2ND NUS GRADUATE SYMPOSIUM IN MATHEMATICS

21 April 2014 (Monday)
Department of Mathematics
S17 #04-06 & #04-05

Faculty of Science
Department of Mathematics

NUS GRADUATE SYMPOSIUM IN MATHEMATICS
21 April 2014, Department of Mathematics, NUS

PROGRAMME

Time/Venue	S17-04-06 (SR1)	S17-04-05 (SR2)
08:50 - 09:00	*Opening address at SR1*	
09:00 - 09:20	Gao Fan	Du Mengyu
09:20 - 09:40	Zhang Rong	Li Xudong
09:40 - 10:00	Yu Jinjiong	Cui Ying
10:00 - 10:20	Yang Yu	Yang Liuqin
10:20 - 10:50	*Tea break @ Math Lounge*	
10:50 - 11:10	Zhou Feng	He Wei
11:10 - 11:30	Wang Haitao	Chen Junrui
11:30 - 11:50	Liu Yiqun	Li Shangru
11:50 - 12:10	Lei Yaoting	Qiao Lei
12:10 - 14:00	*Lunch @ Math Lounge*	
14:00 - 14:20	Xu Jing	Jia Xiaowei
14:20 - 14:40	Yang Chen	Zhao Xiaofei
14:40 - 15:00	Chen Weiqiang	Luo Chang
15:00 - 15:20	Zhao Yufei	Wang Yan
15:20 - 15:40	Xie Peichu	-----

ABSTRACTS

TIME	TALK	VENUE
08:50 - 09:00	**Opening Address by Prof Zhu Chengbo**	S17-04-06
09:00 - 09:20	**GAO Fan** *Title:* Arithmetic of Varieties, Langlands Program and Metaplectic Forms The talk, which is of expository nature, will start with elementary examples elaborating on the connection between arithmetic of varieties and automorphic forms. Following that, basic conjectures in the Langlands program will be introduced and known results and applications will be briefly explored. At the end, metaplectic forms together with any speculative role it might play for such connection will be mentioned.	S17-04-06
	DU Mengyu *Title:* A Brief Introduction to an Approximate Newton-CG Method Newton-CG method is known to be an efficient algorithm for some problems with positive semidefinite constraint and linear constraints. It converges fast and can always generate high accuracy solutions. However, it will face difficulties in the large-scale case and can become time-consuming. In this talk, we will give a brief introduction to an approximate Newton-CG method which is capable in solving large scale problems.	S17-04-05

TIME	TALK	VENUE
09:20 - 09:40	**ZHANG Rong** *Title:* Fatou Sets and Julia Sets in Real Polynomial Maps In my presentation, I will give an introduction to problems and known results on Fatou sets and Julia sets of positive measure in real and complex one-dimensional dynamics. In 1985, Sullivan proved there was no wandering domain of rational map in the complex sphere. In his famous paper, he made use of quasiconformal mapping as the main tool and solved the big problem on the Fatou sets. Therefore, we only need to consider the complement part Julia sets of Fatou sets. In 1996 Bruin, Keller, Nowicki and van Strien proved existence of wild attractors for Fibonacci unimodal maps, and a counterpart in the complex setting was studied by Nowicki and van Strien also. The latter paper contains a gap which is currently not fixed. I will introduce some of the key ingredients in their results, which include: real bounds, complex bounds for Fibonacci maps and a probability method to estimate the measure of Julia sets.	S17-04-06
	LI Xudong *Title:* On the convergence of the alternating direction method of multipliers Alternating direction method of multipliers (ADMM) is a common tool for convex optimization problems. This method is well suited to large-scale problems arising in statistics, machine learning, and related areas. In this talk, some recent convergence results for ADMM will be reviewed. Results on the rate of convergence will also be mentioned.	S17-04-05

TIME	TALK	VENUE
09:40 - 10:00	**YU Jinjiong** *Title:* An almost sure invariance principle for random walks in a space-time random environment Firas Rassoul-Agha and Timo Seppalainen consider a discrete time random walk in a space-time i.i.d. random environment. They use a martingale approach to show that the walk is diffusive in almost every fixed environment. They improve on existing results by proving an invariance principle and considering environments with an annealed L2 drift. They also state an a.s. invariance principle for random walks in general random environments whose hypothesis requires a subdiffusive bound on the variance of the quenched mean, under an ergodic invariant measure for the environment chain.	S17-04-06
	CUI Ying *Title:* A global approach for nonsmooth nonconvex nearest correlation matrix problem with rank constraint. In many applications the sample correlation matrices are not positive semidefinite and fail to satisfy the desired low rank structure. The calibration model is nonsmooth and nonconvex due to the rank constraint, causing a lot of difficulty to find the global optimal solution. We design several smoothing algorithms to solve the dual problem, and accelerate the convergence speed locally with semismooth Newton-CG algorithm. With the help of the modified principle component analysis, we obtain a feasible primal solution with a certain level of global optimality. Numerical results show that our approach is fast and robust.	S17-04-05

