liu (Peking University)

Title: *The defocusing energy critical wave equation with a trapping potential*

Abstract: In this talk, we consider the defocusing energy critical wave equation with a trapping potential. When the potential decays fast enough, it is easy to show that all finite energy solutions exist globally, hence our main interest is to describe the long time dynamics. In the radial case, our previous works gave a complete answer and we were able to classify all the long time dynamics. Here we partly extend previous result to the nonradial case, and show that the set of initial data for which solutions scatter to an unstable excited state forms a finite co-dimensional path connected C1 manifold in the energy space. This gives us a better understanding of the non-generic behavior of solutions, with the generic behavior left as an open problem. This talk is based on joint works with Hao Jia, Wilhelm Schlag and Guixiang Xu.

SS 18. Number Theory

Organizers: Hourong Qin & Wei Zhang

	June 11	June 12	June 13	June 14
Chair				
9:00-9:45			**Xin Wan**	
9:45-10:30			**Hui Zhu**	
10:30-11:00	**Tea Break**			
Chair				
11:00-11:45		**Ye Tian**	**Fei Xu**	
11:45-12:30		**Lei Fu**	**Xuhua He**	
12:30-14:00	**Lunch Break**			
Chair				
14:00-14:45	**Xinyi Yuan**	**Wen-Ching Winnie Li**	**Chuangxun Cheng**	
14:45-15:30	**Ruochuan Liu**	**Ling Long**	**Steven Weintraub**	
15:30-16:00	**Tea Break**			
Chair				
16:00-16:45	**Kai-Wen Lan**	**Tong Liu**	**Miaofen Chen**	
16:45-17:30	**Yichao Tian**	**Liang Xiao**	**Shanwen Wang**	
	Reception		**Banquet** *(by Invitation)*	

Venue: Room 2001, East Main Tower, Guanghua Building

SS 18. Number Theory

14:00-14:45, Monday, June 11

Speaker: Xinyi Yuan (University of California, Berkeley)

Title: *Positivity of Hodge bundles of abelian varieties*

Abstract: Given a semi-abelian scheme over a projective curve over a field of characteristic 0, the Hodge (vector) bundle is known to be nef. However, in positive characteristics, the Hodge bundle can fail to be nef by an example of Moret-Bailly. Up to some simple operations on the semi-abelian scheme, we can even obtain a semi-abelian scheme with an ample Hodge bundle in some cases. We will also present some applications of this result.

14:45-15:30, Monday, June 11

Speaker: Ruochuan Liu (Peking University)

Title: *On slopes of modular forms*

Abstract: We will discuss recent progress on slopes of modular forms.

16:00-16:45, Monday, June 11

Speaker: Kai-Wen Lan (University of Minnesota, Twin Cities)

Title: *Local systems over Shimura varieties: a comparison between two constructions*

Abstract: Given a Shimura variety X associated with some algebraic group G, and some algebraic representation V of G (satisfying some conditions when restricted to the center), we can define two kinds of filtered vector bundles with integrable connections, over X. The first one is based on the classical complex analytic construction using double quotients, while the second one is a new p-adic analytic construction based on the p-adic Riemann-Hilbert correspondence in the recent work by Ruochuan Liu and Xinwen Zhu. We know how to relate these two when X is of Hodge type, using the relative cohomology of some family of abelian varieties over X. But what should we do when X is a general Shimura variety, in which case no convenient family of algebraic varieties (or, rather, "motives") are available? In this talk, we shall review the background materials and formulate the problem more precisely, and give an answer. (This is joint work with Hansheng Diao, Ruochuan Liu, and Xinwen Zhu.)

16:45-17:30, Monday, June 11

Speaker: Yichao Tian (MCM & AMSS, Chinese Academy of Sciences)

Title: *Beilinson-Bloch-Kato conjecture for Rankin-Selberg motives (Case of $GL(2) * GL(3)$)*

Abstract: This is part of a joint report with Liang Xiao on our ongoing collaboration project with Liang Xiao, Wei Zhang and Xinwen Zhu. In my talk, I will focus on the simplest non-trivial case of $GL(2) \times GL(3)$. I will state precisely what are the conditions needed for our method to work. Then I will discuss some key geometric ingredients for our proof, namely the reduction of certain unitary Shimura varieties at an inert but non-quasi-split primes.

11:00-11:45, Tuesday, June 12

Speaker: Ye Tian (MCM & AMSS, Chinese Academy of Sciences)

Title: *The converse to a theorem of Gross-Zagier and Klyvagin: CM case*

Abstract: Let E be an elliptic curve defined over rationals and p a prime. A theorem of Gross-Zagier and Kolyvagin says that if the analytic rank of E is one then the Mordell-Weil rank of E is also one and Shafarevich-Tate group of E is finite, and therefore the corank of p-Selmer group of E is one. In this talk, we show its converse: corank of p-Selmer group one implies analytic rank one when E has CM under some condition on p. This is a joint work with Burungale and Skinner.

11:45-12:30, Tuesday, June 12

Speaker: Lei Fu (Tsinghua University)

Title: *The p-adic Gelfand-Kapranov-Zelevinsky hypergeometric complex*

Abstract: To a torus action on a complex vector space, Gelfand, Kapranov and Zelevinsky introduce a system of differential equations, called the GKZ hypergeometric system. Its solutions are GKZ hypergeometric functions. We study the p-adic counterpart of the GKZ hypergeometric system. In the language of dagger spaces introduced by Grosse-Klönne, the p-adic GKZ hypergeometric complex is a twisted relative de Rham complex of meromorphic differential forms with logarithmic poles for an affinoid toric dagger space over the dagger unit polydisc. It is a complex of modules with integrable connections and with Frobenius structures defined on the dagger unit polydisc such that traces of Frobenius on fibers at Techmüller points define the hypergeometric function over the finite field introduced by Gelfand and Graev.

14:00-14:45, Tuesday, June 12

Speaker: Wen-Ching Winnie Li (Pennsylvania State University)

Title: *Distribution of Primes*

Abstract: The distribution of prime numbers has been one of the central topics in number theory. It has a deep connection with the zeros of the Riemann zeta function. The concept of "primes" also arises in other context. For example, in a compact Riemann surface, as introduced by Selberg, primitive closed geodesic cycles play the role of primes; while in a finite complex arising as a quotient of a building, for each positive dimension, there are primes of similar nature. In this talk we shall discuss the distributions of such primes and their connection with the analytic behavior of the associated zeta and **L**-functions.

14:45-15:30, Tuesday, June 12

Speaker: Ling Long (Louisiana State University)

Title: *Hypergeometric functions and arithmetic*

Abstract: Hypergeometric functions are a class of special functions with a lot of symmetries. There are also hypergeometric functions over finite fields that are useful for counting points on (hypergeometric) algebraic varieties. In this talk, we will discuss a few applications of hypergeometric functions to arithmetic problems including computing periods of modular forms (joint work with Wen-Ching Winnie Li and Fang-Ting Tu) and proving certain type of (super)congruences with arithmetic origin (joint work with Ravi Ramakrishna).

16:00-16:45, Tuesday, June 12

Speaker: Tong Liu (Purdue University)

Title: *Frobenius filtration and torsion comparison*

Abstract: We use A_∞ cohomology developed by Bhatt, Morrow and Scholze to study comparison between torsion etale cohomology and torsion crystalline cohomology. In particular, we extend part of Fontaine-Messing theory and Breuil-Caruso theory to allow formal proper smooth scheme. The key point is to connect the filtration defined by Frobenius of A_∞ cohomology with filtration defined by crystalline cohomology.

16:45-17:30, Tuesday, June 12

Speaker: Liang Xiao (University of Connecticut)

Title: *An analogue of Ihara's lemma for some even unitary groups and application*

Abstract: The classical Ihara's lemma states that the natural map

$$H^1_{\mathrm{et}}(X_0(N), \mathbb{F}_\ell)^{\oplus 2} \to H^1_{\mathrm{et}}(X_0(pN), \mathbb{F}_\ell)$$

for $p \nmid N$ is injective, when localized at a non-Eisenstein ideal. We formulate an analogous conjecture for even unitary groups, and give a proof using the geometry of Shimura varieties. This is a key ingredient or rather a stand-alone byproduct of a joint project with Yifeng Liu, Yichao Tian, Wei Zhang and Xinwen Zhu. If time permits, we will discuss its relation between the level raising for even unitary groups, and where it is used in project.

9:00-9:45, Wednesday, June 13

Speaker: Xin Wan (MCM, Chinese Academy of Sciences)

Title: *BSD formula for elliptic curves and modular forms*

Abstract: we introduce recent progresses on BSD formulas in the analytic rank 0 and 1 cases for elliptic curves and generalizations to modular forms. If time allows we also explain some main ideas.

9:45-10:30, Wednesday, June 13

Speaker: Hui June Zhu (University at Buffalo, the State University of New York)

Title: *p-adic distribution of zeta roots in Z_p tower of function fields*

Abstract: Considering a Z_p tower (C_n) of function fields in characteristic p, we prove that over the projective line with finite ramification points, if the genus of C_n is at most quadratic in p^n for n large enough, then the reciprocal roots of Zeta functions of C_n are uniformly distributed p-adically. Furthermore, for a large class of such Z_p tower, we prove the distribution is a finite union of arithmetic progressions. (Joint work with Michiel Kosters)

11:00-11:45, Wednesday, June 13

Speaker: Fei Xu (Capital Normal University)

Title: *Brauer-Manin obstruction for Markoff surfaces*

Abstract: Inspired by the recent work of Ghosh and Sarnak, we show that there are infinitely many Markoff surfaces which do not satisfy strong approximation with Brauer-Manin obstruction. This is a joint work with Colliot-Thelene and Dasheng Wei.

11:45-12:30, Wednesday, June 13

Speaker: Xuhua He (University of Maryland)

Title: *The good, and the not-bad*

Abstract: The problem of the reduction modulo p of a Shimura variety has a long and complicated history, perhaps beginning with Kronecker. It is known that the modular curve has good reduction at p if the level structure is prime to p. If the level structure is of $\Gamma_0(p)$-type, then the modular curve has semi-stable reduction. Are there other level structures such that the reduction modulo p is good, resp. is not-so-bad (i.e. semi-stable)?

A more precise interpretation of the question is to ask for good, resp. semi-stable, reduction of a specific class of p-integral models of Shimura varieties. It is known for a long time that the Drinfeld case has the semi-stable reduction. Very recently, Faltings discovered a new case of semi-stable reduction. This triggered our interest in the classification of semi-stable local models. In this talk, I will discuss the classification of the good and semi-stable reductions. It is based on a joint work with G. Pappas and M. Rapoport.

14:00-14:45, Wednesday, June 13

Speaker: Chuangxun Cheng (Nanjing University)

Title: *Displays and p-divisible formal groups*

Abstract: In this presentation, I will talk about the relation between displays and p-divisible groups. In particular, I will explain the result of Zink-Lau, which establishes equivalence between the category of nilpotent displays over R and the category of p-divisible formal groups over R, for those R in which p is nilpotent. Then I will explain a generalization of Zink-Lau's result and establish a similar equivalence between the category of nilpotent O-displays and the category of π-divisible formal O-modules. At the end, I will give several applications of the generalized result.

14:45-15:30, Wednesday, June 13

Speaker: Steven H. Weintraub (Lehigh University)

Title: *Behavior of a sequence associated to generalized continued fractions*

Abstract: We further our investigation of continued fractions with "numerator" an arbitrary positive integer N, which we refer to as cf_N expansions, begun with M. Anselm. Let E be a positive integer that is not a perfect square, and consider a periodic cf_N expansion of $\sqrt{E}$. (Our conjecture that for $N > 1$ the "best" cf_N expansion of $\sqrt{E}$ is not always periodic remains open.) Let C_n be the n-th convergent of this expansion, and write $C_n = \tilde{p}_n/\tilde{q}_n$ with $\tilde{p}_n$ and $\tilde{q}_n$ relatively prime positive integers. Set $\tilde{w}_n = \tilde{p}_n^2 - E\tilde{q}_n^2$. We conjectured that the sequence $\{\tilde{w}_n\}$ is always periodic up to a factor f. The present author has proved this conjecture. This generalizes the case $N = 1$, where, as is well-known, $f = (-1)^t$, where t is the length of the (necessarily periodic) continued fraction expansion of $\sqrt{E}$. While the information we obtain is not as detailed as in the case $N = 1$, where precise information is available (implying the existence of nontrivial solutions to Pell's equation), we present numerical examples to show that our results are in general best possible.

16:00-16:45, Wednesday, June 13

Speaker: Miaofen Chen (East China Normal University)

Title: *Fargues-Rapoport conjecture for some p-adic period domains*

Abstract: Rapoport and Zink introduce the p-adic period domain (also called the admissible locus) and the weakly admissible locus inside the rigid analytic p-adic flag varieties. Over the admissible locus, there exists a universal crystalline Qp-local system which interpolates a family of crystalline representations attached to all classical points. The weakly admissible locus is an approximation of the admissible locus obtained by removing a profinite set of closed Schubert varieties. In this talk, we will prove Fargues-Rapoport conjecture for the basic local Shimura datum which gives a group theoretic characterization when the admissible locus and the weakly admissible locus coincide. The main ingredient of the proof consists in a thorough study of modifications of G-bundles of Fargues-Fontaine curve. This is a joint work with Laurent Fargues and Xu Shen.

16:45-17:30, Wednesday, June 13

Speaker: Shanwen Wang (Fudan Univeristy)

Title: *Algebraic distributions and Euler systems*

Abstract: In this talk, we will explain a strategy of the construction of Euler systems, introduced by Colmez using the algebraic distribution.

SS 19. Numerical Analysis

Organizers: Jin Cheng & Jie Shen

	June 11	June 12	June 13	June 14
9:00-10:30				
10:30-11:00	**Tea Break**			
11:00-12:30				
12:30-14:00	**Lunch Break**			
Chair				
14:00-14:30	**Xiaoming Wang**	**Xiaoping Wang**	**Qi Wang**	
14:30-15:00	**Junshan Lin**	**Mejdi Azaiez**	**Tao Yin**	
15:00-15:30	**Jinru Chen**	**Ran Zhang**	**Jing Tian**	
15:30-16:00	**Tea Break**			
Chair				
16:00-16:30	**Kazufumi Ito**	**Hong Wang**	**Ricardo Delgadillo**	
16:30-17:00	**Wenbin Chen**	**Hongxing Rui**	**Xiaoyan Liu**	
17:00-17:30	**Jianguo Huang**	**Yanqiu Wang**	**Lijin Wang**	
	Reception		**Banquet** *(by Invitation)*	

Venue: Conference Room No.5, Fuxuan Hotel

SS 19. Numerical Analysis

14:00-14:30, Monday, June 11

Speaker: Xiaoming Wang (Fudan University)

Title: *Coupling and decoupling of free flow and porous media flow*

Abstract: Many natural and engineering processes involve the interaction of free flows and the flows in porous media. Well-known examples include flows in hyporheic zone, contaminant transport in karst aquifer, flows in PEM fuel cell, etc. We report results on the study of three inter-related important issues associated with the interaction of the different types of flows: (1) What are the appropriate interface boundary conditions that couples the free flow and the porous media flow? (2) Are there efficient and accurate numerical schemes that decouples the free-flow and porous media flow so that legacy codes can be utilized in numerical simulations? (3) Are there physically important parameter regimes where the two subsystems decouple naturally?

14:30-15:00, Monday, June 11

Speaker: Junshan Lin (Auburn University)

Title: *Integral equation methods for computing resonances in subwavelength metallic structures*

Abstract: The extraordinary electromagnetic field enhancement in subwavelength metallic structures is partially related to the resonances induced by tiny structures or plasmons. In this talk, I will introduce integral equation approaches for obtaining the resonances in two-dimensional structures. Both perfect electric conductors (PECs) and plasmonic metals will be discussed. For PECs, the integral equations lead to a resonance condition formulated by nonlinear equations, which can be solved very efficiently with an initial guess obtained from the asymptotic analysis. For plasmonic metals, a new integral equation formulation and a strategy for obtaining initial guess will be presented.

15:00-15:30, Monday, June 11

Speaker: Jinru Chen (Nanjing Normal University)

Title: *A conforming enriched finite element method for interface problems*

Abstract: A new conforming enriched finite element method is presented for interface problems with interface-unfitted meshes. For elliptic interface problems, the con-

forming enriched finite element space is constructed based on the P1-conforming finite element space. Approximation capability of the conforming enriched finite element space is analyzed. The standard conforming Galerkin method is considered without any penalty stabilization term. Our method does not limit the diffusion coefficient of the elliptic interface problem to a piecewise constant. Finite element errors in H1-norm and L2-norm are proved to be optimal.

For Stokes/Stokes-elliptic interface problems, the conforming enriched finite element pair is constructed based on the MINI element pair. A ghost penalty term is used in the standard discretization form as a stabilization term. An inf-sup stability result is derived, which is uniform with respect to the mesh size. Finite element errors are proved to be optimal. Our method breaks the limit of the immersed finite element method which can only deal with the constant jump coefficient and the case of identical governing equations on either side of the interface. Numerical experiments are carried out to validate theoretical results.

16:00-16:30, Monday, June 11

Speaker: Kazufumi Ito (North Carolina State University)

Title: *Semismooth Newton method for Quasi-variational inequalities and Hamilton-Jacobi Bellman equations*

Abstract: We consider a class of Quasi-variational inequalities and Hamilton-Jacobi Bellman equations and develop a Newton-like method. Free boundary problems and a multi-dimensional scalar conservation laws can be formulated and treated by our approach and method.

16:30-17:00, Monday, June 11

Speaker: Wenbin Chen (Fudan University)

Title: *Optimal convergence analysis of a mixed finite element method for fourth-order elliptic problems*

Abstract: A Ciarlet-Raviart type mixed finite element approximation is constructed and analyzed for a class of fourth-order elliptic problems arising from solving various gradient systems. Optimal error estimates are obtained, using a super-closeness relation between the finite element solution and the Ritz projection of the PDE solution. Numerical results agree with the theoretical analysis.

17:00-17:30, Monday, June 11

Speaker: Jianguo Huang (Shanghai Jiao Tong University)

Title: *A robust finite element method for elastic vibration problems*

Abstract: A robust finite element method is introduced for solving elastic vibration problems in two dimensions. The discretization in time is based on the P_1-continuous discontinuous Galerkin (CDG) method, while the spatial discretization on the Crouziex-Raviart (CR) element. It is proved that the error of the displacement (resp. velocity) in the energy norm (resp. L^2 norm) is bounded by $O(h+k)$ (resp. $O(h^2+k)$), where h and k denote the mesh sizes of the subdivisions in space and time, respectively. Under some regularity assumptions on the exact solution, the error bound is independent of the Lamé coefficients of the elastic material under discussion. Several numerical results are reported to illustrate numerical performance of the proposed method.

14:00-14:30, Tuesday, June 12

Speaker: Xiaoping Wang (Hong Kong University of Science and Technology)

Title: *The threshold dynamics method and applications*

Abstract: In this talk, I will review some recent work on the threshold dynamics method for diffusion generated motion of the interface on solid surface. We also analyze the contact line behavior of the method from asymptotic expansion and the contact line dynamics is also derived. Applications to wetting on solid surface, image segmentation are presented.

14:30-15:00, Tuesday, June 12

Speaker: Mejdi Azaiez (Bienvenue à Bordeaux INP)

Title: *Data reduction and applications*

Abstract: Model Reduction methods are nowadays basic numerical tools in the treatment of large-scale parametric problems appearing in real-world problems. They are applied with success, for instance, in signal processing, analysis of random data, solution of parametric partial differential equations and control problems, among others. In signal processing, Karhunen-Loève's expansion (KLE) provides a reliable procedure for a low dimensional representation of spatiotemporal signals. Different research communities use different terminologies for the KLE. It is named the proper orthogonal decomposition (PODin mechanical computation, referred to as the principal components analysis (PCA) in statistics and data analysis or called singular value decomposi-

tion (SVD) in linear algebra. These techniques allow large reduction of computational costs, thus making affordable the solution of many parametric problems of practical interest, otherwise out of reach.

The extension of KLE to the tensor representation of multivariate functions is, however, a challenging problem. Real problems are quite often multivariate. Let us mention, for instance the analysis of multivariate stochastic variables, simulation and control of thermal flows and multi-component mechanics, among many others. Some recent techniques have been introduced to build low-dimensional tensor decompositions of multivariate functions and data. Among them, the High-Order Singular Value Decomposition (HOSVD) provides low-dimensional approximation of tensor data, in a similar way as the Singular Value Decomposition allows to approximate bi-variate data . Also, the Proper Generalized Decomposition (PGD) appears to be well suited in many cases to approximate multivariate functions by low-dimensional varieties. However, in general there is not an optimal tensor of rank 3 or larger to approximate a given high-dimensional tensor.

In this talk we give a numerical study to compare the perfomance of some methods to build low-dimensional tensor decompositions of multivariate functions. we also present a recursive POD (R-POD), based upon the successive application of the bivariate POD to each of the modes obtained in the previous step. In each step only one of the parameters is active, while the set of the remaining parameters is considered as a passive single parameter. We introduce a feasible version of the R-POD, in which the expansion is truncated whenever the singular values are smaller than a given threshold. This provides a fast algorithm, as only a small number of modes is computed, just those required to achieve a targeted error level.

15:00-15:30, Tuesday, June 12

Speaker: Ran Zhang (Jilin University)

Title: *The weak Galerkin finite element method for eigenvalue problems*

Abstract: This talk is devoted to studying eigenvalue problem by the weak Galerkin (WG) finite element method with an emphasis on obtaining lower bounds. The WG method uses discontinuous polynomials on polygonal or polyhedral finite element partitions. As such it is more robust and flexible in solving eigenvalue problems since it finds eigenvalue as a min-max of Rayleigh quotient in a larger finite element space. We demonstrate that the WG methods can achieve arbitrary high order convergence. This is in contrast with classical nonconforming finite element methods which can only provide the lower bound approximation by linear elements with only the second order convergence. Numerical results are presented to demonstrate the efficiency and

accuracy of the WG method.

16:00-16:30, Tuesday, June 12

Speaker: Hong Wang (University of South Carolina)

Title: *Analysis and fast numerical methods of fractional differential equations*

Abstract: In this talk we will analyze the wellposedness of different types of fractional differential equations with different fractional Neumann boundary conditions. We will also go over lossless fast numerical methods for fractional partial differential equations on general convex domains.

16:30-17:00, Tuesday, June 12

Speaker: Hongxing Rui (Shandong University)

Title: *Superconvergence of MAC scheme for stokes and Navier-Stokes equations on non-uniform grids*

Abstract: The marker and cell (MAC) method, a finite volume method based on staggered grids, has been one of the simplest and most effective numerical schemes for solving the Stokes and Navier-Stokes equations. The superconvergence on uniform grids for Stokes equations has been observed since 1992 but numerical analysis was not obtained completely.

