5TH NUS GRADUATE SYMPOSIUM IN MATHEMATICS

17 April 2017 (Monday)
Department of Mathematics
S17 #04-05 & #04-06

NUS GRADUATE SYMPOSIUM IN MATHEMATICS
17 April 2017, Department of Mathematics, NUS

PROGRAMME

Time/Venue	S17-04-06		S17-04-05	
08:50 – 09:00	**Opening Address** Prof ZHU Chengbo			
09:00 – 09:45	**Multiscale modeling and simulation for complex fluids and micro-fluidics** Prof REN Weiqing	*p2*		
09:45 – 10:15	*Tea break @ Mathematics Department Lounge*			
10:15 – 11:00	**Automorphisms of complex varieties – an approach from the minimal model program** Prof ZHANG De-Qi	*p2*		
11:00 – 11:20	LIU Zhaoqiang	*p2*	WANG Liuquan	*p3*
11:20 – 11:40	PANG Tongyao	*p3*	SONG Xu	*p3*
11:40 – 12:00	XU Guodong	*p3*	PENG Cheng	*p4*
12:00 – 14:00	*Lunch @ Mathematics Department Lounge*			
14:00 – 14:20	WU Bin	*p4*	ZHAO Quan	*p5*
14:20 – 14:40	JIANG Wei	*p4*	CUI Hanwen	*p5*
14:40 – 15:00	HUANG Shan	*p4*	CHEN Bo	*p6*
15:00 – 15:20	LEE Junbeom	*p5*	LUO Caihua	*p6*
15:20 – 15:50	*Tea break @ Mathematics Department Lounge*			
15:50 – 16:10	Birzhan MOLDAGALIYEV	*p6*	Fedor PAVUTNITSKIY	*p7*
16:10 – 16:30	LAM Xin Yee	*p6*	LI Ning	*p8*
16:30 – 16:50	ZHANG Yangjing	*p7*	MENG Sheng	*p8*
16:50 – 17:10	Andreas GUNAWAN	*p7*	HUANG Ruizhi	*p8*
17:10 – 17:30	GUAN Yu	*p7*	FENG Xianzhe	*p9*
17:30 – 17:50			DAO Van Thinh	*p9*

(Number in italic denotes page number of abstract)

ABSTRACTS

Prof REN Weiqing
Multiscale modeling and simulation for complex fluids and micro-fluidics

In many areas of science and engineering, we face the problem that we are interested in analyzing the macroscale behavior of a given system, but we do not have a complete and accurate model for the macroscale quantities that we are interested in. On the other hand, we often do have a microscale model with satisfactory accuracy - the difficulty being that solving the full microscale model is far too inefficient, due to the disparate spatial and temporal scales that have to be resolved in such simulations. Therefore, it is desirable to develop multiscale models and algorithms that are based on a combination of the two formulations, in order to take the advantage of both the efficiency of the macroscale model and the accuracy of the microscale model. In this talk, I will discuss two examples, one for the modeling of complex fluids and the other for the modeling of moving contact lines.

Prof ZHANG De-Qi
Automorphisms of complex varieties – an approach from the minimal model program

We consider automorphisms of algebraic manifolds or more generally endomorphisms of compact Kahler manifolds. We give sufficient conditions to run the minimal model program (or Mori's program) equivariantly with respect to the given symmetries. The conclusion: Fano manifolds and complex tori or their quotients are the dynamically essential cases.

LIU Zhaoqiang
When it is meaningful to perform k-means to learn Gaussian Mixture model

Clustering is a ubiquitous problem in many fields and k-means algorithm is a widely used approach for clustering. It tries to find an optimal clustering which minimize the sum of squared error. In a real application, for example, clustering head images by identity, there is a certain unknown "correct" target clustering. While applying k-means, we make a key implicit assumption that any optimal clustering is close to the correct target clustering. Otherwise, performing k-means is meaningless. Despite the wide usage of k-means, there is few theoretical guarantees about when the implicit assumption is satisfied.

In this paper, with the assumption that samples are generated from a Gaussian mixture model, we provide sufficient conditions for the closeness of any optimal clustering and the correct target clustering of the samples. Moreover, for the purpose of significantly faster running time and reduced memory usage, we present that under weaker assumptions for the Gaussian mixture model, any optimal clustering for the samples with reduced dimensionality is also close to the correct target clustering. These results also explain why k-means can be a good choice of learning Gaussian mixture model, as presented in Kumar and Kannan [2010]. Furthermore, we verify the correctness of our theorems in synthetic experiments.