TIME	TALK	VENUE
10:00 - 10:20	**YANG Yu** *Title:* Various notations of positive maps and quantum information In order to describe the structure of convex cone of positive maps between matrix algebras, various notations of positivity are involved. Surprisingly, people find that positive maps are important in the study of entanglement in quantum information theory. In this talk, I will explain the relationship among various notations of positivity and entanglement, including some classical results as well as recent progresses.	S17-04-06
	YANG Liuqin *Title:* SDPNAL+: A Majorized Semismooth Newton-CG Augmented Lagrangian Method for Semidefinite Programming with Nonnegative Constraints By Liuqin Yang, Defeng Sun, Kim-Chuan Toh In this paper, we present a majorized semismooth Newton-CG augmented Lagrangian method, called SDPNAL+, for semidefinite programming (SDP) with partial or full nonnegative constraints on the matrix variable. SDPNAL+ is a much enhanced version of SDPNAL introduced by Zhao, Sun and Toh [SIAM Journal on Optimization, 20 (2010), pp. 1737-1765] for solving generic SDPs. SDPNAL works very efficiently for nondegenerate SDPs and may encounter numerical difficulty for degenerate ones. Here we tackle this numerical difficulty by employing a majorized semismooth Newton-CG method coupled with a block coordinate descent method to solve the inner problems. Numerical results for various large scale SDPs with or without nonnegative constraints show that the proposed method is not only fast but also robust in achieving accurate solutions. It outperforms, by a significant margin, two other competitive codes: (1) an alternating direction based solver called SDPAD by Wen et al. [Mathematical Programming Computation, 2 (2010), pp. 203-230] and (2) a two-easy-block-decomposition hybrid proximal extragradient method called 2EBD-HPE by Monteiro et al. [Mathematical Programming Computation, (2013), pp. 1-48]. In contrast to these two codes, we are able to solve all the 95 difficult SDP problems arising from QAP problems tested in SDPNAL to an accuracy of 10^{-6} efficiently, while SDPAD and 2EBD-HPE successfully solve 30 and 16 problems, respectively. It is also noted that SDPNAL+ appears to be the only viable method currently available to solve large scale SDPs arising from rank-1 tensor approximation problems constructed by Nie and Li [arXiv preprint arXiv:1308.6562, (2013)]. The largest rank-1 tensor approximation problem solved is nonsym(21,4), in which its resulting SDP problem has matrix dimension n = 9,261 and the number of equality constraints m = 12,326,390. Keywords: semidefinite programming, degeneracy, augmented Lagrangian, semismooth Newton-CG method, block coordinate descent method.	S17-04-05

TIME	TALK	VENUE
10:50 - 11:10	**ZHOU Feng** *Title:* Multiple solutions for the Prescribed Scalar Curvature Equation The Prescribed Scalar Curvature Problem was raised by L. Nirenberg: which function K on unit sphere S^n is the scalar curvature of a metric g on S^n conformally equivalent to the standard metric g_1? When n≥3, the problem is equivalent to finding a positive solution to the Prescribed Scalar Curvature Equation in S^n. The hallmarks of the Prescribed Scalar Curvature Equation are the critical Sobolev exponent, the non-compactness of Sobolev embedding, typified by the blow-up phenomenon. In this talk, we will consider the multiple solutions for the Prescribed Scalar Curvature Equation. For n≥6, using the Lyapunov-Schmidt reduction method (the finite dimensional reduction method), we construct scalar curvature functions on S^n, so that each of them enables the Prescribed Scalar Curvature Equation to have an infinite number of positive solutions which form a blow-up sequence.	S17-04-06
	HE Wei *Title:* Conditional Distributions and Expectations of Correspondences We prove some regularity properties (convexity, closeness, compactness and preservation of upper hemicontinuity) for distributions, integrations, regular conditional distributions and conditional expectations of correspondences under the condition of setwise coarseness. We show the necessity of the setwise coarseness condition when any of these properties holds.	S17-04-05

TIME	TALK	VENUE
11:10 - 11:30	**WANG Haitao** *Title:* Navier-Stokes equation in half space with nonzero far field flow In this talk, I will review previous works for N-S equation in half space, such as Solonnikov's and Ukai's. They first obtain the solution formula for linearized equation, and use solution formula to prove the existence for nonlinear problem with small initial data. Then I will present similar result for N-S equation with nonzero far field flow and more general boundary condition.	S17-04-06
	CHEN Junrui *Title:* On the role of energy mix for optimization of emission market architecture We analyze the performance of tradable pollution permit market given existing energy-generating technologies. Within a general equilibrium framework, we show how the architecture of a proposed emission trading scheme should be optimized with respect to the allocation over energy production technologies present in the market.	S17-04-05