In this talk we will present the second order superconvergence in L2 norm for both velocity and pressure for the MAC scheme for Stokes and Navier-Stokes equations. We also obtain the second order superconvergence for some terms of H1 norm of the velocity, and the other terms of H1 norm are second order superconvergence on uniform grids. Numerical experiments using the MAC scheme show agreement of the numerical results with theoretical analysis.

Some corresponding and extended results such as staggered grids finite difference methods for Stokes-Darcy problems are also mentioned.

17:00-17:30, Tuesday, June 12

Speaker: Yanqiu Wang (Nanjing Normal University)

Title: *A nonconforming finite element on polygonal meshes*

Abstract: A nonconforming lowest order Crouzeix-Raviart type finite element is con-

structed on polygonal meshes. Local construction in each polygon depends on whether the polygon has odd or even number of vertices. Because of this, the topological structure of connected regions consisting of polygons with even number of vertices plays an essential role in understanding the global finite element space. To analyze such topological structure, a new technique tool using the concept of cochain complex and cohomology is developed. Despite the seemingly complicated theoretical analysis, implementation of the element is straight-forward. The nonconforming finite element method has optimal a priori error estimates and supporting numerical results are presented.

14:00-14:30, Wednesday, June 13

Speaker: Qi Wang (Beijing Computational Science Research Center)

Title: *Numerical approximations to thermodynamically consistent models*

Abstract: Thermodynamically consistent models are mandatory for describing nonequilibrium dynamics. These models obey not only a set of conservation laws, but also the thermodynamical laws, especially, the second law of thermodynamics. As the result, these model are endowed with good mathematical properties in terms of well-posedness. I will discuss a general strategy to develop numerical approximations to approximate these models so that the thermodynamical consistence is respected at the discrete level as well. Applications to materials and life science will be given.

14:30-15:00, Wednesday, June 13

Speaker: Tao Yin (Université Grenoble Alpes)

Title: *The hyper-singular boundary integral operators for scattering problems in elasticity and thermoelasticity*

Abstract: In this talk, the Galerkin boundary element method (BEM) is concerned for solving the three dimensional exterior elastic and thermoelastic wave scattering problems. New analytically accurate regularized formulations are derived for the hyper-singular boundary integral operators (BIOs) associated with the time-harmonic Navier equation and Biot system of linearized thermoelasticity. Using the derived regularized formulations, all the integrals involved in the weak forms of the hyper-singular BIOs are at most weakly-singular. In numerical implementations, all weakly-singular integrals are evaluated semi-analytically under a special local coordinate system. The accuracy of the regularized formulations is demonstrated using several numerical examples. This is a joint work with G. Bao and L. Xu.

15:00-15:30, Wednesday, June 13

Speaker: Jing Tian (Towson University)

Title: *On a 3D Finite Volume solver for an incompressible viscoelastic fluid system*

Abstract: In this study, we develop a Finite Volume solver for a 3D incompressible viscoelastic fluid system. The Finite Volume solver is implemented by using a high performance software OpenFOAM. We have imposed the divergence free condition as a constraint on the momentum equation to derive a pressure equation and a predictor-corrector procedure is applied when solving the velocity field. Both stability analysis and numerical experiments are given to show the robustness and accuracy of our algorithm.

16:00-16:30, Wednesday, June 13

Speaker: Ricardo Delgadillo (Michigan State University)

Title: *Gaussian Beam based algorithm for the time-dependent Kohn-Sham equations*

Abstract: In this paper, we develop a numerical scheme for solving the time-dependent Kohn-Sham (TDKS) equations asymptotically. Our strategy will be to use a single-step predictor-corrector algorithm to solve the TDKS equations. The novelty introduced in our algorithm is that it makes use of the Gaussian beam (GB) method to solve the time-dependent Shrödinger equation asymptotically. The GB method was developed to efficiently compute an approximate solution to the Shrödinger by using asymptotic analysis similar to the WKB method. The analysis shows that the GB method is a great approximation for systems in the semi-classical regime. This will enable us to study systems in Time-dependent density functional theory (TDDFT) in the limit $\hbar \to 0$ equivalently, in the limit as $N \to \infty$, where N is the number of particles in the system.

16:30-17:00, Wednesday, June 13

Speaker: Xiaoyan Liu (University of La Verne)

Title: *A highly accurate approximation of conic sections by quartic Bézier curves*

Abstract: A new approximation method for conic section by quartic Bézier curves is proposed. This method is based on the quartic B ézier approximation of circular arcs. We give the upper bound of Hausdorff distance between the conic section and the quartic Bézier curve, and also show that the approximation order is eight. And we prove that our approximation method has a smaller upper bound than previous quartic Bézier approximation methods. A quartic G_2-continuous spline approximation of conic

sections is obtained by using the subdivision scheme at the shoulder point of the conic section.

17:00-17:30, Wednesday, June 13

Speaker: Lijin Wang (University of Chinese Academy of Sciences)

Title: *Exponential discrete gradient schemes for stochastic differential equations*

Abstract: In this talk, we present a class of stochastic exponential discrete gradient schemes for SDEs with linear and gradient components in the coefficients. The root mean-square errors of the schemes are analyzed, and the structure-preserving properties of the schemes for SDEs with special structures are investigated. Numerical tests are performed to verify the theoretical results and illustrate the numerical behavior of the proposed methods.

SS 20. Operations Research

Organizers: Yanqin Bai, Yu-Hong Dai & Jiming Peng

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Deren Han
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<tr><td>11:45-12:30</td><td>Kees Roos</td><td>Sergiy Butenko</td></tr>
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Xiaojin Zheng
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<tr><td>14:45-15:30</td><td>Jeff Hong</td><td>Xin Chen</td></tr>
<tr><td>15:30-16:00</td><td colspan="4">Tea Break</td></tr>
<tr><td>Chair</td><td>Jeff Hong</td><td></td><td>Liwei Zhang</td><td></td></tr>
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<tr><td>16:30-17:00</td><td>Zhe Liang</td><td>Yanqin Bai</td></tr>
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(by invitation)</td><td></td></tr>
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Venue: June 11th and 14th, Yifu Science and Technology Building

June 12th and 13th Polyvalent Hall, Level 13, Guanghua Building.

SS 20. Operations Research

14:00-14:45, Monday, June 11

Speaker: Tamás Terlaky (Lehigh University)

Title: *Mixed integer second order cone optimization (MISOCO): conic cuts, warm start, and rounding*

Abstract: MISOCO has numerous applications in engineering sciences, finance, and healthcare, thus MISOCO has gained considerable interest in recent years. Efficient Interior Point Methods and software are available to solve continuous SOCO problems. The theory of Disjunctive Conic Cuts (DCCs) for MISOCO is well developed, and several recent papers prove the power of DCCs in solving in solving MISOCO problems. Recent developments, as the main focus of this presentation, include the identification of pathological disjunctions, the identification of the optimal partition, new efficient warm start strategies, and a novel rounding heuristic.

14:45-15:30, Monday, June 11

Speaker: L. Jeff Hong (City University of Hong Kong)

Title: *A Knockout-Tournament approach to large-scale indifference-Zone ranking and selection*

Abstract: Ranking and selection is similar to a sport tournament where the goal is to find a champion. Traditional R&S procedures typically compare the best with all competing K-1 alternatives. Motivated by the form of knockout tournaments typically used in tennis grand slams, we propose a R&S procedure where the best only needs to survive $\log_2$ K comparisons. We show that the procedure works well for large-scale problems and is particularly suitable for commercial cloud services. This is a joint work with Mr. Ying Zhong from City University of Hong Kong.

16:00-16:30, Monday, June 11

Speaker: Lei Zhao (Tsinghua University)

Title: *Optimal learning for urban delivery fleet allocation*

Abstract: In a two-tiered city logistics system, an urban logistics company usually partitions the urban area into regions and allocates its delivery fleet (e.g., vehicles, couriers) to these regions. On a daily basis, the delivery station in each region receives the delivery packages from the city distribution centers and delivers them to customers

within the region, using its allocated delivery vehicles. A tactical decision in such a city logistics system is the allocation of its delivery fleet to the regions to minimize the expected operational cost of the entire system. However, due to the complexity of the urban delivery operations and the day-to-day variance of the customer demand, an accurate evaluation of the expected operational cost associated with an allocation decision can be very expensive. We propose a learning policy that adaptively selects the fleet allocation to learn the underlying expected operational cost function by incorporating the value of information. Specifically, we exploit the monotonicity of the expected operational cost in the number of allocated delivery vehicles in a region and extend the idea of knowledge gradient with discrete priors (KGDP) with resampling and re-generation (KGDP-R & R). Our numerical results demonstrate the effectiveness of KGDP-R & R against other learning policies as well as its managerial implications as compared to heuristics in practice.

16:30-17:00, Monday, June 11

Speaker: Zhe Liang (Tongji University)

Title: *A fast column generation based algorithm to solve the flight recovery problem with airport capacity constraints and maintenance flexibility*

Abstract: We consider the flight recovery problem with airport capacity constraints and maintenance flexibility. The problem is to re-schedule flights and re-assign aircraft in real time with minimized recovery cost for airlines after disruptions occur. In most published studies, airport capacity and flexible maintenance are not considered simultaneously via an optimization approach. To bridge this gap, we propose a column generation heuristic to solve the problem. The framework consists of a master problem for selecting routes for aircraft and subproblems for generating routes. Airport capacity is explicitly considered in the master problem and swappable planned maintenances can be incorporated in the subproblem. Instead of discrete delay models which are widely adopted in much of the existing literature, in this work flight delays are continuous and optimized accurately in the subproblems. The continuous-delay model can improve the accuracy of the optimized recovery cost by up to 37.74%. The computational study based on real-world problems shows that the master problem gives very tight linear relaxation with small, often zero, optimality gaps. Large-scale problems can be solved within 30 min and the run time can be further shortened by parallelizing subproblems on more powerful hardware. In addition, from a managerial point of view, computational experiments reveal that swapping planned maintenances may bring a considerable reduction in recovery cost by about 20% and 60%, depending on specific problem instances. Furthermore, the decreasing marginal value of airport slot

quota is found by computational experiments.

17:00-17:30, Monday, June 11

Speaker: Xiaodong Hu (AMSS, Chinese Academy of Sciences)

Title: *Equilibria for robust routing of atomic players*

Abstract: Atomic routing games have attracted a great deal of attention over decades due to their various real-world applications, e.g., routing packets (vehicles) in communication (transportation) networks. We study the setting under incomplete information about edge costs, which is given by interval estimates. The players when making their path choices only know the interval estimates on edge costs, while the actual realization of each edge's cost can take any value from the corresponding interval, regardless of the values realized for other edges. Each player would select a path that is robust against the worst-case realization of uncertain edge costs which could happen to her. We adopt the minmax-regret criterion to model the robustness. Given a path (strategy) problem of the game, the maximum regret of a player is the worst-case difference between her total cost or her bottleneck cost and the optimum she could attain given a priori knowledge about actual realization of edge costs. The routing game is referred to as a robust routing game if every players aims at minimizing her maximum regret. An NE of this game, termed as robust Nash equilibrium (RNE), is a path problem under which no player can reduce her maximum regret by unilateral deviation.

Concerning this problem with bottleneck-type objective, in view of the general NP-hardness for determining the RNE existence, we study the special case where all intervals of edge costs have the same length. We prove that every RNE of this special case is an NE of the corresponding bottleneck routing games under complete information.

11:00-11:45, Tuesday, June 12

Speaker: Nick Sahinidis (Carnegie Mellon University)

Title: *ALAMO: Machine learning from data and first principles*

Abstract: We have developed the ALAMO methodology with the aim of producing a tool capable of using data to learn algebraic models that are accurate and as simple as possible. ALAMO relies on integer nonlinear optimization, derivative-free optimization, and global optimization to build and optimize models. We present the methodology behind ALAMO and comparisons with a variety of learning techniques, including the lasso.

11:45-12:30, Tuesday, June 12

Speaker: Kees Roos (Delft University of Technology)

Title: *A new method for solving the homogeneous feasibility problem*

Abstract: Finding a nonnegative nonzero vector in the null space of a matrix is a fundamental problem that arises in many applications. The same holds for its dual problem, which is the problem of finding a positive vector in the row space of a matrix. The first problem is called the Von Neumann problem, after John von Neumann, who proposed the first solution method in a private communication to George Dantzig in 1948; it has been published by Dantzig only in 1992 [1]. The second problem is the so-called Perceptron problem. The perceptron models a hypothetical nervous system, or machine, and is designed to illustrate some of the fundamental properties of intelligent systems [2].

Nowadays both problems find much interest in Artificial Intelligence, especially in Big Data and Machine Learning. Usually the problems that arise are so large that the standard methods for solving linear optimization problems (like the Simplex Method and Interior-Point Methods) fail to work. Therefore the emphasis is currently on the use of cleverly designed first-order methods. In our presentation we fucus on a new method that combines the Mirror-Prox method of Nemirovski [3] and a rescaling method introduced by Chubanov [4].

References

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[2] F. Rosenblatt. The Perceptron: a Probabilistic Model for Information Storage and Organization in the Brain. Psychological Review, 65(6):386–408, 1958.

[3] A. Nemirovski. Prox-method with rate of convergence O(1/t) for variational inequalities with Lipschitz continuous monotone operators and smooth convex-concave saddle point problems. SIAM J. Optim., 15(1):229–251, 2004.

[4] S.Chubanov. A polynomial projection algorithm for linear feasibility problems. Mathematical Programming, 153:687–713, 2015.

14:00-14:30, Tuesday, June 12

Speaker: Yong Xia (Beihang University)

Title: *S-lemma: extensions and new applications in nonconvex optimization*

Abstract: S-lemma is a fundamental tool in revealing hidden convexity of some nonconvex quadratic optimiztion problems. In this talk, we establish a generalized version of the classical S-lemma. As new applications, we globally solve a few nonconvex nonquadratic optimization problems raised in literature in polynomial time.

14:30-15:00, Tuesday, June 12

Speaker: Junfeng Yang (Nanjing University)

Title: *Progressive hedging algorithm: connections and a stochastic variant*

Abstract: Progressive hedging algorithm (PHA) was originally proposed by Rockafellar and Wets in 1991 for stochastic convex optimization. Recently, it was extended to solving stochastic variational inequality by Rockafellar and Sun. It is known that PHA is an application of the proximal point algorithm. In this talk,we establish its connections with the alternating direction method of multipliers and the Douglas-Rachford splitting method. A stochastic variant which can reduce the per iteration cost significantly is also discussed for stochastic variational inequality problems. This talk includes joint works with Xiaojun Chen, Defeng Sun and Yangyang Xu.

15:00-15:30, Tuesday, June 12

Speaker: Xiaojin Zheng (Tongji University)

Title: *Quadratic convex reformulation for nonconvex binary quadratically constrained quadratic programming via surrogate constraint*

Abstract: We investigate in this paper nonconvex binary quadratically constrained quadratic programming (QCQP) which arises in various real-life fields. We propose a novel approach of getting the quadratic convex reformulation (QCR) for this class of optimization problem. Our approach employs quadratic surrogate functions and convexifies all the quadratic inequality constraints to construct QCR. The price of this approach is the introduction of an extra quadratic inequality. The "best" QCR among the proposed family, in terms that the bound of the corresponding continuous relaxation is best, can be found via solving a semidefinite programming (SDP) problem. Furthermore, we prove that the bound obtained by the continuous relaxation of our best QCR is as tight as Lagrangian bound of binary QCQP. Computational experiment is also conducted to illustrate the solution efficiency improvement of our best QCR when applied in off-the-shell software.

11:00-11:45, Wednesday, June 13

Speaker: Oleg Burdakov (Linkoping University)

Title: *On solving saddle-point problems and non-linear monotone equations*

Abstract: Problem of finding saddle points for strictly convex-concave functions is considered. We present pseudo-orthogonal direction algorithms for solving this problem. They are extensions of some conjugate direction algorithms known in unconstrained optimization. For quadratic functions, hey converge to saddle points in a finite number of steps. In the non-quadratic case, the asymptotic rate of their convergence is quadratic. Extensions to non-linear monotone equations are discussed.

11:45-12:30, Wednesday, June 13

Speaker: Sergiy Butenko (Texas A&M University)

Title: *Asymptotic bounds for clustering problems in random graphs*

Abstract: For a simple, undirected graph, we consider the problem of finding a maximum-cardinality subset of vertices such that every connected component (cluster) in the corresponding induced subgraph satisfies a given property. We present asymptotic bounds on the optimal objective of this problem in uniform random graphs. These results are applied to specific cluster structures, such as cliques and clique relaxation models.

14:00-14:45, Wednesday, June 13

Speaker: Jiming Peng (University of Houston)

Title: *Assessing systemic risk in financial networks under incomplete information*

Abstract: Since the financial crisis in 2007-2008, the assessment and control of systemic risk has become one of the most important topics in economics and finance. In this talk, we introduce a new optimization model to assess the risk in a financial network for which only incomplete information is available. We develop an integrated approach that combine classical optimization techniques and introduce new optimization techniques to identify the worst-case scenario of the network structure. Numerical experiments demonstrate that the risk in the identified worst-case scenario is much more significant than what have been estimated in the literature.

14:45-15:30, Wednesday, June 13

Speaker: Xin Chen (University of Illinois)

Title: *On sparsity of the solution to a random quadratic optimization problem*

Abstract: We study the standard quadratic optimization problem (StQP), i.e. the problem of minimizing a quadratic form on the standard simplex. The StQP arises in numerous applications, and is known to be NP-hard. When the Hessian matrix of the quadratic objective function is randomly generated, we establish sparsity of its global optimal solution(s) for a broad class of the distributions by deriving a series of estimates involving, in particular, the random interval partitions induced by the order statistics of the elements.

16:00-16:30, Wednesday, June 13

Speaker: Liwei Zhang (Dalian University of Technology)

Title: *Convergence analysis on a smoothing approach to joint chance constrained programs*

Abstract: This report aims to solve the joint chance constrained programs (JCCP) by a DC (difference of two convex functions) function approach, which was established by Hong et al. [Oper. Res. 2011:59:617-630]. They used a DC function to approximate the chance constraint function $E[1[0,\infty](c(x,\xi))]$ and constructed a sequential convex approximation method to solve the approximation problem. A disadvantage of this method is perhaps that the DC function they used is nonsmooth. In this article, we first propose a class of smoothing functions to approximate the maximum function $c(.,z)$ and the indicator function $1[0,\infty](.)$. Then, we construct the conservative smooth DC approximation function to $E[1[0,\infty](c(x,\xi))]$ and obtain the smooth DC approximation problems to JCCPs. We show that the solutions of a sequence of smooth approximation problems converge to some Karush-Kuhn-Tucker point of JCCPs under a certain asymptotic regime.

16:30-17:00, Wednesday, June 13

Speaker: Yanqin Bai (Shanghai University)

Title: *Document classification via nonlinear metric learning*

Abstract: In this talk, we propose a nonlinear metric learning method with multiple kernels. For solving the problem, we develop an intrinsic steepest descent algorithm with adaptive step-size on symmetric positive definite matrices groups. Finally, we

show two experiments to demonstrate the performance the proposed nonlinear metric learning method and the steepest descent algorithm.

17:00-17:30, Wednesday, June 13

Speaker: Jia Liu (Xi'an Jiaotong University)

Title: *Stochastic geometric optimization with joint probabilistic constraints*

Abstract: This talk discusses geometric programs with joint probabilistic constraints. When the stochastic parameters are normally distributed and independent of each other, we approximate the problem by using piecewise linear functions, and transform the approximation problem into a convex geometric program. We prove that this approximation method provides a lower bound. Then, we design a sequential convex optimization scheme to find an upper bound. Finally, numerical tests are carried out on a stochastic shape optimization problem.

11:00-11:30, Thursday, June 14

Speaker: Xinwei Liu (Hebei University of Technology)

Title: *A primal-dual interior-point relaxation method for nonlinear programming*

Abstract: We present a primal-dual interior-point relaxation method for nonlinear programming problems, which is based on solving a particular logarithmic barrier positive relaxation problem with barrier and scaling parameters. A prominent feature of our method is that it does not require any primal or dual iterates to be interior-points, which provide a new approach for improving interior-point methods. A logarithmic barrier penalty function dependent on both primal and dual variables is used to prompt the global convergence of the method, where the penalty and barrier parameters are updated adaptively. Without assuming any regularity condition, it is proved that our method will terminate at an approximate KKT point of the original problem provided the barrier parameter tends zero. Otherwise, either an approximate infeasible stationary point or an approximate singular stationary point of the original problem will be found. Some preliminary numerical results are reported, which show that our algorithm is not only efficient for well-posed feasible problems, but also is applicable for some ill-posed feasible problems and some infeasible problems.

11:30-12:00, Thursday, June 14

Speaker: Yiran He (Sichuan University)

Title: *Perturbation theory of metric regularity*

Abstract: Metric regularity plays important roles in the fields of optimization and optimal control. It has been shown that metric regularity can be used to weaken the monotonicity of the mapping in the proximal point algorithm. A perturbation of a metrically regular mapping by a locally Lipschitz single-valued mapping is still metrically regular, but it is more difficult if the perturbation is by a set-valued mapping. This talk aims to analyze this topic.

12:00-12:30, Thursday, June 14

Speaker: Deren Han (Beihang University)

Title: *Alternating direction methods of multipliers for optimization problems involving nonconvex functions*

Abstract: The efficiency of the classic alternating direction method of multipliers has been exhibited by various applications for large scale separable optimization problems, both for convex objective functions and for nonconvex objective functions. While there are a lot of convergence analysis for the convex case, the nonconvex case is still an open problem and the research for this case is in its infancy. In this talk, we consider two classes of optimization problems involving nonconvex functions. The first case is the "strongly+weakly" convex model and the second on is the general nonconvex model. For both cases, by using different analysis techniques, we prove the global convergence of the algorithms, and under some further conditions on the problem's data, we also analyze the convergence rate.

SS 21. Ordinary Differential Equations and Dynamical Systems

Organizers: Jiangong You & Kening Lu

	June 11	June 12	June 13	June 14
Chair			***Maoan Han***	
9:00-9:30			**Dongmei Xiao**	
9:30-10:00			**Wenmeng Zhang**	
10:00-10:30			**Weinian Zhang**	
10:30-11:00	**Tea Break**			
Chair			***Dongmei Xiao***	
11:00-11:30			**Zhiren Wang**	
11:30-12:00			**Jinxin Xue**	
12:00-12:30			**Wen Huang**	
12:30-14:00	**Lunch Break**			
Chair	***Jiangong You***		***Weinian Zhang***	***Jifa Jiang***
14:00-14:30	**Xiangdong Ye**		**Shigui Ruan**	**Xiang Zhang**
14:30-15:00	**Maoan Han**		**Jifa Jiang**	**Jinqiao Duan**
15:00-15:30	**Dawei Yang**		**Zhenxin Liu**	**Qi Zhou**
15:30-16:00	**Tea Break**			
Chair	***Xiangdong Ye***		***Shigui Ruan***	***Xiang Zhang***
16:00-16:30	**Jianshe Yu**		**Weishi Liu**	**Ji Li**
16:30-17:00	**Xuanji Hu**		**Yi Wang**	**Zeng Lian**
17:00-17:30	**Yongluo Cao**		**Zengjie Du**	
	Reception		**Banquet** ***(by invitation)***	

Venue: Room 106, Think Tank Building

SS 21. Ordinary Differential Equations and Dynamical Systems

14:00-14:30, Monday, June 11

Speaker: Xiangdong Ye (University of Science and Technology of China)

Title: *Sequence entropy: results and questions*

Abstract: In this talk we will review some results realted to the sequence entropy and state some open questions.