PANG Tongyao
Phase retrieval: an wavelet frame based approach

Phase Retrieval problem is to recover a complex signal, given a number of observations on the magnitude of linear measurements. This problem has direct applications in X-ray crystallography, diffraction imaging and microscopy. Motivated by the extensively studied theory of (tight) wavelet frame and its great success in various applications, we propose a wavelet-based model for phase retrieval using the balanced approach. Movever, hybrid fidilty term and penalty term are introduced to remove complicated noises and pursuit smoothness and sparisity more roustly. Finally, an algorithm iterating in the siganal domain and updating the penalty parameter adaptively are proposed to save computational time and accelerate the converengece.

XU Guodong
Estimating Defocus Amount Through Rank of Local Patches

This paper addresses the problem of defocus map estimation from a single image. We present a fast yet effective approach to estimate the spatially varying amounts of defocus blur at edge locations, which is based on the maximum ranks of the corresponding local patches with different orientations in gradient domain. Such an approach is motivated by the theoretical analysis which reveals the connection between the rank of a local patch blurred by a defocus-blur kernel and the blur amount of the kernel. After the amounts of defocus blur at edge locations are obtained, a complete defocus map is generated by a standard propagation procedure. The proposed method is extensively evaluated on real image dataset, and the experimental results show its superior performance to existing approaches.

WANG Liuquan
Modular forms and k-colored generalized Frobenius partitions

Let k and n be positive integers. Let $c\phi_{k}(n)$ denote the number of k-colored generalized Frobenius partitions of n and $\mathrm{C}\Phi_k(q)$ be the generating function of $c\phi_{k}(n)$. In this talk, we first introduce a new method for finding representations of $\mathrm{C}\Phi_k(q)$. In particular, we find alternative representations of $\mathrm{C}\Phi_{k}(q)$ for $k\le 17$. Then we present some relations between $c\phi_{k}(n)$ and the ordinary partition function $p(n)$. Lastly, an interesting congruence satisfied by $c\phi_{k}(n)$ will be given. This is a joint work with Prof Chan Heng Huat and Yang Yifan.

SONG Xu
L^2-invariants and applications

We first recall the Cheeger-Müller theorem on the equality of analytic torsion and topological torsion for closed Riemannian manifolds and Lück's generalization to general compact Riemannian manifolds. Then we pass to the L^2 versions, introduce some L^2 invariants and recall some conjectures and applications. At last, we will review some recent results for locally Riemannian symmetric spaces.

PENG Cheng
On the Ershov hierarchy

Ershov generalized the n-r.e. hierarchy to transfinite levels based on Kleene's ordinals and it is a natural measure to study the sets below K. We will survey some early work by Ershov and others on the Ershov hierarchy and present the most fundamental results. We will also introduce some questions we are thinking now.

WU Bin
Large Economies with Social Types

This paper presents a comprehensive theory of large economies in which agents have names and bio-social traits. We prove the existence of competitive equilibrium of the large economy with social types under the condition of nowhere equivalence. Moreover, we illustrate that the nowhere equivalence condition is also necessary for the existence of the competitive equilibrium.

JIANG Wei
A Unified Theory for Diversified Firms: Liquidity Management, Tobin's q, Financial Synergies, and M&A

We propose a tractable dynamic corporate liquidity management framework to examine strategies of cash holding, corporate investment, external financing, and payout for diversified firms.

HUANG Shan
Life-Cycle Consumption, Investment, and Voluntary Retirement with Cointegration between the Stock and Labor Markets

We present an optimal life-cycle consumption, investment, and voluntary retirement model for a borrowing and short sale constrained investor who faces co-integration between the stock and labor markets. With reasonable parameter values, there exists a target wealth-to-income ratio under which the investor does not participate in the stock market at all, whereas above which the investor increases the proportion of financial wealth invested in the stock market as she accumulates wealth. We analyze the effects on investment of retirement flexibility with and without co-integration. We also isolate the effects on retirement of risk aversion with and without uninsurable income risks. The model presented here predicts that early retirement is economically plausible in the stock market booms, like those observed in the late 1990's.

Author: Dai Min, Huang Shan, Park Seyoung

LEE Junbeom
Recovering Linear Equations of XVA in Bilateral Contracts

In this talk, we investigate conditions to represent derivative price under XVA explicitly. As long as we consider different borrowing/lending rates, XVA problem becomes a non-linear equation and this makes finding explicit solution of XVA difficult. It is shown that the associated valuation problem is actually linear under some proper conditions so that we can have the same complexity in pricing as classical pricing theory. Moreover, the conditions mentioned above is mild in the sense that it can be obtained by choosing adequate covenants between the investor and counterparty.