TIME	TALK	VENUE
11:30 - 11:50	**LIU Yiqun** *Title:* Details not available yet	S17-04-06
	LI Shangru *Title:* Optimal Switching under Convexity Assumptions We address a method of approximate calculation of optimal control policy applicable to a particular class of stochastic control problems. In these problems, the stochastic dynamics exhibit a certain convexity preserving property. Within our numerically tractable approach, we show a convergence to the value function of the original problem uniformly on compact sets. Further we will present the error estimation with duality method. Some applications will also be given in the talk.	S17-04-05

TIME	TALK	VENUE
11:50 - 12:10	**LEI Yaoting** *Title:* How Does Pay Duration Affect Managers' Choice of Effort and Risk? We study the incentive effects of rewarding a risk-averse manager with restricted stock of the firm she manages. The manager can only sell the firm stock after a given lockup period. In a continuous-time portfolio choice framework, we allow the manager to apply costly effort and to choose the level of risk of her investments, which in turn affect the expected value and volatility of the firm's stock price. We also allow the manager to be able to partially hedge the risk of the restricted stock by taking offsetting positions in a market index. We show that the liquidity constraints associated with the restricted stock generate large (endogenous) risk aversion. We show that the maximum amount of effort chosen by the manager declines over the lockup period. In order to induce maximum effort throughout the lockup period, the manager needs to be offered increasing amounts of restricted stock. Lastly, we show that the subjective value of the restricted stock is a hump-shaped function of the level concentration of the manager's personal portfolio.	S17-04-06
	QIAO Lei *Title:* Modelling Spaces of Players in Idealized Limit Games This paper demonstrates the class of atomless spaces that accurately models the space of players in a large game which represents an idealized limit of a sequence of finite-player games. Through two examples, we show that arbitrary atomless probability spaces, in particular, the Lebesgue unit interval, may not be appropriate to model the space of players of an idealized limit. This inappropriateness hinges on the fact there is a convergence sequence of exact pure- strategy Nash equilibria in the sequence of finite-player games, while the idealized limit game of the sequence does not have any equilibrium. Instead, a saturated probability space is shown to be not only sufficient but also necessary, to model the space of players in any idealized limit. This complements the study of large games with a bio-social typology in Khan et al. as such a connection between finite-limiting and idealized continuum-limit games was not able to be obtained in their framework.	S17-04-05

TIME	TALK	VENUE
14:00 - 14:20	**XU Jing** *Title:* Level Shifts of U.S. Short Term Rates, from Pre-Bubble Years to Post-Tsunami Era: Modeling, Estimation and Prediction U.S. short term yields data in the new century exhibits prominent level shifting feature. This empirical fact naturally motivates a question: is it possible to incorporate this feature and hence improve the performance of interest rate models at the short end of yield curve? To answer this question, we propose a novel random level shift extension of short rate models in this paper. On the theoretical side, we comprehensively study the bond pricing issues with random level shift. We propose efficient numerical method and accurate short maturity approximation formula. On the empirical side, we consider the extension of celebrated affine term structure models and estimate them using empirical data, employing an estimation method based on maximum likelihood. We find that those extended affine models uniformly outperform the original ones in terms of out-of-sample predictive power.	S17-04-06
	JIA Xiaowei *Title:* Numerical Methods and Multi-scale Analysis for the Perturbed Kuramoto-Sivashinsky Equation Models for free-interface problems in two dimensional space have been well developed in the past years, but the research for solving explicit equation for the interface dynamics still keeps going. We want to get good numerical solution through well designed algorithms to reveal the physical phenomenon. In this talk, we will focus on the different numerical methods for solving the Perturbed Kuramoto-Sivashinsky (K-S) equation. From the numerical results, we will see the convergence of Perturbed equations to the K-S equation. Also I will talk about the well-posed and ill-posed initial problems, provide a multi-scale analysis for the ill-posed initial problem and compute the dynamics.	S17-04-05