14:30-15:00, Monday, June 11

Speaker: Maoan Han (Shanghai Normal University)

Title: *On the maximum number of periodic solutions for higher dimensional systems*

Abstract: In this paper, we study the problem of the maximum number of zeros of vector analytic real functions with a small parameter based on higher dimensional generalization of Rouch'e's theorem from complex analysis. Then using the obtained result we study the maximum number of periodic solutions for higher dimensional systems. Finally we present an application to autonomous systems.

15:00-15:30, Monday, June 11

Speaker: Dawei Yang (Suzhou University)

Title: *Geometric theory and ergodic theory of three-dimensional flows*

Abstract: Three dimensional flows are very interesting because of the existence of the Lorenz attractor, whose phenomenon is sometimes called the Butterfly Effect. In this talk, we would like to present some recent progress in the study of three-dimensional flow, from the geometric and ergodic perspective. From the geometric viewpoint, we have proved that any three-dimensional vector field can be accumulated either by Morse-Smale vector fields (very simple dynamics), or by vector fields with Smale's horseshoes (very chaotic dynamics); we also proved that any three-dimensional vector field can be accumulated either by homoclinic tangencies (related to Newhouse phenomena), or by global singular hyperbolic vector fields (the generalization of Lorenz-like dynamics). From the ergodic viewpoint, we have proved the existence of Sinai-Ruelle-Bowen measures of Lorenz-like attractors (even in the higher-dimensional case), and we have proved the large deviation property of the SRB measure; we have established the thermodynamics formalism theory for Lorenz-like attractor, and have proved

the intrinsic ergodicity of Lorenz-like attractors as a consequence. The talk is based on joint works with S. Crosivier, S. Gan, R. Leplaideur and J. Zhang.

16:00-16:30, Monday, June 11

Speaker: Jianshe Yu (Guangzhou University)

Title: *Modelling mosquito population suppression based on delay differential equations*

Abstract: Mosquito-borne diseases have threatened over half the world's human beings. The most conventional methods for the control of these diseases have been insecticide spraying or larval source eradication. These methods are not sustainable to keep the mosquito density below the epidemic risk threshold. More recently, a novel strategy to suppress the mosquito population has been implemented in Saizi island, Guangzhou, China, since 2015 . More than 95% of local population of Aedes Albopictus have been suppressed by releasing Wolbachia-infected male mosquitoes into natural mosquito population to induce cytoplasmic incompatibility (CI) that eggs of wild females fail to hatch if fertilized by sperm from an infected male. In this paper, we propose to model the mosquito population suppression with the help of a delay differential equation model describing the suppression effect by releasing Wolbachia-infected male mosquitoes in the field. We first give a detailed and complete description of the global dynamics of solutions of the delay differential equation. And then, our analysis determines the release threshold denoted by $\hat{r}$ for the mosquito suppression. When the release rate is above $\hat{r}$, it will guarantee the suppression effect, whereas when it is below $\hat{r}$, it will miss our aim.

16:30-17:00, Monday, June 11

Speaker: Xuanji Hu (Huazhong Normal University)

Title: *Construction of quasi-periodic schrödinger operators with cantor spectrum*

Abstract: It is well known that, for fixed Diophantine frequencies and generic small smooth or analytic quasi-periodic potentials, both continuous and discrete Schrödinger operators have Cantor spectrum. However, so far there is no concrete example in the continuous case, and there is no concrete example besides the cosine-like potentials in the discrete case. In this paper, we present a strategy for explicitly constructing quasi-periodic Schrödinger operators with Cantor spectrum (Joint work with Y. Shan and J. You).

17:00-17:30, Monday, June 11

Speaker: Yongluo Cao (East China Normal University Soochow University)

Title: *The continuity of the Caratheodory singular dimension for nonconformal repellers*

Abstract: In this talk, we report some recent results about the estimates of dimension for nonconformal repellers. Furthermore, using the logarithms of the singular values of derivative as pontential for nonconformal repellers, we define its Caratheodory singular dimension and consider the continuity of the Caratheodory singular dimension with respect to the maps. This is joint work with Pesin and Yun Zhao.

9:00-9:30, Wednesday, June 13

Speaker: Dongmei Xiao (Shanghai Jiao Tong University)

Title: *Competitive exclusion or coexistence in competitive LV systems*

Abstract: In this talk, I will introduce competitive Lotka-Volterra systems in a constant and homogeneous environment and in inhomogeneous advective environment, respectively . In biology, we try to understand which factors affect the outcome of the competition: competitive exclusion or typies of coexistence. In mathematics we wonder if the global dynamics of the systems can be deduced from its local dynamics.

9:30-10:00, Wednesday, June 13

Speaker: Wenmeng Zhang (Chongqing Normal University)

Title: *Smooth linearization and its dependence on parameters for hyperbolic diffeomorphisms*

Abstract: Smooth linearization means converting a non-linear system into a linear one by a smooth coordination transformation. The theory of Belitskii's C1 linearization together with its dependence on parameters was used in [M. Field et al., Ann. Math. 2007, 166: 269-291], but the part of dependence was not proved yet. In this talk, we introduce some new results on smooth linearization and its dependence on parameters. Moreover, we also discuss the possibility of proving the dependence of Belitskii's C1 linearization on parameters.

10:00-10:30, Wednesday, June 13

Speaker: Weinian Zhang (Sichuan University)

Title: *Invariant manifolds with/without spectral gap*

Abstract: In this talk we discuss invariant manifolds obtained with or without a spectral gap condition, showing approximation to weak hyperbolic manifolds (with gap condition) and giving the existence and smoothness for invariant submanifolds on a center manifold (without gap condition).

11:00-11:30, Wednesday, June 13

Speaker: Zhiren Wang (Penn State University)

Title: *A criterion for existence of invariant probability measures under lattice actions*

Abstract: The aim of this talk is to explain a criterion that, for a differentiable action by a higher rank lattice action, uses non-resonance between Lyapunov exponents and roots of the ambient Lie group to guarantee the existence of invariant probability measures. This is a joint work with A. Brown and F. Rodriguez Hertz.

11:30-12:00, Wednesday, June 13

Speaker: Jinxin Xue (Tsinghua University)

Title: *On C^0 and C^1 Liouville Arnold theorem*

Abstract: The classical Liouville Arnold theorem is a fundamental result on integrable systems. It says that a Hamiltonian system with n degrees of freedom with n commuting independent integrals and compact level sets can be locally written as the cotangent bundle of n-torus on which the dynamics is linear flow on each leaf. Note that to define the flow, the Hamiltonian is necessarily C^2. In this talk, we explain that how to relax the C^2 assumption to C^1 to get a C^1 version of the Liouville Arnold theorem, using Herman-Yoccoz theory, weak KAM theorem and C^0 symplectic dynamics. We also explore the C^0 version of Liouville Arnold theorem using C^0 symplectic dynamics. This is a joint work with Marie-Claude Arnaud.

12:00-12:30, Wednesday, June 13

Speaker: Wen Huang (University of Science and Technology of China)

Title: *Local stable and unstable sets for positive entropy C1 dynamical systems*

Abstract: For any C1 diffeomorphism on a smooth compact Riemannian manifold that admits an ergodic measure with positive entropy, a lower bound of the Hausdorff dimension for the local stable and unstable sets is given in terms of the measure-theoretic entropy and the maximal Lyapunov exponent. The mainline of our approach to this result is under the settings of topological dynamical systems, which is also applicable to infinite dimensional C1 dynamical systems. This is a joint work with Shilin Feng, Rui Gao and Zeng Lian.

14:00-13:30, Wednesday, June 13

Speaker: Shigui Ruan (University of Miami)

Title: *Periodic solutions of abstract semilinear equations with applications to biological models*

Abstract: We study the existence of periodic solutions to the abstract semilinear equation

$$\frac{du}{dt} = A(t)u(t) + F(t, u(t)), \quad t \geq 0$$

in a Banach space X, where $A(t)$ is a T-periodic linear operator on X (not necessarily densely defined) satisfying the hyperbolic conditions, and $F : [0, \infty) \times \overline{D(A)} \to X$ is continuous and T-periodic in t. The idea is to combine Poincare map technique with fixed point theorems to derive various conditions on the operator $A(t)$ and the map $F(t, u)$ to ensure that the abstract evolution equation has periodic solutions. Three cases are considered: (i) If $A(t) = A$ is time-independent and is a Hille-Yoshida operator, conditions on F are given to guarantee the existence of mild periodic solutions; (ii) If $A(t)$ is time-dependent and satisfies the hyperbolic condition, sufficient conditions on $A(t)$ and F are presented to ensure the existence of mild periodic solutions; (iii) If $A(t) = A$ is time-independent, is a Hille-Yoshida operator and generates a compact semigroup on $\overline{D(A)}$, the existence of mild periodic solutions is also discussed. As applications, the main results are applied to establish the existence of periodic solutions in a delayed periodic red-blood cell model; age-structured models with periodic harvesting, and diffusive logistic equations with periodic coefficients. (Based on joint work with Qiuyi Su).

14:30-15:00, Wednesday, June 13

Speaker: Jifa Jiang (Shanghai Normal University)

Title: *Decomposition formula and stationary measures for stochastic Lotka-Volterra system with applications to turbulent convection*

Abstract: Motivated by the remarkable works of Busse and his collaborators in the 1980s on turbulent convection in a rotating layer, we explore the long-run behavior of stochastic Lotka-Volterra (LV) systems both in pull-back trajectories and in stationary measures. A decomposition formula is established to describe the relationship between the solutions of stochastic and deterministic LV systems and the stochastic logistic equation. By virtue of this formula, it can be verified that every pull-back omega limit set is an omega limit set of the deterministic LV system multiplied by the random equilibrium of the stochastic logistic equation. The formula is also used to derive the existence of a stationary measure, its support and ergodicity. We prove the tightness of stationary measures and that their weak limits are invariant with respect to the corresponding deterministic system and supported in the Birkhoff center. The developed theory is successfully utilized to completely classify three dimensional competitive stochastic LV systems into 37 classes. The expected occupation measures weakly converge to a strongly mixing measure and all stationary measures are obtained for each class except class 27 c). Among them there are two classes possessing a continuum of random closed orbits and strongly mixing measures supported in cone surfaces, which weakly converge to the Haar measures of periodic orbits as the noise intensity vanishes. In the exceptional class 27 c), almost every pull-back trajectory cyclically oscillates around the boundary of the stochastic carrying simplex characterized by three unstable stationary solutions. The limit of the expected occupation measures is neither unique nor ergodic. These are subject to turbulent characteristics. This is a joint work with Chen Lifeng and Dong Zhao, Niu Lei and Zhai Jianliang.

15:00-15:30, Wednesday, June 13

Speaker: Zhenxin Liu (Dalian University of Science and Engineering)

Title: *Recurrent solutions for stochastic differential equations*

Abstract: In this talk, we will discuss the problem of recurrence (in particular stationarity, periodicity, quasi-periodicity, Bohr almost periodicity, Bohr almost automorphy, Birkhoff recurrence, almost recurrence in the sense of Bebutov, Levitan almost periodicity, pseudo-periodicity, pseudo-recurrence, Poisson stability) of solutions for semi-linear stochastic equations by the comparability method.

16:00-16:30, Wednesday, June 13

Speaker: Weishi Liu (University of Kansas)

Title: *Poisson-Nernst-Planck systems and Ion channel problems*

Abstract: Poisson-Nernst-Planck (PNP) type systems serve as basic primitive models for ionic flow through ion channels. Mathematical analysis of PNP models plays crucial roles in understanding of ionic flow properties. In this talk, we will present a dynamical system framework for an analysis of PNP systems and report a number of results that have direct implications to ionic flow properties.

16:30-17:00, Wednesday, June 13

Speaker: Yi Wang (University of Science and Technology of China)

Title: *Invariant cone families in infinite-dimensional dynamical systems*

Abstract: In this talk, we will report some recent progress on the invariant cone families (ICF) in infinite-dimensional dynamical systems. For linear cocycles, we will discuss the close relation of the ICF with Multiplicative Ergodic Theorem, dominated splitting (exponential separation), as well as Krein-Rutman Type Theorem. For nonlinear cocycles, we show that ICF plays a key role in investigating the dynamics of nonautonomous parabolic equations on the cycle or on the higher-dimensional domain with symmetry. In particular, we show the appearance of almost periodically (automorphically) forced circle flow and the asymptotic symmetry for infinite-dimensional systems generated by these nonlinear parabolic equations.

17:00-17:30, Wednesday, June 13

Speaker: Zengjie Du (Jiangsu Normal University)

Title: *The existence of solitary wave solutions of delayed Camassa-Holm equation via a geometric approach*

Abstract: In this talk, we discuss the Camassa-Holm equation, which is a model for shallow water waves. We first establish the existence of solitary wave solutions for the equation without delay. And then we prove the existence of solitary wave solutions for the equation with a special local delay convolution kernel and a special nonlocal delay convolution kernel by using the method of dynamical system, especially the geometric singular perturbation theory and invariant manifold theory. According to the relationship between solitary wave and homoclinic orbit, the Camassa-Holm equation is transformed into the ordinary differential equations with fast variables by using the

variable substitution. It is proved that the equation with disturbance also possesses homoclinic orbit, and there exists solitary wave solution of the delayed Camassa-Holm equation. (jointly with Ji Li and Xiaowan Li).

14:00-14:30, Thursday, June 14

Speaker: Xiang Zhang (Shanghai Jiao Tong University)

Title: *Slow-fast systems: turning point theory and its application*

Abstract: In this talk, we introduce our recent results on turning point theory, which causes stability loss delay phenomena, of singularly perturbed systems. As an application of our theory, we study the existence of relaxation oscillation of a model from bioeconomy. The main tools are geometric singular perturbation theory including blow–up techniques.

14:30-15:00, Thursday, June 14

Speaker: Jinqiao Duan (Illinois Institute of Technology & Huazhong University of Science and Technology)

Title: *Geometrical methods for stochastic dynamics*

Abstract: Dynamical systems arising in engineering and science are often subject to random fluctuations. The noisy fluctuations may be Gaussian or non-Gaussian, which are modeled by Brownian motion or α-stable Levy motion, respectively. Non-Gaussianity of the noise manifests as nonlocality at a "macroscopic" level. Stochastic dynamical systems with non-Gaussian noise (modeled by α-stable Levy motion) have attracted a lot of attention recently. The non-Gaussianity index α is a significant indicator for various dynamical behaviors. The speaker will overview recent advances in geometrical methods for stochastic dynamical systems, including random invariant sets, random invariant manifolds, stochastic bifurcation, mean exit time, escape probability, tipping time, most probable orbits, and transition pathways between metastable states.

15:00-15:30, Thursday, June 14

Speaker: Qi Zhou (Nanjing University)

Title: *Exponential dynamical localization: criterion and its applications*

Abstract: We give a criterion for exponential dynamical localization in expectation for ergodic families of operators acting on $\ell^2(\mathcal{Z}^d)$. As applications, we prove exponential dynamical localization in expectation for almost Mathieu operator in the supercritical region. We also prove exponential dynamical localization in expectation a class of high dimension analytic long-range operator.

16:00-16:30, Thursday, June 14

Speaker: Ji Li (Huazhong University of Science and Technology)

Title: *On traveling wave of viscous Camassa Holm equation*

Abstract: Camassa Holm equation is a model for shallow water wave. The traveling wave of the invisic CH equation is discussed first in terms of phase analysis. The second part is about the viscous CH equation. For non critical cases, the relation of wave height and wave speed is provided. For critical case, the existence and non existence of solitary wave is discussed. Geometric singular perturbation theory is applied.

16:30-17:00, Thursday, June 14

Speaker: Zeng Lian (Sichuan University)

Title: *On the dynamics of uniformly hyperbolic systems driven by an external force*

Abstract: Study on hyperbolic systems has a long history and quite a lot of remarkable results has been derived in field. In this talk, I will report our recent study on the dynamics of uniformly hyperbolic systems driven by an external force, of which we derived the existence of periodic structures and horseshoes. This is the joint work with Wen Huang and Kening Lu.

SS 22. Partial Differential Equation--Elliptic and Parabolic

Organizers: Xinan Ma & Lihe Wang

	June 11	June 12	June 13	June 14
Chair				
9:00-9:40			**Lihe Wang**	
9:45-10:25			**Chuanqiang Chen**	
10:30-11:00	**Tea Break**			
Chair				
11:00-11:40		**Xuefeng Wang**	**Zhizhang Wang**	
12:30-14:00	**Lunch Break**			
Chair				
14:00-14:45	**Zhiqiang Wang**	**Chunpeng Wang**	**Free Discussion** **Wang Lihe ***	
14:45-15:30	**Dongsheng Li**	**Kelei Wang**		
15:30-16:00	**Tea Break**			
Chair				
16:00-16:45	**Xing Liang**	**Shuangjie Peng**		
16:45-17:30	**Chunjing Xie**	**Genggeng Huang**		
	Reception		**Banquet** ***(by Invitation)***	

Venue: June 11th, June 12th(afternoon), June 13th : Room 208, West Side Building, Guanghua Building. June 12th(morning), 106 Think Tank Building.

SS 22: Partial Differential Equation–Elliptic and Parabolic

14:00-14:40, Monday, June 11

Speaker: Zhiqiang Wang (Tianjin University & Utah State University)

Title: *Localized bound statess for semiclassical nonlinear Schrödinger equations*

Abstract: We discuss the existence of localized sign-changing solutions for the semiclassical nonlinear Schrödinger equations. When the potential V has a local minimum point P, as $\epsilon \to 0$, we construct an infinite sequence of localized sign-changing solutions clustered at P and these solutions are of higher topological type in the sense that they are obtained from a minimax characterization of higher dimensional symmetric linking structure. Our method is rather robust without using any non-degeneracy conditions.

14:45-15:25, Monday, June 11

Speaker: Dongsheng Li (Xi'an Jiaotong University)

Title: *Asymptotic Behavior of solutions of Monge-Ampère Equations in Half Spaces*

Abstract: We study the asymptotic behavior at infinity of convex viscosity solutions of Monge-Ampère equations in half spaces. Namely, we prove that any convex viscosity solution of $\det D^2 u = f$ in R^n_+ tends to a quadratic polynomial at infinity with at least $|x|^{1-n}$ decay if u is a quadratic polynomial on ∂R^n_+ , $f = 1$ outside a bounded domain and for some $0 < \mu < 1$, $\mu|x|^2 \le u \le \mu^{-1}|x|^2$ as $|x| \to \infty$.

16:00-14:40, Monday, June 11

Speaker: Liang Xing (University of Science and Technology of China)

Title: *Spreading Speeds of Nonlocal KPP Equations via Generalized Principal Eigenvalues and Homogenization*

Abstract: In this talk, I will introduce the theory of generalized principal eigenvalues and the homogenization methods of nonlocal diffusion equations. Based on these techniques, we will show the spreading properties of nonlocal KPP equations in heterogeneous medias.

16:45-17:25, Monday, June 11

Speaker: Chunjing Xie (Shanghai Jiao Tong University)

Title: *Subsonic flows in nozzles and asymptotic behavior for elliptic equations in cylindrical domains*

Abstract: In this talk we will address the wellposedness theory and asymptotic behavior for subsonic flows in nozzles. The results also share the feature for the solutions of general elliptic equations in cylindrical domains. The basic techniques are energy estimate and Harnack estimate.

11:00-11:40, Tuesday, June 12

Speaker: Xuefeng Wang (Southern University of Science and Technology)

Title: *Using effective boundary conditions to model fast diffusion on a road in a large field*

Abstract: We consider a logistic diffusion equation on the plane consisting of two components, a straight "road" and a "field", in each of which the diffusion rate differs significantly. Compared to the size of the field, the width of the road is assumed to be small. Thus in this diffusion equation multiple scales appear in two places: the spatial variable and the diffusion parameter. Such an equation is not easy to solve numerically, and it is not easy to see the effects of the road. Recently, Berestycki, Roquejo?re and Rossi provide a model which is meant to resolve these issues. On the hand, we first use the idea of effective boundary conditions (EBCs) to propose, rigorously, a different model: we study the limit of the solution of the original logistic equation as the width of the road approaches zero, obtaining a limiting model, in which the road now is the horizontal line with EBCs imposed on it. This effective problem has no multiple scales and hence should be easier to solve numerically. Moreover, to see the effects of the road, we further investigate the asymptotic propagation speed of the e?ective model, showing that the road indeed enhances the spreading speed along any direction within a certain angle with the road, provided that the diffusion rate on the road is of the order of the reciprocal of the width of the road.

14:00-14:40, Tuesday, June 12

Speaker: Chunpeng Wang (Jilin University)

Title: *Subsonic and Sonic Jet Flows for Given Surrounding Pressures from Convergent Nozzles*

Abstract: This talk concerns the compressible subsonic and sonic jet flows for a given

surrounding pressure from a two-dimensional finitely long convergent nozzle with straight solid wall. For a given surrounding pressure and a given incoming mass flux, we seek a subsonic or sonic jet flow with the given incoming mass flux such that the flow velocity at the inlet is along the normal direction, the flow satisfies the slip condition at the wall, and the pressure of the flow at the free boundary coincides with the given surrounding pressure. The well-posedness is shown and the properties of the flow are investigated.

14:45-15:25, Tuesday, June 12

Speaker: Kelei Wang (Wuhan University)

Title: *Simons cone and saddle solutions of the Allen-Cahn equation*

Abstract: Simons cone plays an important role in the study of the Bernstein problem for minimal hypersurfaces. For the Allen-Cahn equation, a similar conjecture of De Giorgi states that monotone solutions or minimizers in low dimensions are one dimensional, a property similar to the flatness of minimal hypersurfaces in the Bernstein problem. As in the minimal surfaces, it is also believed that in dimension 8 and higher there are minimizers which are not one dimensional. Some examples will be discussed in this talk. We will also discuss some properties of saddle solutions, a direct counterpart of Simons cone in the Allen-Cahn problem. This is a joint work with Yong Liu and Juncheng Wei.

16:00-16:40, Tuesday, June 12

Speaker: Shuanjie Peng (Central China Normal University)

Title: *Some results on planar vortex patch in incompressible steady flow*

Abstract: In this talk, we investigate a steady planar flow of an ideal fluid in a bounded domain and focus on the existence and uniqueness of vortex for the vortex patch problem with prescribed vorticity strength. We will also introduce some recent results on this problem.