ZHAO Quan
Solid state dewetting with axisymmetric geometry

Solid thin films on substrate are typically unstable and can exhibit complicated morphologies evolution even below their melting temperature. Driven by capillary instabilities, the thin film can produce a series of growing holes, retracting edges, or even breaking up into small islands. This process, known as dewetting, tends to minimize the surface energies via surface diffusion. We derive the sharp interface model of solid-state dewetting in the form of axisymmetric geometry based on thermodynamic variation, and then propose a parametric finite element approximation for the geometric PDES. A reduced model via Onsager's principle will also be given to describe the migration of solid-state dewetting of tinny annulus.

CUI Hanwen
On the apparent contact angle in electro-wetting on dielectric

Since the discovery of electro-capillarity, it has been witnessing wide applications in various fields (e.g., Amazon Kindle in electronic displays). Yet this discovery, that the electric field deforms the liquid-liquid interface, has not been well understood. Take the electro-wetting on dielectric (EWoD) model, and it does not match experiments. While the models predict an invariant contact angle of the droplet on dielectric, this contact angle has been observed to decrease as the voltage grows.

This talk explains how a boundary layer hypothesis could get rid of such an incompatibility: While the local contact angle remains constant, the liquid-liquid interface curves infinitely near the contact line, making the apparent contact angle noticeably smaller than the local one. This hypothesis could be validated by asymptotic analysis, with its inner region problem solved efficiently thanks to a Schwarz-Christoffel mapping. Based on these simulations, this talk illustrates how the dependence of the apparent contact angle determined by the above hypothesis on voltage is in accordance with the empirical formulation.

CHEN Bo
An Efficient Inexact Symmetric Gauss-Seidel Based Majorized ABCD Method for PDE-Constrained Sparse Optimization

In this paper, elliptic optimal control problems involving the L^1-control cost (L^1-EOCP) is considered. To numerically discretize L^1-EOCP, the standard piecewise linear finite element is employed. However, different from the finite dimensional L^1-regularization optimization, the resulting discrete L^1-norm does not have a decoupled form. A common way is to use an approximate L^1 norm, which will incur an additional error. To avoid the additional error, we consider to solve L^1-EOCP via its dual, which can be reformulated as a multi-block unconstrained convex composite minimization problem. Motivated by the success of the accelerated block coordinate descent (ABCD) method for solving large scale convex minimization problems in finite dimensional space, we consider extending this method to L^1-EOCP.

LUO Caihua
From modular forms to Langlands program II

It is well known that the Selberg ¼ conjecture and the Ramanujan-Petersson conjecture can be unified under Langlands program, i.e. cuspidal automorphic representations of GL(n) are tempered (generalized Ramanujan conjecture). Due to an observation of Langlands, the generalized Ramanujan conjecture follows from the functoriality of symmetric powers of automorphic representations of GL(n). In this talk, we try to share this example to see the beauty of Langlands functoriality.

Birzhan MOLDAGALIYEV
Introduction to Algorithmic Randomness

In 1919 Von Mises gave first formal definition of algorithmic randomness for infinite binary sequences. Since there was no formal definition of computability at that time, his definition was not precise enough. With formalization of the notion of an algorithm in 1930s, there had been numerous models used to define randomness in the context of computability theory. In this talk, I am going to present a short history of the subject. I plan to end the talk with the questions motivating my own research.

LAM Xin Yee
Fast algorithms for large scale generalized distance weighted discrimination

High dimension low sample size statistical analysis is important in a wide range of applications. In such situations, the highly appealing discrimination method, support vector machine, can be improved to alleviate data piling at the margin. This leads naturally to the development of distance weighted discrimination (DWD), which can be modeled as a second-order cone programming problem and solved by interior-point methods when the scale (in sample size and feature dimension) of the data is moderate.

Here, we design a scalable and robust algorithm for solving large scale generalized DWD problems. Numerical experiments on real data sets from the UCI repository demonstrate that our algorithm is highly efficient in solving large scale problems, and sometimes even more efficient than the highly optimized LIBSVM for solving the corresponding SVM problems.

ZHANG Yangjing
An algorithm for Partial Gaussian Graphical Model

We consider estimating part of the inverse covariance matrix in the Partial Gaussian Graphical Model, a discriminative extension of Gaussian Graphical Model. This problem is realized via penalizing the maximum likelihood estimation by l_1 regularization. In this way, it can be reformulated as a regularized convex log determinant optimization. We propose to solve it with the classical Augmented Lagrangian Method (ALM). At each iteration, we need to solve an optimization sub-problem by an inexact generalized Newton's method. Moreover, we incorporate the ADMM to provide an initial point.