TIME	TALK	VENUE
14:20 - 14:40	**YANG Chen** *Title:* Optimal Consumption and Investment with Asymmetric Long-term/Short-term Capital Gains Taxes We propose an optimal consumption and investment model with asymmetric long-term/short-term capital gains tax rates for both lower income and wealthy investors. We characterize and develop an iterative algorithm to compute the optimal policy. Opposite to the existing literature, we show that it may be optimal to defer even large long-term gains and losses. In addition, the optimal policy for lower income investors is qualitatively different from that for wealthy ones. Furthermore, raising capital gains tax rates for lower income investors can significantly increase their consumption, stock investment, and welfare, due to negative effective tax rates.	S17-04-06
	ZHAO Xiaofei *Title:* On multichannel solutions of nonlinear Schr\"{o}dinger equations: numerics and analysis. A wide class of conservative nonlinear dispersive equations, such as nonlinear Schr\"{o}dinger equations and Korteweg-de Vries equations (give some refs here), admit solutions with more than one channel or the multichannel solutions, which means that the asymptotic behavior of the solution is given by a linear combination of a localized (in space), periodic (in time) wave (solitary or standing wave) and a dispersive part. The multichannel solutions are important and useful in both theoretical analysis and applications. For example, the nonlinear scattering theory in the study of nonintegrable equations and the design of absorbing boundary conditions for the partial differential equations. This talk is focused on the multichannel solutions in the nonlinear Schr\"{o}dinger (NLS) equations in d dimensions. Firstly, the mathematical framework and related theory are given on the multichannel solutions in the NLS, where a coupled nonlinear system known as modulated equations in literature is introduced to describe the standing wave and dispersive wave. Then based on the modulated equations, algorithm, analysis and numerical explorations are carried out for the multichannel solutions.	S17-04-05

TIME	TALK	VENUE
14:40 - 15:00	**CHEN Weiqiang** *Title:* Representations of High Angular Resolution Diffusion Images (HARDI) by Tight Frames High Angular Resolution Diffusion Imaging (HARDI) is a non-invasive bio-imaging technique that relies on the measurement of the diffusion of water molecules in biological tissues. It models water diffusion at a voxel with an orientation distribution function (ODF) on a spherical domain that can capture multiple orientations at a voxel. Traditional methods of estimating the ODF from HARDI signals expresses the ODF in terms of globally supported spherical harmonics, which generally do not yield sparse representations of localized HARDI signals. My research topic focuses on possible constructions of locally supported tight frames on the sphere which might be helpful in the sparse representations and denoising of HARDI signals.	S17-04-06
	LUO Chang *Title:* On local structural controllability of directed networks Controllability of complex networks has drawn much attention in recent years due to combined techniques from network science and control theory. In this talk, I will introduce a new network controllability framework, the local (structural) controllability. In the first part, I will mainly discuss the mathematical formulation of local controllability problem for directed networks and show that the solution can be found either by looking for a minimum-weight perfect matching or by solving a linear program. For our purpose, the Hungarian algorithm is used to design algorithms to identify the minimum driver nodes for local controllability. In the second part, I will briefly present some results on the application of local controllability to model networks, in an attempt to investigate how local controllability is affected by various network measures.	S17-04-05

TIME	TALK	VENUE
15:00 - 15:20	**ZHAO Yufei** *Title:* Discrete Gabor frames and its application on image restoration We use the Gramian and dual Gramian analysis to study the frame properties of finite discrete Gabor systems and their adjoint systems, and derive the necessary and sufficient conditions on constructing tight Gabor frames for C^N. For example, one can design tight frames generated from square-root B-spline functions of different sizes. Furthermore, such tight systems can be modified to be Gabor frames with zero DC offset, as well as closed-form dual frames. For 2D case, orientation selectivity is obtained through the tensor product of the 1D complex-valued systems. Also, the Gabor frames with different scales can correspondingly characterize the cartoon and texture parts of images. Based on these properties, multi-scale discrete Gabor frames possess advantages in the image restoration, compared with other existing systems.	S17-04-06
	WANG Yan *Title:* Sharp Interface Model For Solid-State Dewetting Problems With Weakly Anisotropic Surface Energy By Yan Wang, Wei Jiang, Weizhu Bao, David J. Srolovitz We propose a sharp interface model for simulating solid-state dewetting problems with weakly anisotropic surface energy. Derivation of the model and boundary conditions is based on a energy variational approach. We introduce a relaxation process in the wetting angle boundary condition, which is used to tackle the multiple roots problem induced by the anisotropic surface energy. Front tracking method for this problem is easy to implement with an explicit finite different scheme based on cubic spline interpolation. The consistency between our numerical results and Winterbottom-Wulff constructions demonstrates excellent performance of our model. In addition, we perform a series of simulations for thin film with weakly anisotropic surface energy and report the findings referred to the results with isotropic surface energy.	S17-04-05

TIME	TALK	VENUE
15:20 - 15:40	**XIE Peichu** *Title:* A wavelet approach to the total variation model of images In the context of generalized functions, we can appropriately identify the wavelet inner-products as a sampling of the image's directional derivations (up to certain scale). If the Sobolev regularity of the image is provided, we can furthermore establish its global version: the correspondence between variation and wavelet model, through a conception called \Gamma-convergence. In the presentation we will go through the basic ideas and constructions of the above.	S17-04-06