16:45-17:25, Tuesday, June 12

Speaker: Genggeng Huang (Fudan University)

Title: *Error Estimates for the Monge-Ampere Equation*

Abstract: In this talk, we talk about error estimates for solutions to the Dirichlet problem of the Monge-Ampere equation $\det D^2 u = f$ in Ω, where f is a positive and continuous function and Ω is a bounded convex domain in the Euclidean space $\mathbb{R}^n$. We approximate the solution u by a sequence of convex polyhedra v_h, which are generalised solutions to the Monge-Ampère equation in the sense of Aleksandrov, and the associated Monge-Ampère measures ν_h are supported on a properly chosen grid in Ω. We will derive error estimates for the cases when f is smooth, Hölder continuous, and merely continuous. This is a joint work with Haodi Chen and Xu-Jia Wang.

16:45-17:25, Tuesday, June 12

Speaker: Lihe Wang ()

Title: *To be announced.*

Abstract: To be announced.

9:45-10:25, Wednesday, June 13

Speaker: Chuanqiang Chen (Zhejiang University of Technology)

Title: *Smooth solutions to the L_p-Dual Minkowski problem*

Abstract: In this talk, we consider the L_p-dual Minkowski problem. By studying the a priori estimates and curvature flows, we establish the existence theorem of the smooth solutions. This is a recent joint work with Yong Huang, and Yiming Zhao.

11:00-11:40, Wednesday, June 13

Speaker: Zhizhang Wang (Fudan University)

Title: *On the curvature estimates for Hessian equations*

Abstract: The curvature estimates for k curvature equations with general right hand sides is a longstanding problem. In this paper, we completely solve the problem when k=n-1. We also discuss some applications of our estimates.

SS 23. Partial Differential Equations--Hyperbolic

Organizers: Hongjie Dong & Zhen Lei

	June 11	June 12	June 13	June 14
9:00-10:30				
10:30-11:00	Tea Break			
11:00-12:30				
12:30-14:00	Lunch Break			
Chair	*Hongjie Dong*	*Zhen Lei*		*Changyou Wang*
14:00-14:30	Changyou Wang	Hao Jia		Chunpeng Wang
14:30-15:00	Haigang Li	Wei Wang		Chengjie Liu
15:00-15:30	Yi Wang	Peng Qu		
15:30-16:00	Tea Break			
Chair	*Chunjing Xie*	*Hao Jia*		
16:00-16:30	Hongjie Dong	Yu Deng		
16:30-17:00	Ting Zhang	Chunjing Xie		
17:00-17:30	Yanjin Wang	Yifei Wu		
	Reception		Banquet (by Invitation)	

Venue: June 11th, Room 3104, No.3. Lecture Hall Building

June 12th, Room 206, June 14th, Room 304, West Side Building, Guanghua Building.

SS 23. Partial Differential Equations–Hyperbolic

14:00-14:30, Monday, June 11

Speaker: Changyou Wang (Purdue University)

Title: *A variational problem arising from the optimal design of heat insulation*

Abstract: I will describe a minimization problem:

$$\inf\{E(u,\Omega) = \int_\Omega (1/2|Du|^2 - u)dx + (\int_{\partial\Omega} |u|d\sigma)^2\}$$

over $u \in H^1(\Omega)$ and $volume(\Omega) = 1$. This minimization problem results from an optimal design for heat insulation. I will report some recent result on the existence of such a minimization problem, that involves the free boundary issues. I will also discuss a result on the stability of the unit ball solution. This is a joint work with Qinfeng Li and Hengrong Du from Purdue University.

14:30-15:00, Monday, June 11

Speaker: Haigang Li (Beijing Normal University)

Title: *Babuska problem in composite materials*

Abstract: In high-contrast fiber-reinforced composite materials, the stress concentration is a common phenomenon, which always causes damage initiation. The problem is modeled by a class of second order elliptic equations and systems of divergence form, with discontinuous coefficients. For the original problem proposed by Ivo Babuska concerning the system of linear elasticity, we develop an iteration technique with respect to the energy integral to overcome the difficulty from the lack of maximal principle and obtain the optimal blow-up rates of the gradients when two inclusions are close to touch. Our results hold for convex inclusions with arbitrary shape and in all dimensions. For the scalar case, we further establish an explicit dependence of the derivatives on the ellipticity coefficients and the distance between interfacial boundaries of inclusions, which unifies the known results in the literature and answers two open problems proposed by Li-Vogelius (ARMA2000). This is based on a series of joint work with Professor Jiguang Bao (BNU), Yanyan Li (Rutgers), Hongjie Dong (Brown) et al.

15:00-15:30, Monday, June 11

Speaker: Yi Wang (AMSS, Chinese Academy of Sciences)

Title: *Wave phenomena to the three-dimensional Navier-Stokes/Euler-Vlasov-Fokker-Planck equations*

Abstract: We talk about the wave phenomena to a fluid-particle model described by the three-dimensional Vlasov-Fokker-Planck equations coupled with the compressible Navier-Stokes/Euler equations (denoted by NS/E-VFP in abbreviation). For this purpose, a new micro-macro decomposition around the local Maxwellian to the kinetic part of the NS/E-VFP system is first established and then a new two-fluid model with one fluid equipped with the isothermal pressure and the degenerate viscosity coefficients depending on the density function linearly, is derived from the Chapman-Enskog expansion of the Vlasov-Fokker-Planck equation.

Moreover, this new decomposition gives a unified proof framework for the stability analysis of basic wave patterns for NS/E-VFP system and as an application of the new decomposition, the time-asymptotic stability of planar rarefaction wave is proved for the three-dimensional both NS-VFP and E-VFP systems. Note that such a wave phenomena has never been observed to the pure Vlasov-Fokker-Planck equation and the wave phenomena here comes essentially from the fluid-particle interactions between the compressible Navier-Stokes/Euler equations and the kinetic Vlasov-Fokker-Planck equations through the friction (or drag) force and Brownian motion.

16:00-16:30, Thursday, June 14

Speaker: Hongjie Dong (Brown University)

Title: *L_p estimates for time-dependent stokes systems with singular WMO coefficients*

Abstract: We prove the mixed-norm Sobolev estimates for solutions to both divergence and non-divergence form time-dependent Stokes systems with measurable coefficients having small mean oscillations with respect to the space variable in small cylinders. As a special case, our results imply Caccioppli's type estimates for the Stokes systems with variable coefficients. Our results cover some class of coefficients whose skew-symmetric parts are singular. As such, a new ε-regularity criterion for Leray-Hopf weak solutions of Navier-Stokes equations is obtained as a consequence of our regularity results.

16:30-17:00, Monday, June 11

Speaker: Ting Zhang (Zhejiang University)

Title: *Stochastic Boussinesq equations with multiplicative noise*

Abstract: In this talk, we consider the stochastic Boussinesq equations in $\mathbb{T}^d$ with the nonlinear multiplicative noise. We establish the local existence of pathwise solutions. Furthermore, we show that the linear multiplicative noise would provide a regularizing effect: the global existence of solutions occurs to high probability if the initial data are sufficiently small, or if the noise coefficients are sufficiently large. (Based on joint works with Lihuai Du)

17:00-17:30, Monday, June 11

Speaker: Yanjin Wang (Xiamen University)

Title: *Incompressible inviscid resistive MHD surface waves in 2D*

Abstract: We consider the dynamics of a layer of an incompressible electrically conducting fluid interacting with the magnetic field in a two-dimensional horizontally periodic setting. The upper boundary is in contact with the atmosphere, and the lower boundary is a horizontally flat bottom. We prove the global well-posedness of the inviscid and resistive problem with surface tension around a non-horizontal uniform magnetic field; moreover, the solution decays to the equilibrium almost exponentially. One of the key observations here is an induced damping structure for the fluid vorticity due to the resistivity and transversal magnetic field. This is a joint work with Professor Zhouping Xin.

14:00-14:30, Tuesday, June 12

Speaker: Hao Jia (University of Minnesota)

Title: *On the De Gregorio modification of Constantin-Lax-Majda (CLM) model*

Abstract: In order to understand the three dimensional Euler equations, Constantin, Lax and Majda proposed a one dimensional model $\partial_t \omega = \omega H \omega$. They showed that the model can be solved explicitly and may blow up in finite time. De Gregorio later suggested a modification by adding a transport term $\partial_t \omega + u\omega_x = u_x \omega$, $u_x = H\omega$. Numerical simulations suggest that this model is globally wellposed and generic solutions converge to steady states. The global regularity question is still open. In this talk, we report a recent result showing stability of the ground states, which seems to capture some key features of general solutions. Joint work with S. Stewart and V. Sverak.

14:30-15:00, Tuesday, June 12

Speaker: Wei Wang (Zhejiang University)

Title: *On some free boundary problems in ideal incompressible complex fluids*

Abstract: It is well-known that vortex sheets for incompressible Euler equations are not stable (called Kelvin-Helmholtz instability). However, in 1953, Syrovatskij derived a stability condition which indicates that when the magnetic field is sufficiently strong, current-vortex sheets for MHD equations could probably be stable. In this talk, we will present the local-in-time existence result of the solution for the incompressible current-vortex sheets under Syrovatskij's stability condition, which gives a rigorous confirmation of the stabilizing effect of the magnetic field on the Kelvin-Helmholtz instability. The method can also be applied to other free boundary problems in ideal incompressible complex fluids such as the plasma-vacuum interface problem, vortex-sheets problems in elasto-dynamics under different stability conditions. These works are joint with H. Li, Y. Sun and Z. Zhang.

15:00-15:30, Tuesday, June 12

Speaker: Peng Qu (Fudan University)

Title: *Global classical solutions to partially dissipative quasilinear hyperbolic systems violating the Kawashima condition*

Abstract: This talk would discuss the Cauchy problem for the quasilinear hyperbolic system of balance laws in R_d, $d \geq 2$. The system is partially dissipative in the sense that there is an eigen-family violating the Kawashima condition. By imposing certain supplementary degeneracy conditions with respect to the non-dissipative eigen-family, global unique smooth solutions near constant equilibria are constructed. The proof is based on the introduction of the partially normalized coordinates, a delicate structural analysis, a family of scaled energy estimates with minimum fractional derivative counts and a refined decay estimates of the dissipative components of the solution. This talk is based on the collaboration with Prof. Yanjing Wang.

16:00-16:30, Tuesday, June 12

Speaker: Yu Deng (Courant Institute of Mathematical Sciences)

Title: *Asymptotic behavior of a wave equation*

Abstract: We adapt the method of spacetime resonance of Germain-Masmoudi-Shatah to the study of wave equations, and establish the asymptotic behavior for a model equation, which is related to the "weak null condition" introduced by Lindblad-Rodnianski.

This is joint work with Fabio Pusateri.

16:30-17:00, Tuesday, June 12

Speaker: Chunjing Xie (Shanghai Jiao Tong University)

Title: *Well/ill-posedness for rotating shallow water system*

Abstract: In this talk, we discuss the recent progress on rotating shallow water system. First, global existence of classical solutions for two dimensional and one dimensional rotating shallow water system will be studied. Second, formation of shocks for one dimensional rotating shallow water system is investigated. Finally, we discuss the non-uniqueness phenomena and structures of entropy weak solutions for two dimensional rotating shallow water system.

17:00-17:30, Tuesday, June 12

Speaker: Yifei Wu (Tianjin University)

Title: *Instability of the solitary waves for the generalized Boussinesq equations in one dimension*

Abstract: In this talk, we discuss the instability of the solitary wave solutions for some dispersive equations. First, we consider the nonlinear Klein-Gordon equation. It has the standing wave solutions $u_\omega = e^{i\omega t}\phi_\omega$ in the L2-subcritical case, with the frequency $\omega \in (-1, 1)$. It was proved by Shatah (1983), Shatah, Strauss (1985), and Ohta, Todorova (2007) that there exists a critical frequency $\omega_c \in (0, 1)$ such that the standing waves solution u_ω is orbitally stable when $\omega_c < |\omega| < 1$, orbitally unstable when $|\omega| < \omega_c$, and orbitally unstable when $|\omega| = \omega_c$ and $d \geq 2$. The one dimension problem was left after then. In this talk, we give the proof of this remained problem.

Second, we discuss the extension of the argument to the general dispersive equations. In particular, we study the instability of the solitary wave solutions for a class of the dispersive equations in the degenerate case, without any restriction on the regularity of the nonlinearity.

As a high non-trivial application, we consider the generalized derivative Schrödinger equation, for which the solitary wave solution in the degenerated case was proved previously by Fukaya (2016) to be orbitally instable when the power $\sigma \in [3/2, 2)$. Now we can cover the whole region of $\sigma \in (0, 1)$. This is a jointed work with Zihua Guo, and Cui Ning.

14:00-14:30, Thursday, June 14

Speaker: Chunpeng Wang (Jilin University)

Title: *Subsonic and sonic jet flows for given surrounding pressures from convergent nozzles*

Abstract: This talk concerns the compressible subsonic and sonic jet flows for a given surrounding pressure from a two-dimensional finitely long convergent nozzle with straight solid wall. For a given surrounding pressure and a given incoming mass flux, we seek a subsonic or sonic jet flow with the given incoming mass flux such that the flow velocity at the inlet is along the normal direction, the flow satisfies the slip condition at the wall, and the pressure of the flow at the free boundary coincides with the given surrounding pressure. The well-posedness is shown and the properties of the flow are investigated.

14:30-15:00, Thursday, June 14

Speaker: Chengjie Liu (Shanghai Jiao Tong University)

Title: *The relaxation limit of thermal non-equilibrium flows*

Abstract: The talk is devoted to the relaxation limit of thermal non-equilibrium flows in half space with general initial data. We construct the initial layers and study the interaction between initial layers and possible boundary layers. Then, it is shown that the solution is uniformly bounded in a conormal Sobolev space in the vanishing relaxation limit. This is a joint work with Prof. Tao Luo from City University of Hong Kong.

SS 24. Probability

Organizers: Zhenqing Chen, Zenghu Li & Jiangang Ying

	June 11	June 12	June 13	June 14
Chair			***Tiefeng Jiang***	
9:00-9:30			**Jonathon Peterson**	
9:30-10:00			**Wei Liu**	
10:00-10:30			**Xin Chen**	
10:30-11:00	**Tea Break**			
Chair			***Jonathon Peterson***	
11:00-11:30			**Yanxia Ren**	
11:30-12:00			**Zechun Hu**	
12:00-12:30			**Jing Wang**	
12:30-14:00	**Lunch Break**			
Chair	***Zhenqing Chen***		***Shui Feng***	***Dayue Chen***
14:00-14:30	**Xia Chen**		**Zhenqing Chen**	**Shui Feng**
14:30-15:00	**Litan Yan**		**Jinghai Shao**	**Wei Sun**
15:00-15:30	**Dongsheng Wu**		**Dejun Luo**	**Yanqi Qiu**
15:30-16:00	**Tea Break**			
Chair	***Litan Yan***		***Jinghai Shao***	***Jiangang Ying***
16:00-16:30	**Tiefeng Jiang**		**Erkan Nane**	**Hao Wu**
16:30-17:00	**Fangjun Xu**		**Qiang Yao**	**Xinxing Chen**
17:00-17:30	**Deng Zhang**		**Liping Li**	**Dayue Chen**
	Reception		**Banquet** ***(by Invitation)***	

Venue: June 11th, Room 1501, June 14th, Room 1801, WEST Main Tower, Guanghua Building; June 13th, Room 1801, EAST Main Tower, Guanghua Building

SS 24. Probability

14:00-14:30, Monday, June 11

Speaker: Xia Chen (Jilin University)

Title: *Parabolic Anderson model with a fractional Gaussian noise that is rough in time*

Abstract: This paper concerns the parabolic Anderson equation

$$\frac{\partial u}{\partial t} = \frac{1}{2}\Delta u + u\frac{\partial^{d+1} W^{\mathbf{H}}}{\partial t \partial x_1 \dots \partial x_d}$$

generated by a $(d+1)$-dimensional fractional noise with the Hurst parameter $\mathbf{H} = (H_0, H_1, \dots, H_d)$ with special interest in the setting that some of $H_0, \dots, H_d$ are less than half. In a speaker's recent work, the case of the spatial roughness has been investigated. To put the last piece of the puzzel in place, this work investigates the case when $H_0 < 1/2$ with the concern on solvability, Feynman-Kac's moment formula and intermittency of the system.

14:30-15:00, Monday, June 11

Speaker: Litan Yan (Donghua University)

Title: *Cauchy principal values of some integral functionals driven by a fractional Brownian motion*

Abstract: In this talk, we consider the Cauchy principal values of some integral functionals driven by a fractional Brownian motion with arbitrary Hurst index. Some calculus and limit theorems associated with these integral functionals are introduced. This is a joint work with Xichao Sun and Xianye Yu.

15:00-15:30, Monday, June 11

Speaker: Dongsheng Wu (University of Alabama in Huntsville)

Title: *Sharp space-time regularity of the solution to a stochastic heat equation driven by a fractional-colored noise*

Abstract: In this talk, we study a stochastic heat equation with a fractional-colored Gaussian noise, whose "spatial operator" is the square integrable generator of a Levy process. After establishing the existence of solution for the stochastic heat equation, we study the regularity of the solution (field) in both time and space variables. Under mild conditions, the main results give the exact uniform modulus of continuity and

Chungtype laws of iterated logarithm. Our results generalize and strengthen the corresponding results of Balan and Tudor (2008) and Tudor and Xiao (2017). The main tool used in our derivation is the strong local nondeterminism of the solution field. This talk is based on joint works with R. Herrell, R. Song and Y. Xiao.

16:00-16:30, Monday, June 11

Speaker: Tiefeng Jiang (University of Minnesota)

Title: *Largest entries of sample correlation matrices from equi-correlated normal populations*

Abstract: We the limiting distribution of the largest off-diagonal entry of the sample correlation matrices of high-dimensional Gaussian populations with equi-correlation structure. Assume the entries of the population distribution have a common correlation coefficient $\rho > 0$ and both the population dimension p and the sample size n tend to infinity with $\log p = o(n^{\frac{1}{3}})$. As $0 < \rho < 1$, we prove that the largest off-diagonal entry of the sample correlation matrix converges to a Gaussian distribution, and the same is true for the sample covariance matrix as $0 < \rho < 1/2$. This differs substantially from a well-known result for the independent case where $\rho = 0$, in which the above limiting distribution is an extreme-value distribution. We then study the phase transition between these two limiting distributions and identify the regime of ρ where the transition occurs. It turns out that the thresholds of such a regime depend on n and converge to zero. If ρ is less than the threshold, larger than the threshold or is equal to the threshold, the corresponding limiting distribution is the extreme-value distribution, the Gaussian distribution and a convolution of the two distributions, respectively. The proofs rely on a subtle use of the Chen-Stein Poisson approximation method, conditioning, a coupling to create independence and a special property of sample correlation matrices. The results are then applied to evaluating the power of a high-dimensional testing problem of identity correlation matrix.

16:30-17:00, Monday, June 11

Speaker: Fangjun Xu (East China Normal University)

Title: *Asymptotic behavior for an additive functional of two independent self-similar Gaussian processes*

Abstract: We derive the asymptotic behavior for an additive functional of two independent self-similar Gaussian processes when their intersection local time exists, using the method of moments.

17:00-17:30, Monday, June 11

Speaker: Deng Zhang (Shanghai Jiao Tong University)

Title: *Optimal bilinear control of stochastic nonlinear Schr?dinger equations*

Abstract: In this talk we consider the optimal bilinear control problem of quantum mechanical systems with final observation governed by a stochastic nonlinear Schr?dinger equation with linear multiplicative noise. The existence of an open loop optimal control and first order Lagrange optimality conditions are derived, via Skorohod's representation theorem, Ekeland's variational principle and the existence for the linearized dual backward stochastic equation. The approach in particular applies to the deterministic case. This is a joint work with Viorel Barbu and Michael R?ckner.

9:00-9:30, Wednesday, June 13

Speaker: Jonathon Peterson (Purdue University)

Title: *Quantitative CLTs for random walks in random environments*

Abstract: The classical central limit theorem (CLT) states that for sums of a large number of i.i.d. random variables with finite variance, the distribution of the rescaled sum is approximately Gaussian. However, the statement of the central limit theorem doesn't give any quantitative error estimates for this approximation. Under slightly stronger moment assumptions, quantitative bounds for the CLT are given by the Berry-Esseen estimates. In this talk we will consider similar questions for CLTs for random walks in random environments (RWRE). That is, for certain models of RWRE it is known that the position of the random walk has a Gaussian limiting distribution, and we obtain quantitative error estimates on the rate of convergence to the Gaussian distribution for such RWRE. This talk is based on joint works with Sungwon Ahn and Xiaoqin Guo.

9:30-10:00, Wednesday, June 13

Speaker: Wei Liu (Jiangsu Normal University)

Title: *Quasi-linear (stochastic) partial differential equations with time-fractional derivatives*

Abstract: In this paper we develop a method to solve (stochastic) evolution equations on Gelfand triples with time-fractional derivative based on monotonicity techniques. Applications include deterministic and stochastic quasi-linear partial differential equa-

tions with time-fractional derivatives, including time-fractional (stochastic) porous media equations (including the case where the Laplace operator is also fractional) and p-Laplace equations as special cases.

10:00-10:30, Wednesday, June 13

Speaker: Xin Chen (Shanghai Jiao Tong University)

Title: *Stochastic variational principles for dissipative equations with advected quantities*

Abstract: We present symmetry reduction for material stochastic Lagrangian systems with advected quantities whose configuration space is a Lie group. Such variational principles yield deterministic as well as stochastic constrained variational principles for dissipative equations of motion in spatial representation. We apply this technique to the compressible Navier-Stokes equation and to magnetohydrodynamics for charged viscous compressible fluids. A stochastic Kelvin-Noether theorem is derived. This talk is based on a joint work with Ana Bela Cruzeiro and Tudor Ratiu.

11:00-11:30, Wednesday, June 13

Speaker: Yanxia Ren (Peking University)

Title: *Spine decompositions and limit results for models with branching structure*

Abstract: Consider a Galton-Watson process $((Z_n)_{n\geq 0}; \mathbf{P})$ with offspring distribution $\mu = (\mu(n))_{n\geq 0}$. Let L be a random variable with law μ. Assume that $Z_0 = 1$ and the process is critical in the sense that

$$\mathbf{E}[L] = \sum_{k=0}^{\infty} k\mu(k) = 1. \tag{2}$$

Suppose L has finite variance

$$0 < \sigma^2 := \sum_{k=0}^{\infty} (k-1)^2 \mu(k) = \sum_{k=0}^{\infty} k(k-1)\mu(k) < \infty. \tag{3}$$

For simplicity, we will call a Galton-Watson process with offspring distribution μ a μ-Galton-Watson process.