Andreas Dwi Maryanto GUNAWAN
Verification of network model for evolution using two containment problems

Tree containment problem (TCP) and cluster containment problem (CCP) are two popular methods for checking whether a network model of evolution is consistent. Both problems are NP-complete in general, and a lot of effort has been devoted to find networks classes where the containment problems can be solved quickly. CCP for the class of reticulation-visible network is known to be solvable in quadratic time, while recently TCP for the same class is also proven solvable in quadratic time, which gave a positive answer to a five-year-long conjecture in phylogenetic study.

The solution is based on a simple-yet-powerful decomposition theorem, which is also used to create two algorithms for solving TCP and CCP in arbitrary networks. In this talk, I will briefly explain the decomposition theorem and its implementation for solving TCP and CCP.

GUAN Yu
Best Rank - 1 Approximation of a Symmetric Tensor

Offer 3 Algorithms to find the best rank-1 approximation of a symmetric tensor and analysis the convergence property.

Fedor PAVUTNITSKIY
Simplicial James-Hopf map and unstable Adams spectral sequence for suspensions

We extend the classical definition of James-Hopf invariant from free monoid to free group, which allows us to realize coalgebra idempotents on the level of lower central series tower and hence obtain a decomposition of unstable Adams spectral sequence for suspensions

LI Ning
Associated Cycles and Theta Lift

Associated cycle is a nilpotent invariant of a representation defined by Vogan, which is defined from the associated variety. The notion allows us to study a representation in terms of the nilpotent orbits. The associated variety of the irreducible admissible representation is a union of the closure of equi-dimensional nilpotent orbits related to the representation. The associated cycle is a refined notion of the associated variety by considering a linear combination of the closure of the orbits whose multiplicity gives the rank of the module localized at the orbit.

In this talk, I will discuss some relations between associated cycle and theta lift.

MENG Sheng
Building blocks of Polarized Endomorphisms of Normal Projective Varieties

An endomorphism f of a projective variety X is polarized (resp. quasi-polarized) if $f^\ast H \sim qH$ for some ample (resp. nef and big) Cartier (integral) divisor H and integer $q > 1$.

First, we use cone analysis to show that a quasi-polarized endomorphism is always polarized, and the polarized property descends via any equivariant dominant rational map. Next, we show that a suitable maximal rationally connected fibration (MRC) can be made f-equivariant using a construction of N.~Nakayama, that f descends to a polarized endomorphism of the base Y of this MRC and that this Y is a Q-abelian variety (quasi-\'etale quotient of an abelian variety).

Finally, we show that we can run the minimal model program (MMP) f-equivariantly for mildly singular X and reach either a Q-abelian variety or a Fano variety of Picard number one.

This is a joint work with Prof Zhang De-Qi.

HUANG Ruizhi
On cancellation and homotopy rigidity of classic functors

We show that simply connected co-H-spaces and connected H-spaces can be uniquely decomposed into prime factors in the category of pointed p-local spaces of finite type, which can be used to develop a p-local version of Gray's correspondence between homotopy types of prime co-H-spaces and homotopy types of prime H-spaces, and the split fibration which connects them as well. Further, we use the unique decomposition theorem to study the homotopy rigidity problem for classic functors. Among others, we prove that $\Sigma \Omega$ and Ω are homotopy rigid on simply connected p-local co-H-spaces of finite type, and $\Omega\Sigma $ and Σ are homotopy rigid on connected p-local H-spaces of finite type.

This is a joint work with Prof Wu Jie.

FENG Xianzhe
A note on non-linear bi-separating operators

First, I will be talking about the characterization of non-linear bi-separating operators between function spaces. Second, I will talk about the properties of the characterization given the kind of function spaces the bi-separating operators act on, such as continuous function space, uniformly continuous function space and Lipschitz continuous function space.

DAO Van Thinh
Average size of 2-Selmer group of Jacobians of Hyperelliptic curves over function fields

In recent years, the average size of 2-Selmer group of Elliptic curves and Jacobian of Hyperelliptic curves were studied widely, and most of those results are in the rational field setting. In function fields case, there are also some results for 2-Selmer group of Elliptic curves (Ngo.B.C et al. for elliptic curves with a marked Weierstrass point, J. Thorne for elliptic curves with two marked points).

In this talk, I will try to calculate the Average size of 2-Selmer group of Jacobians of Hyperelliptic curves over function fields.