In this talk, I will describe a 1-spine decomposition and a 2-spine decomposition for the critical Galton-Watson tree and use the 2-spine decomposition to give a probabilistic

proof of Yaglom's theorem: conditional on $(Z_n > 0)$, the law of $\frac{Z_n}{n}$ converges to the exponential distribution.

Then I will establish a 1-spine decomposition theorem and a 2-spine decomposition theorem for some critical superprocesses. These two kinds of decompositions are unified as a decomposition theorem for size-biased Poisson random measures. These decompositions to can be used to give probabilistic proofs of the asymptotic behavior of the survival probability and Yaglom's exponential limit law for some critical superprocesses. The talk is based on a joint works with Renming Song and Zhenyao Sun.

11:30-12:00, Wednesday, June 13

Speaker: Zechun Hu (Sichuan University)

Title: *Hunt's hypothesis (H) for Lévy processes*

Abstract: This talk discusses Hunt's hypothesis (H) for Lévy processes and contains five parts. Firstly, I will talk about the background on Hunt's hypothesis (H). Secondly, I will recall the meaning of Hunt's hypothesis (H) and its importance. Thirdly, I will introduce Getoor's conjecture and the existing results. Fourthly, I will present our results. Finally, I will mention some problems. The talk is based on joints works with Wei Sun and Jing Zhang.

12:00-12:30, Wednesday, June 13

Speaker: Jing Wang (University of Illinois at Urbana-Champaign)

Title: *Brownian motion and heat content on the Heisenberg group*

Abstract: In this talk we study small time asymptotic of the heat content for a smoothly bounded domain in the Heisenberg group, which captures geometric information of the of the boundary including perimeter and the total horizontal mean curvature of the boundary of the domain. We use probabilistic method by studying the escaping probability of the horizontal Brownian motion process that is canonically associated to the sub-Riemannian (degenerate) structure of the Heisenberg group. This is a joint work with J. Tyson.

14:00-14:30, Wednesday, June 13

Speaker: Zhenqing Chen (University of Washington)

Title: *Supercritical SDEs driven by Levy processes with Holder drifts*

Abstract: Consider the following time-dependent stochastic differential equation (SDE) in $\mathbb{R}^d$:

$$dX_t = \sigma(t, X_{t-})dZ_t + b(t, X_t)dt, \quad X_0 = x \in \mathbb{R}^d,$$

where Z is a d-dimensional non-degenerate α-stable-like Lévy process with $\alpha \in (0, 2)$, and uniform in $t \geq 0$, $x \mapsto \sigma(t, x) : \mathbb{R}^d \to \mathbb{R}^d \otimes \mathbb{R}^d$ is Lipchitz and uniformly elliptic while $x \mapsto b(t, x)$ is β-order Hölder continuous with $\beta \in (1 - \alpha/2, 1)$. The Lévy measure of the Lévy process Z can be anisotropic or singular with respect to the Lebesgue measure on $\mathbb{R}^d$ and its support can be a proper subset of $\mathbb{R}^d$. We show the above SDE has a unique strong solution for every starting point $x \in \mathbb{R}^d$. When $\sigma(t, x) = \mathbb{I}_{d\times d}$, the $d \times d$ identity matrix, and Z is an α-stable process with $0 < \alpha < 1$, our result in particular gives an affirmative answer to an open problem of the field.

14:30-15:00, Wednesday, June 13

Speaker: Jinghai Shao (Tianjin University)

Title: *Stabilization of regime-switching processes by feedback control based on discrete time observations: state-dependent case*

Abstract: This work investigates the almost sure stabilization of a class of regime-switching systems based on discrete-time observations of both continuous and discrete components. It develops Shao's work [SIAM J. Control Optim., 55(2017), pp. 724–740] in two aspects: first, to provide sufficient conditions for almost sure stability in lieu of moment stability; second, to investigate a class of state-dependent regime-switching processes instead of state-independent ones. To realize these developments, we establish an estimation of the exponential functional of Markov chains based on the spectral theory of linear operator. Moreover, through constructing order-preserving coupling processes based on Skorokhod's representation of jumping process, we realize the control from up and below of the evolution of state-dependent switching process by state-independent Markov chains.

15:00-15:30, Wednesday, June 13

Speaker: Dejun Luo (AMSS, Chinese Academy of Sciences)

Title: *Kolmogorov equations associated to 2D stochastic Euler equations*

Abstract: We consider the Kolmogorov equation corresponding to the vorticity form of the 2D stochastic Euler equation with transport-type multiplicative noises. We take the white noise measure as the reference measure which is supported by the Sobolev

space of order less than minus one. Using the method of Galerkin approximation we show the existence and regularity of solutions to the Kolmogorov equation.

16:00-16:30, Wednesday, June 13

Speaker: Erkan Nane (Auburn University)

Title: *Stochastic models for space-time fractional dynamics*

Abstract: Recently, my research has been focused on fundamental properties of stochastic fractional equations, and time-changed stochastic processes that arise as scaling limits of continuous time random walks. These novel processes are interesting on their own, and they have recently been applied to model various phenomena in a wide range of scientific areas including physics, telecommunications, turbulence, image processing, biology, bioengineering, hydrology, geophysics and finance. In this talk I will give highlights of my research on (i) continuous time random walk limits; (ii) stochastic solutions of heat type Cauchy problems with fractional time derivatives; and (iii) various properties of stochastic fractional equations.

16:30-17:00, Wednesday, June 13

Speaker: Qiang Yao (East China Normal University)

Title: *Branching random walks and contact processes on random stretched trees*

Abstract: We consider branching random walks and contact processes on some random stretched trees under some assumptions on infection and recovery rates. We show that in certain circumstances, the branching random walks and contact processes will have weak survival phases. This generalizes the results in homogeneous tree case.

17:00-17:30, Wednesday, June 13

Speaker: Liping Li (AMSS, Chinese Academy of Sciences)

Title: *On symmetric one-dimensional diffusions*

Abstract: The main purpose of this talk is to explore the structure of local and regular Dirichlet forms associated with the symmetric one-dimensional diffusions. Let $(\mathcal{E}, \mathcal{F})$ be a regular and local Dirichlet form on $L^2(I, m)$, where I is an interval and m is a fully supported Radon measure on I. We shall first present a complete representation for $(\mathcal{E}, \mathcal{F})$, which shows that $(\mathcal{E}, \mathcal{F})$ lives on at most countable disjoint 'effective' intervals

with 'adapted' scale function on each interval, and any point outside these intervals is a trap of the diffusion. Furthermore, we shall give a necessary and sufficient condition for $C_c^\infty(I)$ being a special standard core of $(\mathcal{E}, \mathcal{F})$ and identify the closure of $C_c^\infty(I)$ in $(\mathcal{E}, \mathcal{F})$ when $C_c^\infty(I)$ is contained but not necessarily dense in $\mathcal{F}$ relative to the $\mathcal{E}_1^{1/2}$-norm.

14:00-14:30, Thursday, June 14

Speaker: Shui Feng (McMaster University)

Title: *Reversible measure-valued processes associated with Dirichlet Process*

Abstract: The family of Dirichlet processes arises in many subjects and includes many important random measures. The construction of reversible measure-valued processes that lead to these random measures has been an interesting research topic in probability. This talk will survey existing results, and introduce recent joint work with Wei Sun on the construction of reversible processes associated with the two-parameter Dirichlet process. Several unresolved issues will be discussed in the end.

14:30-15:00, Thursday, June 14

Speaker: Wei Sun (Concordia University)

Title: *The complement value problem for non-local operators*

Abstract: We consider the complement value problem for a class of integro-differential operators. The operators have both local and non-local parts. Under mild conditions, we show that there exists a unique bounded continuous weak solution to the complement value problem. Moreover, we give an explicit probabilistic representation of the solution. The theory of semi-Dirichlet forms and heat kernel estimates play an important role in our approach.

15:00-15:30, Thursday, June 14

Speaker: Yanqi Qiu (Academia Sinica)

Title: *Patterson-Sullivan construction for point processes and reconstruction of Hardy functions*

Abstract: In joint work with Alexander Bufetov, we show that the classical Patterson-Sullivan construction can be generalized to the random setting in the theory of point

processes. This construction allows us to recover the value of any Hardy function at any point of the disc from its restriction to a random configuration of the determinant point process with the Bergman kernel. This extrapolation result is then extended to real and complex hyperbolic spaces of higher dimension. Recovering continuous functions by the Patterson-Sullivan construction is also shown to be possible in more general Gromov hyperbolic spaces.

16:00-16:30, Thursday, June 14

Speaker: Hao Wu (Tsinghua University)

Title: *Gaussian free field: level lines and connection probabilities*

Abstract: Gaussian free field (GFF) is of great interest in statistical physics models. On the one hand, it is the height function of many discrete lattice models, for instance dimer model; on the other hand, it is the building block in many constructions in quantum field theory. In this talk, we will discuss the level lines of GFF and we will focus on the following topics: [1] The level lines of GFF are SLE(4). [2] The connection probabilities of level lines of GFF are encoded by the collection of pure partition functions associated to multiple SLE(4)s. [3] Existence and uniqueness of pure partition functions associated to multiple SLE(4)s.

16:30-17:00, Thursday, June 14

Speaker: Xinxing Chen (Shanghai Jiaotong University)

Title: *Some properties of a max-type recursive model*

Abstract: We consider a simple max-type recursive model which was introduced in the study of depinning transition in presence of strong disorder by Derrida and Retaux. Our interest is focused on the critical regime, for which we study the extinction probability and the moment generating function. This talk is based on a joint work with Bernard Derrida, Yueyun Hu, Mikhail Lifshits and Zhan Shi.

17:00-17:30, Thursday, June 14

Speaker: Dayue Chen (Peking University)

Title: *Resistance growth of branching random networks*

Abstract: Consider a rooted infinite GaltonWatson tree with mean offspring number

$m > 1$, and a collection of i.i.d. positive random variables ξ_e indexed by all the edges in the tree. We assign the resistance $m^d \, \xi_e$ to each edge e at distance d from the root. In this random electric network, we study the asymptotic behavior of the effective resistance and conductance between the root and the vertices at depth n. Our results generalize an existing work of AddarioBerry, Broutin and Lugosi on the binary tree to random branching networks. This is a joint work with Yueyun Hu (Université Paris XIII) and Shen Lin (Sorbonne Université) of France.

SS 25. *Quantum Algebras and Related Topics*

Organizers: Yun Gao, Naihuan Jing & Honglian Zhang

V

	June 11	June 12	June 13	June 14
9:00-10:30				
10:30-11:00	**Tea Break**			
Chair		***Yun Gao***	***Yun Gao***	
11:00-11:30		**Jun Morita**	**Shun-Jen Cheng**	
11:30-12:00		**Hioryuki Yamane**	**Susumu Ariki**	
12:00-12:30		**Chengming Bai**	**Toshiki Nakashima**	
12:30-14:00	**Lunch Break**			
Chair			***Naihuan Jing***	***Honglian Zhang***
14:00-14:30			**Seok-Jin Kang**	**Naihong Hu**
14:30-15:00			**Jae-Hoon Kwon**	**Xiangmao Ding**
15:00-15:30			**Li Guo**	**Qiang Fu**
15:30-16:00	**Tea Break**			
Chair			***Naihuan Jing***	***Honglian Zhang***
16:00-16:30			**Fang Li**	**Hongjia Chen**
16:30-17:00			**Fei Xu**	**Qing Wang**
17:00-17:30			**Yung-Ning Peng**	**Jiancai Sun**
	Reception		**Banquet** *(by Invitation)*	

Venue: June 12th Room 108, June 13th and 14th, Room 116, Center for American Studies

SS 25. Quantum Algebras and Related Topics

11:00-11:30, Tuesday, June 12

Speaker: Jun Morita (University of Tsukuba)

Title: *Calabi-Yau algebras and the shifted noncommutative symplectic structure*

Abstract: We will obtain some amalgamation of two root systems of type $H4$ in quaternions. Then, using this structure, we will discuss some discretization in $SU(2)$.

11:30-12:00, Tuesday, June 12

Speaker: Hiroyuki Yamane (University of Toyama)

Title: *Generalized quantum groups and Coxeter groupoids*

Abstract: Coxeter introduced Coxeter groups in 1934, and he classified the finite Coxeter groups in 1935. Those are classified into $A_n, B_n = C_n, D_n, F_4, E_6, E_7, E_8, G_2, I_n, H_3$ and H_4. Coxeter groups appear in many areas of Algebra and Geometry. One of the areas is the representation theory of Lie algebras. Perhaps from 1970's, many researchers have considered that they need a notion of 'Coxeter groupoids' which can be applied for study of the representation theory of Lie superalgebras. In 2000's, Coxeter groupoids became necessary for study of Hopf algebras including 'the generalized quantum groups'. Before achieving (1) below, virtually using Coxeter groupoids, Hiroyuki Yamane decided the defining relations of finite and affine Lie superalgebras of type A-G and their quantum superalgebras (1991, 1994, 1994, 1999, 2001). With collaborators, Hiroyuki Yamane achieved the following results.

(1) Axiomatic definition, Defining relations and Matsumoto-type theorem of Coxeter groupoids (2008)

(2) Shapovalov determinants of the generalized quantum groups (2010)

(3) Classification of the finite dimensional irreducible representations of the generalized quantum groups (2015)

(4) Universal R-matrices of the generalized quantum groups (2015)

(5) Harish-Chandra type theorem of the center of the generalized quantum groups (2018)

(6) Bruhat order of the Coxeter groupoids (2017, online)

12:00-12:30, Tuesday, June 12

Speaker: Chengming Bai (Chern Institute of Mathematics)

Title: *Deformations and their controlling cohomologies of $\mathcal{O}$-operators*

Abstract: We establish a deformation theory of a kind of linear operators, namely, $\mathcal{O}$-operators in consistence with the general principles of deformation theories. On one hand, there is a suitable differential graded Lie algebra whose Maurer-Cartan elements characterize $\mathcal{O}$-operators and their deformations. On the other hand, there is an analogue of the André-Quillen cohomology which controls the deformations of $\mathcal{O}$-operators. Infinitesimal deformations of $\mathcal{O}$-operators are studied and applications are given to deformations of skew-symmetric r-matrices for the classical Yang-Baxter equation.

11:00-11:30, Wednesday, June 13

Speaker: Shun-Jen Cheng (Academia Sinica)

Title: *Irreducible characters of exceptional Lie superalgebras in BGG category*

Abstract: We explain a solution to the irreducible character problem for the finite-dimensional exceptional simple Lie superalgebras $D(2,1,\varsigma)$ and $G(3)$ in the BGG category. This is based on joint works with Weiqiang Wang.

11:30-12:00, Wednesday, June 13

Speaker: Susumu Ariki (Osaka University)

Title: *Tame block algebras of Hecke algebras of classical type*

Abstract: Finite dimensional Hecke algebras appear in Lie theory and play important roles. When we study modular representation theory of finite groups of Lie type, modular representation theory of Hecke algebras plays a role, and this is my main object of the study. Assume that the base field is algebraically closed of odd characteristic. Using categorification of integrable modules over affine Lie algebras and work with cyclotomic quiver Hecke algebras, I have proved recently that if a block algebra of Hecke algebras of classical type is of finite representation type, then it is a Brauer tree algebra whose Brauer tree is a straight line without exceptional vertex. In this talk, I will discuss the classification of block algebras of tame representation type. The main tool here is the silting theory developed by Aihara et al.

12:00-12:30, Wednesday, June 13

Speaker: Toshiki Nakashima (Sophia University)

Title: *Geometric crystals on cluster varieties*

Abstract: The notion of geometric crystal was initiated by A.Berenstein and D.Kazhdan to consider certain geometric analogue to the Kashiwara's crystal base theory. Their structures are described by rational maps and rational functions. If all these rational maps and rational functions are "positive", such geometric crystals are called "positive" and they can be tranferred to the "Langlands dual crystal bases" by tropicalization/ultra-discretization procedure. V.Fock and A.Goncharov defined certain pair of varieties (A,X), called "cluster ensemble" which is obtained by glueing algebraic tori using the "A-mutations and X-mutations" respectively. They gave the conjectures on "tropical duality" between cluster ensemble A-variety and X-variety (called Fock-Goncharov conjectures). We shall define the positive geometric crystal structure on cluster varieties and then obtain the resulting tropicalized crystals, which is expected to be a guide to understand the Fock-Goncharov conjectures in terms of crystal base theory. This is a joint work with Yuki Kanakubo.

14:00-14:30, Wednesday, June 13

Speaker: Seok-Jin Kang (Joeun Mathematical Research Institute)

Title: *Borcherds-Bozec algebras, root multiplicities and the Schofield construction*

Abstract: Using the twisted denominator identity, we derive a closed form root multiplicity formula for all symmetrizable Borcherds-Bozec algebras and discuss its applications including the case of Monster Borcherds-Bozec algebra. In the second half of the paper, we provide the Schoeld construction of symmetric Borcherds-Bozec algebras.

14:30-15:00, Wednesday, June 13

Speaker: Jae-Hoon Kwon (Seoul National University)

Title: *Crystal bases of Kirillov-Reshetikhin modules for generalized quantum groups of type A*

Abstract: The generalized quantum group of type A is an affine analogue of quantum group associated to a general linear Lie superalgebra, appearing in the study of solutions to the three-dimensional Yang-Baxter equation. We construct Kirillov-Reshetikhin

modules, that is, a family of irreducible modules which have crystal bases. We also give an explicit combinatorial description of the crystal structure of Kirillov-Reshetikhin modules, the combinatorial R-matrix, and energy function on their tensor products. This is a joint work with Masato Okado.

15:00-15:30, Wednesday, June 13

Speaker: Li Guo (Rutegers University-Newark)

Title: *Rota-Baxter Algebras and Quasi-Symmetric Functions*

Abstract: In Rota's first construction of free Rota-Baxter algebra in the 1960s, he applied Spitzer's identity to obtain the Waring formula which relates elementary symmetric functions to power symmetric functions. He then suggested that there should be a close connection between Rota-Baxter algebra and generalizations of symmetric functions. He claimed, "In short, (Rota-)Baxter algebras represent the ultimate and most natural generalization of the algebra of symmetric functions." We present some results in support of Rota's claim. We show that a free commutative Rota-Baxter algebra can be interpreted as generalized quasi-symmetric functions from weak compositions. This equips the free commutative Rota-Baxter algebra with a natural Hopf algebra structure. This is joint work with Jean-Yves Thibon, Houyi Yu and Jianqiang Zhao.

16:00-16:30, Wednesday, June 13

Speaker: Fang Li (Zhejiang University)

Title: *Quantum cluster algebras and existence of related maximal green sequences*

Abstract: In this talk, we first introduce the notion of quantum cluster algebras and then study the existence of their related maximal green sequences. First, we prove that each non-negative integer matrix in is uniformly column sign-coherent with respect to any skew-symmetrizable integer square matrix. Using such matrices, we introduce the definition of irreducible skew-symmatrizable matrix. Based on this, the existence of a maximal green sequence for a skew-symmetrizable matrices is reduced to the existence of a maximal green sequence for irreducible skew-symmetrizable matrices.

16:30-17:00, Wednesday, June 13

Speaker: Fei Xu (Shantou University)

Title: *G-posets and group representations*

Abstract: Given a finite group G, we are interested in the category of finite G-posets. We shall examine representations of various categories arising from G-posets, and demonstrate how they can be used to investigate the representations of G.

17:00-17:30, Wednesday, June 13

Speaker: Yung-Ning Peng (National Central University)

Title: *Super Yangian of the general linear Lie superalgebra and 01-sequence*

Abstract: Let YM|N denote the super Yangian associated to the general linear Lie superalgebra gl M|N. In this talk, we will describe a series of new presentation of YM|N by introducing the notion of 01-sequence. Moreover, some further applications and partial results will be mentioned.

14:00-14:30, Thurday, June 14

Speaker: Naihong Hu (East China Normal University)

Title: *Quantum brace algebras and an entire construction for multiparameter quantum groups*

Abstract: In this talk, we will introduce some framework on brace algebras due to Loday-Ronco, the quantum version due to Jian-Fang-Rosso, and will give an entire construction for the multiparameter (small) quantum groups of symmetrizable Kac-Moody algebras, as well as study the variation rule of Hopf 2-cocycle deformations for such construction machinery. This is a joint work with Yunnan Li and Marc Rosso.

14:30-15:00, Thurday, June 14

Speaker: Xiangmao Ding (AMSS, Chinese Academy of Sciences)

Title: *Hopf Algebraic Structure for Tagged Graphs and Topological Recursion*

Abstract: Using the shuffle structure of the graphs, we introduce a new kind of the Hopf algebraic structure for tagged graphs with or without loops. Like a quantum group structure, its product is non-commutative. With the help of the Hopf algebraic structure, after taking account symmetry of the tagged graphs, we reconstruct the topological recursion on spectral curves proposed by B. Eynard and N. Orantin, which includes the one-loop equations of various matrix integrals as special cases.

15:00-15:30, Thurday, June 14

Speaker: Qiang Fu (Tongji University)

Title: *The quantum loop algebra of gln*

Abstract: In the seminal work, Beilinson-Lusztig-MacPherson gave a beautiful realization for quantum gln via a geometric setting of quantum Schur algebras. This remarkable work has important applications to the investigation of integral quantum Schur-Weyl duality. We will talk about BLM realization of quantum affine gln and its applications. This talk is based on joint works with Bangming Deng and Jie Du.

16:00-16:30, Thurday, June 14

Speaker: Hongjia Chen (University of Science and Technology)

Title: *A family of modules over quantum groups I: A_1 case*

Abstract: In this talk, we will construct a family of new modules for the quantum group $U_q(sl_2)$, that is, the category H of $U_q(sl_2)$-modules whose objects are free of rank 1 when restricted to $C[K^{\pm 1}]$ the Cartan part of the quantum group. Moreover, we classify isomorphism classes of objects in H and determine their submodule structures in both cases when q is a root of unity or not. This is the first step of our project, which aims to classify this kind of modules over all quantum groups associated to finite-dimensional simple Lie algebras. The talk is based on the joint work with Yan-an Cai and Yao Ma.

16:30-17:00, Thurday, June 14

Speaker: Qing Wang (Xiamen University)

Title: *Trigonometric Lie algebras, affine Lie algebras, and vertex algebras*

Abstract: The natural connections among trigonometric Lie algebras, (general) affine Lie algebras, and vertex algebras are established. Among the main results, we obtain a realization of trigonometric Lie algebras as what were called the covariant algebras of the affine Lie algebra $\widehat{\mathcal{A}}$ of Lie algebra $\mathcal{A} = \mathfrak{g}l_\infty \oplus \mathfrak{g}l_\infty$ with respect to certain automorphism groups. We then prove that restricted modules of level ℓ for trigonometric Lie algebras naturally correspond to equivariant quasi modules for the (general) affine vertex algebras $V_{\widehat{\mathcal{A}}}(\ell, 0)$ (or $V_{\widehat{\mathcal{A}}}(2\ell, 0)$). Furthermore, we determine irreducible modules and equivariant quasi modules for simple vertex algebra $L_{\widehat{\mathcal{A}}}(\ell, 0)$ with ℓ a positive integer. In particular, we prove that every quasi-finite unitary highest weight (irreducible) module of level ℓ for type A trigonometric Lie algebra gives rise to an irreducible e-

quivariant quasi $L_{\widehat{\mathcal{A}}}(\ell, 0)$-module. This is a joint work with Haisheng Li and Shaobin Tan.

17:00-17:30, Thurday, June 14

Speaker: Jiancai Sun (Shanghai University)

Title: *Twistors of nonlocal vertex algebras*

Abstract: We introduce and study the concept of twistor for a nonlocal vertex algebra. This concept provides a unifying for various constructions of nonlocal vertex algebras, such as twisted tensor products of nonlocal vertex algebras, and iterated twisted tensor products of nonlocal vertex algebras.

SS 26. Recent Advances in Numerical Methods in Partial Differential Equations

Organizers: Ying Li & Jia Zhao

	June 11	June 12	June 13	June 14
9:00-10:30				
10:30-11:00	**Tea Break**			
Chair				
11:00-11:30			**Xiaoming Wang**	
11:30-12:00			**Lei Li**	
12:00--12:30			**Md. Abdullah AI Mahbub**	
12:30-14:00	**Lunch Break**			
Chair				
14:00-14:30			**Juan Wen**	
14:30-15:00			**Yongshuai Wang**	
15:00-15:30			**Fei Wang**	
15:30-16:00	**Tea Break**			
Chair				
16:00-16:30			**Xiaoqin Shen**	
16:30-17:00			**Wenjun Ying**	
17:00-17:25			**Shimin Guo**	
17:25-17:30			**Jia Zhao**	
	Reception		**Banquet** *(by Invitation)*	

Venue: Conference Room No. 6, Fuxuan Hotel.

SS 26. Recent Advances in Numerical Methods in Partial Differential Equations

11:00-11:30, Wednesday, June 13

Speaker: Xiaoming Wang (Fudan University)

Title: *An energy stable fully decoupled scheme for the Cahn-Hilliard-Navier-Stokes-Darcy-heat system*

Abstract: We consider two phase flows in karstic geometry modeled by the Cahn-Hilliard-Navier-Stokes-Darcy-heat system. The coupled system enjoys a natural energy law if we adopt appropriate interface boundary conditions. We present an energy stable and fully decoupled numerical method, i.e., the computation of the phase field, the temperature field, the free flow velocity field, and the porous media velocity field are decoupled. Numerical evidence will be provided demonstrating the order of accuracy and the energy stability.

11:30-12:00, Wednesday, June 13

Speaker: Lei Li (Duke University)

Title: *A conformal mapping formulation for inviscid incompressible fluid drops and its numerical analysis*

Abstract: We study incompressible, irrotational flows of an inviscid fluid with free surface in planar domains. I will talk about some properties of the equations under a conformal mapping formulation, which has a formal Riemannian structure. In particular, linearization of the equations shows a nonlocal hyperbolic structure, which ensures linear stability. I will then describe a filtered-Fourier pseudospectral method for numerical simulation. The convergence of the numerical schemes is then proved making use of the hyperbolic structure. This is a joint work with Jian-Guo Liu and Robert Pego.

12:00-12:30, Wednesday, June 13

Speaker: Md. Abdullah Al Mahbub (East China Normal University)

Title: *A thermal convection model for the coupled free flow and porous media flow*

Abstract: This study is mainly motivated by the desire to achieve an efficient and economical closed loop enhanced geothermal system, which mainly consists of a network of underground heat exchange pipelines and pumps to transfer the geothermal heat. The heat transfer of this geothermal system arises from the thermal interaction

between the borehole heat pumps and the geothermal reservoir. To this end, we propose a new mathematical model for the heat transfer between two different regimes, namely a saturated soil region or liquid-dominated/dry rock geothermal reservoir and a fluid region, between which the thermal convection through the interface is of particular importance. The water or supercritical carbon-dioxide are circulated through the borehole heat pumps acts as working fluid, and therefore is considered as an incompressible fluid region Ω_f. While the geothermal reservoir is considered to be a porous region Ω_D which follows Darcy's law. The convective heat equation is adapted to model the heat transfer in both regions. Furthermore, special boundary conditions are considered to mimic the physical conditions at the interface, i.e., zero fluid exchange, continuity of temperature and continuity of heat flux. To solve the proposed problem, a new fully mixed stabilized finite element approach is developed, and its weak formulation is reported. Regarding the temporal discretization, a backward Euler stabilized coupled scheme and a decoupled schemes are proposed, followed by the stability analysis of both algorithms. Four numerical experiments are designed and executed to show the exclusive feature of the proposed model and the validation of the numerical methods. Our model may shed light to better design the high efficiency and cost-effective closed-loop geothermal system via investigating the minimum length and diameter of pipe needed to provide adequate fluid temperatures to heat pumps over their life cycle.

14:00-14:30, Wednesday, June 13

Speaker: Juan Wen (Xi'an University of Technology)

Title: *A new defect-correction method for the stationary Navier-Stokes equations based on pressure projection*

Abstract: A new defect-correction method based on the pressure projection for the stationary Navier-Stokes equations is proposed. A local stabilized technique based on the pressure projection is used in both defect step and correction step. The stability and convergence of this new method is analyzed detailedly. Finally, numerical examples confirm our theory analysis and validate high efficiency and good stability of this new method.

14:30-15:00, Wednesday, June 13

Speaker: Yongshuai Wang (East China Normal University)

Title: *Partitioned schemes for the blood solute dynamics model by the variational multiscale method*

Abstract: In this paper, we consider a heterogeneous model of solutes absorption processes by the arterial wall. This model is based on an advection-diffusion equation describing the solute dynamics in the vascular lumen, the convective field being provided by the blood velocity. A pure diffusive model coupled with this equation accounting for the solute dynamics inside the arterial wall, where convection is negligible. The two subdomains are physically separated by the endothelial layer, which acts as a selectively permeable membrane and the interface condition matching the two subproblems follow from the nature of this membrane. To compute the approximate solutions, we propose two partitioned schemes for this model by the variational multiscale method. Stability and convergence results are proved for both schemes. We derive error bounds of the fully discrete solution which are first order in time. The optimal error estimates in space could be achieved for the velocity and concentration in the H^1-semi-norm, and for pressure in the L^2-norm with the proper choosing of stabilized parameters. Theoretical results are supported by numerical examples, and a model problem from the physiological interest is also considered.

15:00-15:30, Wednesday, June 13

Speaker: Fei Wang (Xi'an Jiaotong University)

Title: *Virtual element methods for obstacle problem*

Abstract: We study virtual element methods for solving obstacle problem, which is a representative elliptic variational inequality of the first kind. The virtual element methods (VEMs) can be regarded as a generalization of the standard finite element methods with addition of some suitable non-polynomial functions, and the degrees of freedom are carefully chosen so that the stiffness matrix can be computed without actually computing the non-polynomial functions. With this special design, the virtual element methods can easily deal with complicated element geometries. In this paper, we establish a priori error estimates of the virtual element methods for the obstacle problem. We prove that the lowest order VEMs achieve the optimal convergence rate. Some numerical examples are reported to show that the virtual element methods can work on very general polygonal elements, and the convergence rate in H^1 norm matches well with the theoretical prediction.

16:00-16:30, Wednesday, June 13

Speaker: Xiaoqin Shen (Xi'an University of Technology)

Title: *The elastodynamic models and numerical problems*

Abstract: The theory of elastic shells is one of the most important branches of the theory of elasticity. Among all the shell models, a classical and widely recognized model is the Koiter model. Under specific geometric assumptions, spatial assumptions and various boundary conditions, Ciarlet and his colleagues further classified the shell models into the membrane shell model and the flexural shell. In this talk, we discuss elastodynamic models, i.e., the time-dependent Koiter model, the time-dependent generalized membrane model and the time-dependent flexural model, which have not been addressed numerically. We show that the solutions of three models exist and are unique. We semi-discretize the space variables and fully discretize the problems using the time discretization by the Newmark scheme. The corresponding analyses of existence, uniqueness, stability, convergence and priori error estimates are given. Finally, we provide numerical experiments with several kinds of shells to demonstrate the efficiency of three models.

16:30-17:00, Wednesday, June 13

Speaker: Wenjun Ying (Shanghai Jiao Tong University)

Title: *A Cartesian grid method for the biharmonic equation on complex domains*

Abstract: We will talk on a Cartesian grid method for the biharmonic equation on complex domains. The method is a further development of the kernel-free boundary integral method that previously solves second-order elliptic PDEs in the form of boundary integral equations but never really evaluates any boundary or volume integrals in the solution process. For the fourth-order PDE, the biharmonic equation, the method decomposes it into two Poisson equations, derives a boundary integral equation involving both boundary and volume integrals and further solves the boundary integral equations with the generalized minimal residual (GMRES) method. In the GMRES method, evaluation of a boundary or volume integral is done by computing an equivalent but simple interface problem on Cartesian grids with a fast Fourier transform based solver. We have developed both second-order and fourth-order versions of the method for the biharmonic equation. Numerical examples to demonstrate the accuracy and efficiency of the method will be presented. This is joint work with Ms. Yaning Xie.

17:00-17:25, Wednesday, June 13

Speaker: Shimin Guo (Xi'an Jiaotong University)

Title: *Spectral-Galerkin method for three-dimensional Riesz-like space fractional nonlinear coupled reaction-diffusion equations*

Abstract: In this talk, we present a novel fractional model arising in the chemical reaction and develop an efficient spectral method for the three-dimensional Riesz-like space fractional nonlinear coupled reaction-diffusion equations. Based on the backward difference method for time stepping and the Legendre-Galerkin spectral method for space discretization, we construct a fully discrete numerical scheme which leads to a linear algebraic system. Then a direct method based on the matrix diagonalization approach is proposed to solve the linear algebraic system, where the cost of the algorithm is of a small multiple of N^4 (N is the polynomial degree in each spatial coordinate) flops for each time level. In addition, the stability and convergence analysis are rigorously established. We obtain the optimal error estimate in space, and the results also show that the fully discrete scheme is unconditionally stable and convergent of order one in time. Furthermore, numerical experiments are presented to confirm the theoretical claims. As the applications of the proposed method, the fractional Gray-Scott model is solved to capture the pattern formation with an analysis of the properties of the fractional powers.

17:25-17:30, Wednesday, June 13

Speaker: Jia Zhao (Utah State University)

Title: *Fully discrete second-order linear schemes for hydrodynamic phase field models of binary viscous fluid flows with variable densities*

Abstract: In this talk, we present spatial-temporally second-order, energy stable numerical schemes for two classes of hydrodynamic phase field models of binary viscous fluid mixtures of different densities. One is quasi-incompressible while the other is incompressible. We introduce a novel invariant energy qudratization (IEQ) technique to arrive at fully discrete linear schemes, where in each time step only a linear system needs to be solved. These schemes are then proved to be unconditionally energy stable rigorously so that a large time step is plausible. Both spatial and temporal mesh refinements are conducted to illustrate the second order accuracy of the schemes. Several Numerical examples and conducted, and predictions by the two fluid mixture models are compared and discussed. As a conclusion, we believe the quasi-incompressible model is more reliable than the incompressible one. This is a joint work with Yuezheng Gong and Qi Wang.

SS 27. Recent Advances in Stochastic Dynamical Systems and their Applications

Organizers: Xiaofan Li & Yanjie Zhang

	June 11	June 12	June 13	June 14
Chair			***Hongbo Fu***	
9:00-9:30			**Hongbo Fu**	
9:30-10:00			**Ao Zhang**	
10:00-10:30			**Yong Chen**	
10:30-11:00	**Tea Break**			
Chair		***Rui Cai***		
11:00-11:30		**Shuai Lu**		
11:30-12:00		**Rui Cai**		
12:00-12:30		**Hui Wang**		
12:30-14:00	**Lunch Break**			
Chair	***Yong Xu***	***Xiao Wang***		
14:00-14:30	**Andrzej Korzeniowski**	**Jing Wu**		
14:30-15:00	**Hua Zhang**	**Xiao Wang**		
15:00-15:30	**Yong Xu, Xiaoyu Yang**	**Ying Chao**		
15:30-16:00	**Tea Break**			
Chair	***Wei Wei***	***Xiaopeng Chen***		
16:00-16:30	**Wei Wang, Yan Lv**	**Yanmei Kang**		
16:30-17:00	**Wei Wei**	**Fengyan Wu**		
17:00-17:30	**Yanjie Zhang**	**Xiaopeng Chen**		
	Reception		**Banquet** ***(by Invitation)***	

Venue: Conference Room No.6, Fuxuan Hotel.

SS 27. Recent Advances in Stochastic Dynamical Systems and their Applications

14:00-14:30, Monday, June 11

Speaker: Andrzej Korzeniowski (University of Texas at Arlington)

Title: *Quasi birth death processes in the study of unreliable service*

Abstract: We define an unreliable service and construct the corresponding embedded Markov Chain to an M/M/1 queue with so defined protocol. Sufficient conditions for positive recurrence and closed form of stationary distribution are provided. Furthermore, we compute the probability generating function of the stationary queue length and Laplace-Stieltjes transform of the stationary waiting time. In the course of the analysis an interesting decomposition of both the queue length and waiting time has emerged. Various queueing models can be recovered from our work by taking limits of certain parameters.

14:30-15:00, Monday, June 11

Speaker: Hua Zhang (Jiangxi University of Finance and Economics)

Title: *Varadhan estimates for the density of stochastic differential equations with jumps*

Abstract: In this paper, we establish the Varadhan estimate for stochastic differential equations with jumps using the lent particle method created by Bouleau and Denis.

15:00-15:30, Monday, June 11

Speaker: Yong Xu, Xiaoyu Yang (Northwestern Polytechnical University)

Title: *Weak convergence of two-time-scale stochastic delay differential equations driven by Lévy process*

Abstract: Stochastic differential delay equations (SDDEs) have received a great deal of attention due to its wide application in different fields. Lévy process, as a generalized random process, can characterize several stochastic models with jumping items, and many important stochastic processes can be attributed to it. In addition, strong convergence does not hold when the coefficient of the "slow component" depends on the "fast component"[1]. Therefore, we focus on weak convergence of two-time-scale SDDEs driven by Lévy process. And there exist several difficulties in our problems, such as $(x^{\varepsilon(t)}, \xi^{\varepsilon(t)})$ being not Markov, state-dependence of the noises and the dispose of the infinitesimal operator. To overcome these difficulties, firstly, the memory terms

are included into the "slow component", then the existence and uniqueness of the solution is proved. Next, under dissipative conditions, we exhibit exponential ergodicity of the "fast component" by means of the B-D-G inequality and some other inequalities. Further, together with tightness which can be obtained via Ascoli-Arzela theorem, the weak convergence is studied by using martingale methods, truncation technique and property of the Lévy jump measures. Finally some acquired results are extended to the case of "fast component" with memory.

16:00-16:30, Monday, June 11

Speaker: Wei Wang, Yan Lv (Nanjing University)

Title: *Smoluchowski-Kramers approximation for nonlinear wave equations with state dependent damping and highly random oscillation*

Abstract: The Smoluchowski–Kramers approximation of nonlinear stochastic wave equations with state dependent damping and highly random oscillation is derived by a diffusion approximation. In the small mass limit, due to the state dependent damping, one additional term appears in the limit equation as the highly random oscillation appears as a multiplicative white noise. The result also includes the Ornstein-Uhlenbeck colored noises driven system.

16:30-17:00, Monday, June 11

Speaker: Wei Wei (Huazhong University of Science and Technology)

Title: *Methods and problems in deriving Eyring–Kramers formula for stochastic Allen-Cahn equation*

Abstract: In this talk, a procedure to derive Eyring–Kramers formula of 1 dimensional Allen-Cahn equation driven by space–time white noise will be introduced to obtain precise asymptotics of the transition times between metastable states. Based on potential theory, variational principle and SPDE theory, this work was mainly done by Anton Bovier and Florent Barret. Also, progress and problems in obtaining similar results in non-Gaussian situation will be displayed.

17:00-17:30, Monday, June 11

Speaker: Yanjie Zhang (Huazhong University of Science and Technology)

Title: *Effective filtering analysis for non-Gaussian dynamic systems*

Abstract: This work is about a slow-fast data assimilation system under non-Gaussian noisy fluctuations. We obtain its low dimensional reduction via an inertial manifold and prove that the low dimensional formal filter approximates the original filter. Finally, we outline the conclusion and further directions.

11:00-11:30, Tuesday, June 12

Speaker: Shuai Lu (Fudan University)

Title: *On parameter identification in linear stochastic differential equations by Gaussian statistics*

Abstract: Linear stochastic differential equations (SDE) arise in many contemporary sciences and engineering involving dynamical processes. These SDEs are governed by several parameters, for instance the damping coefficient, the volatility or diffusion coefficient and possibly an external forcing. Identification of these parameters allows a better understanding of the dynamical processes and its hidden statistics. By calculating the Gaussian statistics explicitly for the Ornstein–Uhlenbeck process with constant parameters and Langevin equations with periodic parameters, we propose a parameter identification approach recovering these parameters by minimizing the difference between the empirical statistics. The proposed approach is further extended to parameter identification of SDEs which is indirectly observed by another random variable.

11:30-12:00, Tuesday, June 12

Speaker: Rui Cai (Huazhong University of Science and Technology)

Title: *Lévy noise-induced escape in an excitable system*

Abstract: This talk considers the dynamics of escape in the stochastic FitzHugh-Nagumo (FHN) neuronal model driven by symmetric α-stable Levy noise. External or internal stimulation may make the excitable system produce a pulse or not, which can be interpreted as an escape problem. A new method to analyse the state transition from the rest state to the excitatory state is presented. This approach consists of two deterministic indices: the first escape probability (FEP) and the mean first exit time (MFET). We find that higher FEP in the rest state (equilibrium) promotes such a transition and MFET reflects the stability of the rest state directly with the selected escape region. The developed two dimensional numerical simulation method to calculate FEP and MFET can not only avoid a dimension reduction, but is also applicable for the cases with large noise. In addition, FEP provides us with a new perspective to understand the seperatrix of the stochastic FHN model. It can be seen that smaller jumps of

the Levy motion and relatively small noise intensity are conducive to the production of spikes. In order to characterize the effect of noise on the selected escape region in which the equilibrium lies, the area of higher FEP and MFET in the escape region are calculated. Meanwhile, Brownian motion as a special case is also taken into account for comparison.

12:00-12:30, Tuesday, June 12

Speaker: Hui Wang (Huazhong University of Science and Technology)

Title: *Deterministic methods for non-Gaussian stochastic dynamical systems and applications*

Abstract: We investigate the evolution of concentration in a genetic regulation system, when the synthesis reaction rate is under additive and multiplicative asymmetric stable Levy fluctuations. By focusing on the impact of skewness (i.e., non-symmetry) in the probability distributions of noise, we find that via examining the mean first exit time (MFET) and the first escape probability (FEP), the asymmetric fluctuations, interacting with nonlinearity in the system, lead to peculiar likelihood for transcription. This includes, in the additive noise case, realizing higher likelihood of transcription for larger positive skewness index b, causing a stochastic bifurcation at the non-Gaussianity index value a=1 (i.e., it is a separating point or line for the likelihood for transcription). The stochastic bifurcation and turning point phenomena do not occur in the symmetric noise case . While in the multiplicative noise case, non-Gaussianity index value a=1 is a separating point or line for both the MFET and the FEP.

14:00-14:30, Tuesday, June 12

Speaker: Jing Wu (Sun Yat-sen University)

Title: *Approximations and limit theorems for multivalued stochastic differential equations*

Abstract: In this work, we consider the Euler and Yosida approximations of multivalued stochastic differential equations with non-Lipschitz coefficients and establish various limit theorem results.

14:30-15:00, Tuesday, June 12

Speaker: Xiao Wang (Henan University)

Title: *Numerical methods of Fokker-Planck equation driven by Lévy motion*

Abstract: Non-Gaussian Levy noises are present in many models for understanding underlining principles of physics, finance, biology and more. In the talk, we present accurate numerical quadratures for Fokker-Planck equation driven by additive and multiplicative noise due to one-dimensional asymmetric Lévy motion. We provide conditions under which the numerical schemes satisfy maximum principle and also discuss the properties of the probability density functions and the effects of various factors on the solutions.

15:00-15:30, Tuesday, June 12

Speaker: Ying Chao (Huazhong University of Science and Technology)

Title: *Invariant foliations for stochastic dynamical systems with a multiplicative non-Gaussian lévy noise*

Abstract: In this paper, I will deal with the dynamics of a class of stochastic dynamical systems with a multiplicative non-Gaussian Levy noise. We first establish the existence of stable and unstable foliations for this system via the Lyapunov-Perron method. Then we examine the geometric structure of the invariant foliations, and their relation with invariant manifolds. Finally, we illustrate our results in an example.

16:00-16:30, Tuesday, June 12

Speaker: Yanmei Kang (Xi'an Jiaotong University)

Title: *Stochastic resonance in underdamped periodic potential system with alpha stable Lévy noise*

Abstract: In this paper, we investigate the effect of alpha stable Lévy noise with alpha stability index $\alpha(0 < \alpha \leq 2)$ on stochastic resonance (SR) in underdamped periodic potential systems by the non-perturbative expansion moment method and stochastic simulation. Using the spectral amplification factor as a quantifying index, we find that SR can occur in both sinusoidal potentials and ratchet potentials when α is close to 2, while the resonant effect becomes weaker as the stability index decreases. By means of massive numerical statistics, we ascribe this trend to the typical jumps of non-Gaussian Lévy noise $(0 < \alpha < 2)$, which play a destructive role on the periodicity of the long time mean response. We also disclose that the skewness parameter of Lévy noise has a more notable impact on the resonant effect of the asymmetric ratchet potential than that of the symmetric sinusoidal potential because of symmetry breaking.

16:30-17:00, Tuesday, June 12

Speaker: Fengyan Wu (Huazhong University of Science and Technology)

Title: *Lévy noise induced transition in a gene regulatory network*

Abstract: Important effects of noise on a one-dimensional gene expression model involving a single gene have recently been discussed. However, only few works have been devoted to the transition in a two-dimensional model which includes the interaction of genes, which is crucial for describing real genes. We investigate here, a quantitative bistable two-dimensional model (MeKS network) of gene expression dynamics describing the competence development in the Bacillus subtilis under the influence of Levy as well as Brownian motions.

17:00-17:30, Tuesday, June 12

Speaker: Xiaopeng Chen (Shantou University)

Title: *Error estimation on projective integration of expensive multiscale stochastic simulation*

Abstract: Consider when some microscale simulator is too expensive for long time simulations necessary to explore macroscale dynamics. Projective integration uses bursts of the microscale simulator, using microscale time steps, and computes an approximation to the system over a macroscale time step by extrapolation. Projective integration has the potential to be an effective method to compute the long time dynamic behaviour of multiscale systems. However, many multiscale systems are influenced by noise. Thus it is important to consider the projective integration of such systems. By the maximum likelihood estimation, we estimate a linear stochastic differential equation from short bursts of data. The analytic solution of the linear stochastic differential equation then estimates the solution over a macroscale time step. We explore how the noise affects the projective integration in different methods. Monte Carlo simulation suggests design parameters offering stability and accuracy for the algorithms. We then propose a theory error estimation of the algorithm for Ornstein–Uhlenbeck process.

9:00-9:30, Wednesday, June 13

Speaker: Hongbo Fu (Wuhan Textile University)

Title: *Weak order in averaging for SPDEs*

Abstract: This talk focus on averaging principle of a two-time-scale stochastic partial differential equation on a bounded interval $[0, l]$, where both the fast and slow components are directly perturbed by additive noises. Under some regular conditions on drift coefficients, it is proved that the rate of weak convergence for theslow variable to the averaged dynamics is of order $1 - \varepsilon$ for arbitrarily small $\varepsilon > 0$. The proof is based on an asymptotic expansion of solutions to Kolmogorov equations associated with the multiple-time-scale system.

9:30-10:00, Wednesday, June 13

Speaker: Ao Zhang (Huazhong University of Science and Technology)

Title: *Amplitude equation for SPDEs driven by alpha stable noise*

Abstract: It is well known that complicated stochastic evolution systems near a change of stability are often dominated by slow modes. We rigorously approximate the evolution of the system by stochastic ordinary differential equations describing the amplitudes of the dominating modes on a slow time-scale. In this paper we rigorously derive stochastic amplitude equations for a rather general class of SPDEs with quadratic nonlinearities forced by small alpha stable noise. Near a change of stability, we use the natural separation of time-scales to show that the solution of the original SPDE is approximated by the solution of an amplitude equation, which describes the evolution of dominant modes.

10:00-10:30, Wednesday, June 13

Speaker: Yong Chen (Zhejiang Science and Technology University)

Title: *Well-posednees and large deviations for a class of SPDEs with Lévy noise*

Abstract: In this paper, a class of stochastic partial differential equations (SPDEs) with Lévy noise is concerned. Firstly, the local well-posedness is established by the iterative approximation. Then the large deviation principle (LDP) for the regularized SPDEs is obtained by the weak convergence approach. To get the LDP for SPDEs here, an exponential equivalence of the probability measures is proved. The results can be applied to some types of SPDEs such as stochastic Burgers equation, stochastic b-family equation, stochastic modified Novikov equation and stochastic μ-Hunter-Saxton equation.

SS 28. Singularities in Geometry, Topology, and Algebra

Organizers: Rong Du, Yongqiang Liu, Laurentiu Maxim & Botong Wang

	June 11	June 12	June 13	June 14
Chair				
9:00-9:45			**Lawrence Ein**	
9:45-10:30			**James Fullwood**	
10:30-11:00	**Tea Break**			
Chair				
11:00-11:45		**Shoji Yokura**		
11:45-12:30		**Changzheng Li**		
12:30-14:00	**Lunch Break**			
Chair				
14:00-14:30	**Tong Zhang**	**Huaiqing Zuo**		
14:30-15:00	**Cheng Gong**	**Wenbo Niu**		
15:00-15:30	**Yongqiang Zhao**	**Feng Hao**		
15:30-16:00	**Tea Break**			
Chair				
16:00-16:50	**Youngho Yoon**	**Zhi Jiang**		
17:00-17:30	**Zhenjian Wang**	**Xudong Zheng**		
	Reception		**Banquet** *(by Invitation)*	

Venue: Room 801, East Main Tower, Guanghua Building

SS 28. Singularities in Geometry, Topology, and Algebra

14:00-14:30, Monday, June 11

Speaker: Tong Zhang (East China Normal University)

Title: *Sakai's theorem for Q-divisors on surfaces and applications*

Abstract: In this talk, we will introduce a generalization of Sakai's theorem to the setting of Q-divisors on complex algebraic surfaces. As applications, we will present a base-point-freeness result and a very-ampleness result for Q-adjoint linear systems.

14:40-15:10, Monday, June 11

Speaker: Cheng Gong (Soochow University)

Title: *Classification of families of curves with small number of singular fibers*

Abstract: A relatively minimal family of curves $f : S \to \mathbb{P}^1$ with 2 or 3 singular fibers is called a Belyi family or fibration, which has some interesting arithmetic and geometric properties. We classify all Belyi families f of curves of genus $g \geq 2$ with two singular fibers. We compute all sections of f and its Mordell-Weil group. As an application, we prove that any periodic fiber can be realized as a fiber of a Belyi fibration with two.

15:20-15:50, Monday, June 11

Speaker: Yongqiang Zhao (Westlake Institute for Advanced Study)

Title: *Singularities and distribution of rational points*

Abstract: Manin's conjecture describes the conjectural distribution of rational points on a Fano variety, which relates the underlying variety's geometric properties to its arithmetic infomation. In this talk, we will give a friendly introduction to this conjecture and survey various results obtained so far, especially, results on singular del Pezzo surfaces of degree three. If time permits, we will discuss the speaker's results on a class of high dimensional singular hypersurfaces of arbitrary degree. This is a joint work with Lilu Zhao.

16:20-16:50, Monday, June 11

Speaker: Youngho Yoon (Seoul National University)

Title: *A concrete calculation of Hirzebruch-Milnor class in low dimension*

Abstract: Hirzebruch class was introduced on singular spaces, as a way to unify several characteristic classes. For singular projective hypersurfaces (and more generally for projective complete intersections), one can also define the virtual Hirzebruch class. The difference of the two is measured by Hirzebruch-Milnor class, defined by L. Maxim, M. Saito, and J. Schürmann. They provided a formula for this class in terms of Hodge spectrum and resolution of singularities. For low dimensional hyperplane arrangements, however, we can calculate the difference class directly on the ambient space, using an expression of Hirzebruch class in terms of the characteristic polynomial of the arrangement. The result of our calculation agree with theirs in the examples we have considered.

17:00-17:30, Monday, June 11

Speaker: Zhenjian Wang (Tsinghua University)

Title: *Cohomology jump loci from different points of view*

Abstract: In this talk, we investigate some well known results concerning cohomology jump loci, e.g., characteristic varieties and resonance varieties, from different points of view: algebraic geometry, homological algebra, functorial point of view, and the theory of Mixed Hodge Modules(MHM). We also discuss some applications of the theory of cohomology jump loci.

11:00-11:45, Tuesday, June 12

Speaker: Shoji Yokura (Graduate School of Science and Engineering Kagoshima University)

Title: *Congruence formulae for Hirzebruch chi-y genera and motivic Hirzebruch classes of singular varieties*

Abstract: The Euler characteristic is multiplicative for fiber bundles, i.e. the Euler characteristic of the total space of a fiber bundle is equal to the product of the Euler characteristics of the base and the fiber. Chern-Hirzebruch-Serre (1957) showed that the signature is multiplicative for fiber bundles if the action of the fundamental group of the base is trivial on the cohomology of the fiber. Kodaira (1967), Atiyah and Hirzebruch (1969) gave examples of fiber bundles for which the signature is not multiplicative. Meyer (1973) and Endo (1998) showed that the signature is multiplicative mod 4 for certain fiber bundles. Hambleton-Korzeniewski-Ranicki (2007) showed

that the signature is multiplicative mod 4 for any PL-bundle. Cappell-Maxim-Shaneson (2008) showed that Hirzebruch chi-y genus is multiplicative for smooth algebraic fiber bundles under the same trivial monodromy action as in Chern-Hirzebruch-Serre. I will talk about some congruence formulae for Hirzebruch chi-y genus and also for motivic Hirzebruch class, which is a characteristic class "unifying" the three well-known characteristic classes of singular varieties. This is mainly based on joint work with Carmen Rovi (Indiana Univ. Bloomington) and joint work with Laurentiu Maxim (Univ. of Wisconsin-Madison).

12:00-12:30, Tuesday, June 12

Speaker: Changzheng Li (Sun Yat-sen University)

Title: *Primitive forms via polyvector fields*

Abstract: The theory of primitive forms was introduced by Kyoji Saito in early 1980s, which was first known in singularity theory and has attracted much attention in mirror symmetry recently. In this talk, we will introduce a complex differential geometric approach to primitive forms, using compactly supported polyvector fields. We will see some surprising applications of this approach. This is my joint work with Si Li and Kyoji Saito.

14:00-14:30, Tuesday, June 12

Speaker: Huaiqing Zuo (Tsinghua University)

Title: *Derivation Lie algebras and singularities*

Abstract: Let $R = C[x_1, x_2, ..., x_n]/(f_1, ..., f_m)$ be a positively graded Artinian algebra. The non-existence of negative weight derivations on R has been open for a long time. Alexsandrov conjectured that there is no negative weight derivation when R is a complete intersection algebra and Yau conjectured there is no negative weight derivation on R when R is the moduli algebra of a weighted homogeneous hypersurface singularity. On the other hand, Wahl conjectured that non-existence of negative weight derivations is still true for positive dimensional positively graded R. We also found that the jump of dimension of derivation Lie algebra of moduli algebra in the deformation of an isolated hypersurfaces singularity is related with the nil-polynomial associated to the singularity. In this talk we will present our recent progress on these problems. Part of this work is joint with S. S.-T. Yau and H. Chen.

14:40-15:10, Tuesday, June 12

Speaker: Wenbo Niu (University of Arkansas)

Title: *Projective normality and syzygies for some nonsingular varieties*

Abstract: In this talk, we will discuss projective normality and higher syzygies for powers of line bundles on nonsingular projective varieties under suitable cohomological conditions. We focus on two situations: powers of ample line bundles on Calabi-Yau varieties and pluricanonical divisors on varieties of general type. These two cases follow the same approach to consider Arbarello-Sernesi module associated to the variety and then to consider the surjectivity of multiplication maps of line bundles.

15:20-15:50, Tuesday, June 12

Speaker: Feng Hao (Purdue University)

Title: *Vanishing theorem for parabolic Higgs bundles*

Abstract: In this talk, I will introduce a vanishing theorem for semistable parabolic Higgs bundles with trivial parabolic Chern classes. The proof involves a vanishing theorem for parabolic Higgs bundles established by Donu Arapura, Biswas's equivalence between parabolic Higgs bundles and equivariant bundles, and the nonabelian Hodge theory for quasiprojective varieties. As an application, this implies a general semipositivity theorem and a Kodaira-Saito vanishing theorem for complex variations of Hodge structure. This is a joint work with Donu Arapura and Hongshan Li.

16:20-16:50, Tuesday, June 12

Speaker: Zhi Jiang (Fudan University)

Title: *Cohomological rank functions and Severi type inequalities*

Abstract: We will explain some nice properties of cohomological rank functions on abelian varieties, which is introduced by Barja-Pardini-Stoppino and Pareschi and myself. Then we will use these functions to study the geometry of varieties with large irregularities.

17:00-17:30, Tuesday, June 12

Speaker: Xudong Zheng (Johns Hopkins University)

Title: *The Hilbert scheme of points on singular surfaces*

Abstract: The Hilbert scheme of points on a quasi-projective variety parametrizes its zero-dimensional subschemes. When the variety is a singular surface, the geometry of the Hilbert scheme reflects the singularity of the underlying surface. I will present some work in progress on the Hilbert schemes of points on surfaces of embedding dimension three and four. Part of the talk will be on a joint work with Lawrence Ein.

9:00-9:45, Wednesday, June 13

Speaker: Lawrence Ein (university of Illinois at Chicago)

Title: *Jet closure and the local isomorphism problem*

Abstract: I would speak about my joint work with Tommaso de Fernex and Shihoko Ishii, If a morphism of schemes induces isomorphism of all local jet schemes, does it follow that the morphism is an isomorphism? The problem is called the local isomorphism problem. We'll use jet schemes to introduce varioujs closure operations among ideals and relate them to the local isomorphism problem.

10:00-10:30, Wednesday, June 13

Speaker: James Fullwood (Shanghai Jiao Tong University)

Title: *On the Hodge numbers of Calabi-Yau elliptic fibrations*

Abstract: An elliptic fibration may be realized as a resolution of its singular Weierstrass model. When the total space of the elliptic fibration is Calabi-Yau, we find in many examples that there is a simple relationship between its Hodge numbers and the blowups required for its resolution. We then formulate a general conjecture based upon such observations.

SS 29. Statistics

Organizers: Jianhua Guo & Xumin He

	June 11	June 12	June 13	June 14
9:00-10:30				
10:30-11:00	**Tea Break**			
11:00-12:30				
12:30-14:00	**Lunch Break**			
Chair				
14:00-14:30	**Jun S. Liu**			
14:30-15:00	**Fang Yao**			
15:00-15:30	**Feifang Hu**			
15:30-16:00	**Tea Break**			
Chair				
16:00-16:30	**Hongyu Zhao**			
16:30-17:00	**Shurong Zheng**			
17:00-17:30	**Ji Zhu**			
	Reception		**Banquet** *(by Invitation)*	

Venue: Polyvalent Hall, Level 13, Guanghua Building

SS 29. Statistics

14:00-14:30, Monday, June 11

Speaker: Jun S. Liu (Harvard University & Tsinghua University)

Title: *Bayesian aggregation of rank data with covariates and heterogeneous rankers*

Abstract: Rank aggregation is the combining of ranking results from different sources to generate a "better" ranking list. In our applications, the rank data contain covariate information of ranked entities and incomplete ranking lists for non-overlapping subgroups. Since most existing rank aggregation methods do not handle covariate information of the ranked entities as well as the rankers' heterogeneity, we propose the Bayesian Aggregation of Rank-data with Covariates (BARC), its weighted version (BARCW), and its extension to mixture models (BARCM). All three methods employ latent variable models to account for the covariate information and heterogeneity of rankers. Specifically, BARC assumes identical opinion of all rankers with the same quality; BARCW extends it by allowing varying qualities of rankers, while BARCM clusters heterogeneous ranking opinions with a Dirichlet process mixture model. Moreover, we use a parameter-expanded Gibbs sampler to draw posterior samples, and generate aggregated ranking lists with credible intervals quantifying their uncertainty. Simulation studies show the superior performance of our methods compared with other existing methods in a variety of scenarios. Finally, we exploit our proposed method to solve two real-data problems.

14:30-15:00, Monday, June 11

Speaker: Fang Yao (Peking University)

Title: *Intrinsic Riemannian functional data analysis*

Abstract: In this work we develop a new foundational framework for analyzing Riemannian functional data, including intrinsic Riemannian functional principal component analysis (iRFPCA) and intrinsic Riemannian functional linear regression (iRFLR). The key concept in our development is a novel tensor Hilbert space along a curve on the manifold, based on which Karhunen-Loeve expansion for a Riemannian random process is established for the first time. This framework also features a proper comparison of objects from different tensor Hilbert spaces, which paves the way for asymptotic analysis in Riemannian functional data analysis. Built upon intrinsic geometric concepts such as vector field, Levi-Civita connection and parallel transport on Riemannian manifolds, the proposed framework embraces full generality of applications and proper handle of intrinsic geometric concepts. We then provide estimation procedures for

iRFPCA and iRFLR that are distinct from their traditional and/or extrinsic counterparts, and investigate their asymptotic properties within the intrinsic geometry. Numerical performance is illustrated by simulated and real examples.

15:00-15:30, Monday, June 11

Speaker: Feifang Hu (George Washington University)

Title: *The role of statistics in Big Data and AI era*

Abstract: With modern technology, it becomes easier and easier to collect data (BIG DATA). Data are not just numbers, but numbers that carry information about a specific setting; need to be interpreted and help us to make decisions (AI). Statisticians are experts in: (i) producing useful data; (ii) analyzing data to make meanful results; and (iii) drawing practical conclusions. In the BIG DATA and AI era, statisticians are face many new challenges. In this presentation, I will talk about: (1) some new challenges; (2) the importance of statistics in analysising BIG DATA; (3) the role of statisticians in the new Big Data and AI era. Several examples are used to illustrate the role of statistics in the BIG DATA and AI era.

16:00-16:30, Monday, June 11

Speaker: Hongyu Zhao (Yale University)

Title: *Clustering analysis through integrating diverse high dimensional and noisy data sets*

Abstract: Sample clustering has been studied in statistics for many decades and recent advances in collecting diverse, high dimensional, and noisy data present new challenges for clustering analysis. For example, high-throughput genomic technologies coupled with large-scale studies including The Cancer Genome Atlas (TCGA) project have generated rich resources of diverse types of omics data from thousands of patients to better understand disease etiology and treatment responses. Clustering patients into subtypes with similar disease etiologies and/or treatment responses using multiple omics data has the potential to improve the precision of clustering than using a single type of omics data. In another setting, single-cell RNA-sequencing (scRNA-seq) technology can generate genome-wide expression data at the single-cell levels from hundreds to thousands of cells. One important objective in scRNA-seq analysis is to cluster cells where each cluster consists of cells belonging to the same cell type based on gene expression patterns. In this presentation, we will discuss our recently developed methods for analyzing multi-omics cancer and single cell RNA data sets. The improved performance of these methods will be demonstrated on various simulated as well as real TCGA and scRNA-seq data sets. This is joint work with Seyoug Park and

Hao Xu.

16:30-17:00, Monday, June 11

Speaker: Shurong Zheng (Northeast Normal University)

Title: *Test for high dimensional correlation matrices*

Abstract: Testing correlation structures has attracted extensive attention in the literature due to both its importance in real applications and several major theoretical challenges. The aim of this paper is to develop a general framework of testing correlation structures for the one-, two-, and multiple sample testing problems under a high-dimensional setting when both the sample size and data dimension go to infinity. Our test statistics are designed to deal with both the dense and sparse alternatives. We systematically investigate the asymptotic null distribution, power function, and unbiasedness of each test statistic. Theoretically, we make great efforts to deal with the non-independency of all random matrices of the sample correlation matrices. We use simulation studies and real data analysis to illustrate the versatility and practicability of our test statistics.

17:00-17:30, Monday, June 11

Speaker: Ji Zhu (University of Michigan)

Title: *High-dimensional Gaussian graphical model for network-linked data*

Abstract: Graphical models are commonly used in representing conditional independence between random variables, and learning the conditional independence structure from data has attracted much attention in recent years. However, almost all commonly used graph learning methods rely on the assumption that the observations share the same mean vector. In this paper, we extend the Gaussian graphical model to the setting where the observations are connected by a network and propose a model that allows the mean vectors for different observations to be different. We have developed an efficient estimation method for the model and demonstrated the effectiveness of the proposed method using simulation studies. Further, we prove that under the assumption of "network cohesion", the proposed method can estimate both the inverse covariance matrix and the corresponding graph structure accurately. We have also applied the proposed method to a dataset consisting of statisticians' coauthorship network to learn the statistical term dependency based on the authors' publications and obtained meaningful results. This is joint work with Tianxi Li, Cheng Qian and Elizaveta Levina.

SS 30. Symplectic Geometry

Organizers: Weiyi Zhang, Huijun Fan & Yongbin Ruan

	June 11	June 12	June 13	June 14
Chair			***Bohui Chen***	
9:45-10:30			**Yi Lin**	
10:30-11:00	**Tea Break**			
Chair		***Kaoru Ono***	***Bohui Chen***	***Weiyi Zhang***
11:00-11:45		**Felix Janda**	**Kei Irie**	**Farkhod Eshmatov**
11:45-12:30		**Shuai Guo**	**Ryosuke Takahashi**	**Bohui Chen**
12:30-14:00	**Lunch Break**			
Chair	***Huijun Fan***	***Kaoru Ono***	***Bohui Chen***	***Weiyi Zhang***
14:30-15:30	**Kenji Fukaya**	**Anmin Li**	**Kaoru Ono**	**Free discussion**
15:30-16:00	**Tea Break**			
Chair	***Huijun Fan***	***Kaoru Ono***	***Bohui Chen***	***Weiyi Zhang***
16:00-16:45	**Siu-Cheong Lau**	**Li Sheng**	**Shinichiroh Matsuo**	**Free discussion**
16:45-17:30	**Bo Dai**	**Zuoqin Wang**	**Haojie Chen**	
	Reception		**Banquet** ***(by invitation)***	

Venue: June 11th, 12th, 13th(morning)&14th: Room 503, EAST Side Building,
June 13th (afternoon), Room 406, WEST Side Building, Guanghua Building.

SS 30. Symplectic Geometry

14:30-15:30, Monday, June 11

Speaker: Kenji Fukaya (State University of New York)

Title: *Associativity of quantum cohomology of symplectic manifolds with divisor*

Abstract: Relative Gromov-Witten invariant is defined for symplectic manifold equipped with smooth (or normal crossing) divisor. I will explain how its genus zero case defines a ring structure on certain cohomology group, focusing the proof of the associativity of the product. I also explain the construction of closed-open map, which relate this ring to a Hochshild cohomology appearing in Lagrangian Floer theory and how to prove that it is a ring homomorphism.

16:00-16:45, Monday, June 11

Speaker: Siu-Cheong Lau (Boston University)

Title: *Immersed Lagrangians and SYZ for flags*

Abstract: Strominger-Yau-Zaslow proposed that mirror symmetry can be understood via dual Lagrangian fibrations. Gelfand-Cetlin systems provides Lagrangian fibrations for flag manifolds. However, these fibrations have non-trivial Lagrangian spheres in the boundary strata which cannot be probed by Gelfand-Cetlin fibers over the interior. In this talk I will explain how to "push in" these spheres and use deformation spaces of immersed Lagrangians to construct the Rietsch mirrors. This is a joint work with Hansol Hong and Yoosik Kim.

16:45-17:30, Monday, June 11

Speaker: Bo Dai (Peking University)

Title: *Seiberg-Witten-Floer homology and topological field theory*

Abstract: Topological field theory played an important role in the development of low dimensional topology, since the pioneer work of Witten and Atiyah. I will review some work of Kronheimer-Mrowka and others, explain that the Seiberg-Witten invariants for 4-manifolds and the Seiberg-Witten-Floer homology for 3-manifolds provide a 4-dimensional topological field theory.

11:00-11:45, Tuesday, June 12

Speaker: Felix Janda (University of Michigan)

Title: *On higher genus Gromov-Witten invariants of quintic threefolds*

Abstract: I will report on joint work in progress with Q. Chen, S. Guo and Y. Ruan on proving physics conjectures, such as the holomorphic anomaly equations, about the structure of the higher genus Gromov-Witten invariants of quintic threefolds.

11:45-12:30, Tuesday, June 12

Speaker: Shuai Guo (Peking University)

Title: *Higher genus mirror symmetry for quintic* 3*-fold*

Abstract: In this talk. I will try to explain the physics and mathematics that related to a quintic Calabi-Yau hypersurface in the 4-dimensional complex projective space. On the physics side, I will talk about Yamaguchi-Yau's finite generation conjecture, holomorphic anomaly equation and their application in higher genus computation by Huang-Klemm-Quackenbush. On the mathematics side, I will talk about our recent progress on the structures of higher genus Gromov-Witten invariants. This is a joint work with F. Janda and Y. Ruan.

14:30-15:30, Tuesday, June 12

Speaker: Anmin Li (Sichuan University)

Title: *Gromov-Witten invariants and relative Gromov-Witten invariants (I)*

Abstract: We use the approach of Ruan and Li-Ruan to construct virtual neighborhoods and show that the Gromov-Witten invariants can be defined as an integral over top strata of virtual neighborhood. We prove that the invariants defined in this way satisfy all the Gromov-Witten axioms of Kontsevich and Manin. Morever, we discuss the relative Gromov-Witten invariants, following Li-Ruan'paper with more detail calculations.

16:00-16:45, Tuesday, June 12

Speaker: Li Sheng (Sichuan University)

Title: *Gromov-witten invariant and relative gromov-witten invariants (II)*

Abstract: This is a continuous part of the Lecture of Professor Li An-Min. We will

focus on some detail of analysis.

16:45-17:30, Tuesday, June 12

Speaker: Zuoqin Wang (University of Science and Technology of China)

Title: *Semiclassical wave functions associated to isotropic submanifolds*

Abstract: In this talk I will describe a semiclassical analog of the classical theory of Hermite distributions developed by Boutet de Monvel and Guillemin more than 30 years. More precisely, to each isotropic submanifold of the phase space, we define a space of semi-classical states and develop the symbol theory. I will also discuss a couple applications of the theory. This is a joint work with Alejandro Uribe and Victor Guillemin.

9:45-10:30, Wednesday, June 13

Speaker: Yi Lin (Georgia Southern University)

Title: *Localization formula for Riemannian foliations*

Abstract: A Riemannian foliation is a foliation on a smooth manifold that comes equipped with a transverse Riemannian metric: a fiberwise Riemannian metric g on the normal bundle of the foliation, such that for any vector field X tangent to the leaves, the Lie derivative $L(X)g = 0$. In this talk, we would discuss the notion of transverse Lie algebra actions on Riemannian foliations, which is used as a model for Lie algebra actions on the leave space of a foliation. Using an equivariant version of the basic cohomology theory on Riemannian foliations, we explain that when the action preserves the transverse Riemannian metric, there is a foliated version of the classical Borel-Atiyah-Segal localization theorem. Using the transverse integration theory for basic forms on Riemannian foliations, we would also explain how to establish a foliated version of the Atiyah-Bott-Berline-Vergne integration formula, which reduce the integral of an equivariant basic cohomology class to an integral over the set of invariant leaves. This talk is based on a very recent joint work with Reyer Sjamaar.

11:00-11:45, Wednesday, June 13

Speaker: Kei Irie (University of Tokyo)

Title: *Chain level loop bracket and pseudo-holomorphic disks*

Abstract: Let L be a Lagrangian submanifold in a symplectic vector space which is closed, oriented and spin. Using virtual fundamental chains of moduli spaces of nonconstant pseudo-holomorphic disks with boundaries on L, one can define a Maurer-Cartan element of a Lie bracket operation in string topology (the loop bracket) defined at chain level. This observation is due to Fukaya, who also pointed out its important consequences in symplectic topology. In this talk I'll explain how to rigorously carry out this idea. Our argument is based on a string topology chain model previously introduced by the speaker, and the theory of Kuranishi structures on moduli spaces of pseudo-holomorphic disks, which has been developed by Fukaya-Oh-Ohta-Ono.

11:45-12:30, Wednesday, June 13

Speaker: Ryosuke Takahashi (Chinese University of Hongkong)

Title: *Energy bound for kapustin-witten solutions on* $S^3 \times R^+$

Abstract: In the first part of this talk, we will introduce some background works on Kapustin-Witten equation and Witten's conjecture on the relation of its moduli space and Jones polynomials. In the second part of this talk, we will focus on the moduli space of Kapustin-Witten solutions on $S^3 \times R^+$ and prove that there exists an energy bound for the Yang-Mills energy in the case of empty knot.

$$\int_M |F_A|^2 < C$$

for any $(A, \phi) \in \mathfrak{M}$. This is a joint work with Naichung Conan Leung.

14:30-15:30, Wednesday, June 13

Speaker: Kaoru Ono (RIMS, Kyoto University)

Title: *Floer cohomology and covering spaces*

Abstract: I will discuss some observations on Floer cohomology and covering spaces. One is about uniform boundedness of spectral invariants for functions supported on certain domains, which implies (super)heaviness of their complement. Another is about Floer cohomology for symplectic isotopies and give a slight improvement of my old result on the number of fixed points of the time-one map of symplectic isotopies. The former is based on discussion with Y. Sugimoto and the latter is partly based on discussion with H.-V. Le.

16:00-16:45, Wednesday, June 13

Speaker: Shinichiroh Matsuo (Nagoya University)

Title: *Scalar curvature and the twisted Seiberg-Witten equation*

Abstract: We compute the Yamabe invariants for a new infinite class of closed four-dimensional manifolds by using a "twisted" version of the Seiberg-Witten equations.

16:45-17:30, Wednesday, June 13

Speaker: Haojie Chen (Zhejiang Normal University)

Title: *Kodaira dimension of almost complex manifolds*

Abstract: The Kodaira dimension gives a rough classification scheme of complex manifolds up to birational equivalence. It is also introduced on symplectic 4-manifolds and smooth manifolds with dimension less than 4. In this talk, I will present a generalization of Kodaira dimension to almost complex manifolds. I will discuss some structural results including the birational invariance on almost complex 4-manifolds and the relation with symplectic Kodaira dimension. However, it is in general not a deformation invariant, hence not a diffeomorphism invariant. If time allows, I will discuss some interesting non-integrable almost complex structures with large Kodaira dimension. This talk is based on joint work with Weiyi Zhang.

11:00-11:45, Thursday, June 14

Speaker: Farkhod Eshmatov (Sichun University)

Title: *Transitivity of cyclic quiver varieties*

Abstract: Let Q be a quiver with the vertex set I. For $\tau \in \mathbb{C}^I$, we can associate the quiver variety $\mathfrak{M}^\tau(Q)$ and the deformed preprojective algebra $\Pi^\tau(Q)$. The subgroup G of symplectic automorphisms of $\Pi^\tau(Q)$ acts naturaly on $\mathfrak{M}^\tau(Q)$. In this talk I will show that this action is transitive for $Q = \tilde{A}_m\,(m \geq 1)$, the affine Dynkin diagram of type A. This generalizes a well-known result of Berest and Wilson, corresponding to $Q = \tilde{A}_0$, stating that the group symplectic automorphisms of $\mathbb{C}[x, y]$ acts transtively on the Calogero-Moser spaces.

11:45-12:30, Thursday, June 14

Speaker: Bohui Chen (Sichun University)

Title: *(Augmented) symplectic vortices and quantum Kirwan maps*

Abstract: Given a symplectic manifold X with a Hamiltonian compact group K action, the symplectic vortices can be used to define a Gromov-Witten type theory. In this talk we will explain various versions of moduli spaces of symplectic vortex that relate to Kirwan maps. This is an ongoing project with Bai-Ling Wang and Rui Wang.

SS 31. Toplogical Thinking about Mathematics of Data and Complex Information

Organizers: Amir Assadi, Dan Burghelea, Huafei Sun & Yazhen Wang

	June 11	June 12	June 13	June 14
9:00-10:30				
10:30-11:00	**Tea Break**			
Chair				
11:00-11:45		**Elie de Lestrange-Anginieur**		
11:45-12:40		**Shihui Ying**		
12:30-14:00	**Lunch Break**			
Chair				
14:00-15:30	**Huafei Sun** (14:00-14:50) **Yongqiang Cheng** (14:50-15:40)	**Yuan Wang** (14:00-14:50) **Kaixi Zhu** (14:50-15:15) **Huijing Gao** (15:15-15:40)		
15:30-16:00	**Tea Break**			
Chair				
16:00-17:30	**Ning Qian** (16:00-16:50) **Hyekyoung Lee** (16:50-17:40)	**Mengying Sun & Yu Han** (16:00-16:15) **Jiaming Xuan (Yuchen Song & Xueyan Wang)** (16:15-16:30) **Problem Session & Future Directions** (16:30-17:30)		
	Reception		**Banquet** ***(by Invitation)***	

Venue: Room 209, Think Tank Building

SS 31. Toplogical Thinking about Mathematics of Data and Complex Information

14:00-14:50, Monday, June 11

Speaker: Huafei Sun (Beijing Institute of Technology)

Title: *Information geometry and its applications*

Abstract: In this talk, we first introduce the main concepts of canonical information geometry and matrix information geometry. Then we introduce some applications of information geometry.

14:50-15:40, Monday, June 11

Speaker: Yongqiang Cheng (National University of Defense Technology)

Title: *Vector bundle model of complex electromagnetic space and change detection*

Abstract: Electromagnetic space consists of a physical space in which each point is covered by multi-dimensional electromagnetic signals. In order to analyze the topological property of the complex electromagnetic space, a vector bundle model is established to represent the structure of the underlying space. The vector bundle is modeled as the product space of the physical space and signal parameter space, while the signal parameters is inferred by statistical analysis on the principle of randomness. Then, the electromagnetic space is considered as a section of the vector bundle. The change of the complex electromagnetic space can be detected by distinguishing between different sections of the vector bundle. A change detection method is proposed to extract the change information from electromagnetic data. This work provides an effective way for object detection in the complex electromagnetic space.

16:00-16:50, Monday, June 11

Speaker: Ning Qian (Columbia University)

Title: *Visual perception as retrospective Bayesian decoding from high- to low-level features in working memory*

Abstract: External stimuli, such as visual scenes, evoke sensory responses in the brain (a process termed encoding), and these responses lead to the subjective perception of the stimuli (decoding). Experiments have well established a standard encoding hierarchy, with neuronal tuning progressing from less-invariant, lower-level stimulus features to more-invariant, higher-level features along sensory pathways. Researchers have also

studied decoding by using models to relate sensory responses to perception of stimulus features. A common, but rarely tested, assumption is that decoding follows the same hierarchy of encoding. Additionally, under natural viewing conditions, our small fovea and frequent saccades introduce delays between sensory encoding of different parts of a scene and perceptual integration of the whole scene, suggesting that working memory must be involved in perceptual decoding; yet previous decoding models do not consider working memory. In recent work, we used delays to engage working memory of stimuli and found that contrary to the common low-to-high-level decoding assumption, the lower-level perception cannot explain the higher-level perception. However, the higher-level perception, when used as a constraint, naturally explains the lower-level perception, and this decoding scheme is justified by working-memory considerations. Specifically, compared with lower-level stimulus features, higher-level features are more invariant and categorical, thus requiring less information to specify and permitting more stable maintenance in noisy working memory. The brain should therefore prioritize decoding of reliable higher-level features and then use them to constrain the decoding of unstable lower-level features in memory. Possible relationships between our theory and Lin Chen's topological theory of perception will be discussed.

16:50-17:40, Monday, June 11

Speaker: Hyekyoung Lee (Seoul National University Hospital)

Title: *Brain network analysis based on persistent homology*

Abstract: Persistent homology quantifies the persistent topological features of a topological space including a brain network at multi-scales. Now, the persistent homology is widely used for modeling threshold-free brain networks. In this presentation, I would like to introduce the brain network analysis based on persistent homology. The change of connected components during a filtration shows the integration procedure of a brain network, and the hole structure shows the inefficiency and abnormality of brain network. I will present how these changes of connected and hole structures quantify the shape change of a brain network during the progression of Alzheimer's disease.

11:00-11:50, Tuesday, June 12

Speaker: Elie de Lestrange-Anginieur (The Hong Kong Polytechnic University)

Title: *Effect of voluntary spatial attention on the appearance of embedded blur images*

Abstract: Introduction: Visual blur brings a fundamental limit to visual performance by reducing the amount of spatial information at the retinal level [1] while attention

can increase neuronal response [2]. How do optical and neural components interact in shaping our visual perception? In a previous study, we demonstrate that there is a significant interaction between blur constraint and spatial attention in the parafovea [3], showing that attention disengagement can affect the resolution processing advantage provided by a full refractive correction. In this study, we ask whether this attentional impact on resolution processing can modify our perception of blur seen through the aberrated eye, and so our experience of visual degradation in natural visual scenes.
Purpose: To test whether spatial attention to a specific retinal region can alter and redistribute the perceived sharpness of blur images over the visual field. Methods: Three subjects with normal vision performed a perceptual task at 1 meter. While maintaining fixation at the center of the screen (32-inch, resolution 3840x2160), observers were instructed to voluntarily attend a specific spatial location, varying randomly among the four visual quadrant of the visual field. The target, embedded in a background image (a repetitive image pattern), consisted of a small circular patch having 3 degrees of diameter that appears at 8 degree eccentricities. Different levels of pure defocus were simulated by convolving the target with a point spread function calculated for a 2 mm pupil diameter. Stimulus levels were varied with a staircase method in order to find the level of blur required for peripheral stimulus to appear sharp. In a 2-AFC procedure, the neutral test image was measured by asking subjects to discriminate whether the embedded target appeared sharp or blur using a key press. The orienting of attention towards the target was manipulated using a central pointer preceding the visual target onset and which indicates the direction of the subject focus. In valid conditions, simulating focusing of attention, the cue pointed towards the target; in invalid condition the cue pointed towards the opposite quadrant. A second cue following target offset indicates the actual position of the target to be reported.
Results: We found that peripheral images, embedded in a blurry background, exhibits a sharper appearance compared to isolated blur images, with a mean detection levels of about $0.5D \pm 0.15D$ among the subjects. No significant difference was found between the four visual quadrants on the perceived blur across subjects. Under valid cueing condition, peripheral image sharpness was globally increased for two of the subjects as compared to invalid condition, showing a root mean square wavefront error RMSWE gain (=RMSWE valid / RMSWE invalid) of $1.2 \pm 0.2, 1.5 \pm 0.3, 0.96 \pm 0.6$ across visual quadrants for the three subjects.
Conclusion: Because blur is an important cue for primary visual tasks (such as driving), it may be that peripheral blur processing is involuntary controlled by exogenous attention. It is therefore interesting that this study indicates a potential effect of voluntary orienting of spatial attention on the appearance of peripheral blur at different quadrants of the visual field for certain subjects. Further studies are required to confirm our results and gain understanding on how brain and ocular images may interact.
References:

[1] Applegate, R. A., Ballentine, C., Gross, H., Sarver, E. J., Sarver, C. A. "Visual acuity as a function of zernike mode and level of root mean square error," Optom. & Vis. Sc. ,80(2), 97-105 (2003).
[2] Montagna, B., Pestilli, F. & Carrasco, M., "Attention trades off spatial acuity," Vision Research, 49, 735-745 (2009).
[3] E. de Lestrange, T.W. Leung, R. Li; C.S. Kee, "Spatial attention increases paracentral visual acuity under defocused conditions." Association for Research in Vision and Ophthalmology, 2018. Honolulu, Hawaii.

11:50-12:40, Tuesday, June 12

Speaker: Shihui Ying (Shanghai University)

Title: *Manifold preserving: An intrinsic approach for semisupervised distance metric learning*

Abstract: In this paper, we address the semisupervised distance metric learning problem and its applications in classification and image retrieval. First, we formulate a semisupervised distance metric learning model by considering the metric information of inner classes and interclasses. In this model, an adaptive parameter is designed to balance the inner metrics and intermetrics by using data structure. Second, we convert the model to a minimization problem whose variable is symmetric positive-definite matrix. Third, in implementation, we deduce an intrinsic steepest descent method, which assures that the metric matrix is strictly symmetric positive-definite at each iteration, with the manifold structure of the symmetric positive-definite matrix manifold. Finally, we test the proposed algorithm on conventional data sets, and compare it with other four representative methods. The numerical results validate that the proposed method significantly improves the classification with the same computational efficiency.

14:00-14:50, Tuesday, June 12

Speaker: Yuan Wang (University of Wisconsin - Madison)

Title: *Topological signal processing in seizure localization*

Abstract: Epilepsy is a neurological disorder marked by sudden recurrent episodes of sensory disturbance, loss of consciousness, or convulsions, associated with abnormal electrical activity in the brain. Approximately one third of epilepsy patients do not respond to antiepileptic drug treatment and have to revert to surgical removal of the tissues generating seizures in the patient's brain. Post-operative seizure freedom largely depends the accurate localization and delineation of the seizure-generating sites.

Seizure localization is typically based on visual inspection by epileptologists of electroencephalographic (EEG) signals recorded at multiple sites on the scalp or brain of an epilepsy patient. Automated statistical algorithms will improve the chance of surgical success for patients without direct access to epileptologists. To this purpose, we develop a topological signal processing algorithm for comparing an EEG signal before and during a seizure attack. The first part of the talk will relate a pilot study on a multisite single-trial EEG dataset revealing that signals in the diagnosed seizure origin and its symmetric site are topologically indifferent before and during a seizure attack, in contrast to signals at other sites showing significant statistical difference in topological features in the two phases. The second part of the talk will cover progress in ongoing research on stereo-EEG signals from an epilepsy patient declared seizure-free a year after surgery.

14:50-15:15, Tuesday, June 12

Speaker: Kaixi Zhu (Beijing Institute of Technology)

Title: *Stochastic local-to-global methods for air quality prediction*

Abstract: Propose: Assessing and predicting air quality from measurements of atmospheric chemistry data is a priority for minimizing individuals‘ exposure to air quality conditions that negatively impact human health and mortality. This paper establishes methods for estimating regional air pollution ratings and predicting impending pollution events based on chemical data sets. The ratings data set is used to predict and evaluate air quality in the near future.
Methods: Here we discuss the design of mathematical models for predicting air quality based on the empirical topology of regional atmospheric chemistry data. First, Markov chain model trained on historical local data predicts air pollution levels, evaluated by a fuzzy comprehensive decision maker. Secondly, a singular vector machine (SVM) is trained to identify conditions leading to higher pollution levels. Additionally, we describe local-to-global methods for estimation of air quality over a region containing non-uniformly-distributed data points. Together these techniques forecast air quality over an entire region, based on the current state of the atmosphere (and historical training data) from heterogeneously-distributed geographically-disjoint measurement locations.
Findings: This analysis has been demonstrated on air quality data from Hebei Province in China, using measurements from 13 stations (in Baoding, Shijiazhuang, Tangshan, Qinhuangdao, Handan, Xingtai, Zhangjiakou, Chengde, Cangzhou, Langfang, Hengshui, Beijing and Tianjing).
Conclusions: The model provided a useful tool for predicting the air pollution and

evaluate air quality.

15:15-15:40, Tuesday, June 12

Speaker: Huijing Gao (Zhejiang University)

Title: *A topological method for learning patterns in dynamic brain networks from EEG signals*

Abstract: The human brain is one of the most studied complex dynamical systems with many unanswered questions about its structural organization and function. Brain research has greatly benefitted from advances in high performance computation and the mathematical sciences. In particular, recent learning theoretic methods such as Deep Learning (DL) and other similar Artificial Neuronal Networks (ANN) have proved successful in using massive data sets to simulate and model numerous complex information processing capabilities, such as object recognition in vision.

An important factor in success of DL and other brain-like ANN is the types and sufficiency of data for learning. In this research, we study interconnected neuronal functional modules, called Dynamic Brain Networks (DBN), using data sets from observing dynamics in neuronal populations. Electroencephalography (EEG) is a well-established method to measure strength of electrical fields generated by coherent masses of activated neurons. We study the problem of estimating topological structure and dynamics of DBN from EEG signals. As an application, we develop new algorithms to generate inputs for DL models to classify perturbations in brain activity observed in EEG signals. The algorithms combine topological methods for network parameter estimation, adaptive signal processing and learning from human EEG data. The authors are grateful to Professor M.C. and Dr. Y. Wang for helpful information and references.

16:00-16:15, Tuesday, June 12

Speaker: Mengying Sun & Yu Han (AW Education International & Maple Leaf International School-Dalian High School)

Title: *Towards a dynamical data-driven model for policy decision in STEM education and advanced technical training (Preliminary Report)*

Abstract: Mathematical training lies in the foundation of STEM education and training of the future skilled workforce. There have been numerous large-scale studies of the current state of K-16 STEM education, that have shed light on numerous challenges facing public policy researchers and decision-makers. Nonetheless, there has been little work in developing quantitative models for prediction of effectiveness in outcomes of

policies on K-12, post-secondary and STEM education. The need for such models is accentuated by the acceleration of scientific and technological advances of the past [decade or couple decades or century].

The acceleration of technological innovation in the 21st century has brought along with it a plethora of available data relevant to economic and sociopolitical contexts. Thus, given the resources and available technologies, there is a real possibility to develop quantitative models that simulate and test computational theories and complex dynamical systems.

The possible social and economic value of modeling the impact of rapid technological advances on educational and labor markets would be immense. While there are many challenges for such a project, it is nonetheless desirable to investigate the potential for future formulation of data-driven hybrid quantitative-qualitative models. In particular, this applied model would assess the impact of national and international policies on higher education, and the effect of professional training for highly skilled labor markets.

The existing data from the 20th and prior centuries have critical deficiencies, due to the emergence of high performance computation and cyberspace-related phenomena. Indeed, existing comparative studies between the 20th, 19th centuries and earlier do not address the main challenges resulting from rapidly changing needs of the transforming economic landscape.

How can we address the challenges faced by incomplete data to extract informative hints for developing quantitative models? Could such model be effective in testing new or older hypotheses to compare policy alternatives designed to address the socioeconomic impact of education?

In this project, we propose an outline for a "framework" that addresses several significant challenges in developing a data-driven hybrid quantitative-qualitative framework. This potential framework investigates the impact of technological growth on education as mentioned above. Numerous gaps remain in the qualitative aspects of our framework due to insufficient knowledge in the cognitive sciences and educational psychology. Nonetheless, our proposed framework offers a novel perspective on future education training programs that could provide insight to policymakers.

16:25-16:50, Tuesday, June 12

Speaker: Jiaming Xuan (University of Wisconsin Madison, WI)

Title: *A mathematical model for perceptual-cognitive categorization of natural images with application to learning artistic influence of pre-Baroque and Baroque paintings on post-Baroque paintings (Preliminary Report)*

Abstract: There has been remarkable progress in design of brain-like intelligent vision systems to match the performance of human vision. Accomplishment of such ambitious objectives hinges upon successful solution of challenging problems in data analytics and learning theory, which in turn, require mathematical modeling of massive image data sets from natural images at multiple scales & resolutions.

In this preliminary report, we propose a general theory to transform (heterogeneous, multi-scale, multi-resolution) data into a space endowed with additional mathematical structure. Sample data from multiple experiments are used to design an intelligent vison system that learns from paintings to perform visual categorization and perceptual abstraction. The results agree with text analysis from art history articles and books.

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