Joint NUS-USTC Workshop on Frontiers in Mathematics

Thursday 6 March & Friday 7 March 2014
Department of Mathematics, NUS
S17 #04-06 Seminar Room 1

Department of Mathematics
Faculty of Science

School of Mathematical Sciences

Programme

Thursday 6 March, 8:50am to 17:10pm

Morning Session
Chair: Toh Kim Chuan (NUS)

8:50 - 9:00	Opening address Welcome by Professor *Shen Zuowei* (Head), NUS Welcome by Professor Li Jiayu (Chairman), USTC
9:00 - 9:40	Geometric Processing Based on Sparse Optimization Chen Falai, USTC
9:40 - 10:20	First Passage Times of Two-Dimensional Brownian Motion Steven Kou, NUS
10:20 - 10:50	Break @ Mathematics Department Lounge
10:50 - 11:30	Splines over T-meshes Deng Jiansong, USTC
11:30 - 12:10	Multiscale Methods and Analysis for the Nonlinear Klein-Gordon Equation in the Nonrelativistic Limit Regime Bao Weizhu, NUS
12:10 - 14:00	Lunch @ Mathematics Department Lounge (buffet lunch)

Afternoon Session
Chair: Shen Weixiao (NUS)

14:00 - 14:40	Asymptotic behavior of the YMH flow Li Jiayu, USTC
14:40 - 15:20	On the Spacetime Quasiconcave Solutions of the Heat Equation Ma Xinan, USTC
15:20 - 15:50	Break @ Mathematics Department Lounge
15: 50 - 16:30	A Dilogarithm Identity on Moduli Spaces of Curves Tan Ser Peow, NUS
16:30 - 17:10	Complex Manifolds with the Maximal Number of Automorphisms of Positive Entropy Zhang De-Qi, NUS

Programme

Friday 7 March, 9:00am to 12:10pm

Chair: Li Jiayu (USTC)

9:00 - 9:40	Recent Progress on the Gross-Prasad Conjecture Gan Wee Teck, NUS
9:40 - 10:20	Irreducible Diffusion Brings Uniform Propagation Liang Xing, USTC
10:20 - 10:50	Break @ Mathematics Department Lounge
10:50 - 11:30	Wavelet Frames, Sparse Approximation and Mathematical Methods for Image Recovery Ji Hui, NUS
11:30 - 12:10	Furstenberg Conjecture and intersections of Cantor sets Huang Wen, USTC

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Abstracts

Multiscale Methods and Analysis for the Nonlinear Klein-Gordon Equation in the Nonrelativistic Limit Regime

BAO Weizhu, National University of Singapore

In this talk, I will review our recent works on numerical methods and analysis for solving the nonlinear Klein-Gordon (KG) equation in the nonrelativistic limit regime, involving a small dimensionless parameter which is inversely proportional to the speed of light. In this regime, the solution is highly oscillating in time and the energy becomes unbounded, which bring significant difficulty in analysis and heavy burden in numerical computation. We begin with four frequently used finite difference time domain (FDTD) methods and obtain their rigorous error estimates in the nonrelativistic limit regime by paying particularly attention to how error bounds depend explicitly on mesh size and time step as well as the small parameter. Then we consider a numerical method by using spectral method for spatial derivatives combined with an exponential wave integrator (EWI) in the Gautschi-type for temporal derivatives to discretize the KG equation. Rigorous error estimates show that the EWI spectral method shows much better temporal resolution than the FDTD methods for the KG equation in the nonrelativistic limit regime. In order to design a multiscale method for the KG equation, we establish error estimates of FDTD and EWI spectral methods for the nonlinear Schrodinger equation perturbed with a wave operator. Finally, a multiscale method is presented for discretizing the nonlinear KG equation in the nonrelativistic limit regime based on large-small amplitude wave decomposition. This multiscale method converges uniformly in spatial/temporal discretization with respect to the small parameter for the nonlinear KG equation in the nonrelativistic limit regime. Finally, applications to several high oscillatory dispersive partial differential equations will be discussed.

Geometric Processing based on Sparse Optimization

CHEN Falai, University of Science and Technology of China

Sparse optimization has been a hot research area in recent years and it is widely used in in image processing, computer vision and engineering. However, there is very little work focusing on applications of sparse optimization in geometric processing—one of the fundamental subjects in computer graphics and computer aided design. In this talk, I will present two applications of sparse optimization in this subject, one is decoupling noises and features of geometric models and the other is cost effective 3D printing. I will show the key role that sparse optimization plays in solving these problems.

Splines over T-meshes

DENG Jiansong, University of Science and Technology of China

A T-mesh is basically a rectangular grid that allows T-junctions. In the talk, we will discuss spline spaces over T-meshes. This type of spline function allows local refinement. The dimension formulae and the basis function construction are reviewed. Its applications in surface modeling and isogemetric analysis are included as well.

Recent Progress on the Gross-Prasad Conjecture

GAN Wee Teck, National University of Singapore

I will explain the Gross-Prasad conjecture in the context of unitary groups. In the local setting, it concerns a branching problem in representation theory. In the global setting, it concerns a certain period of automorphic forms. I will describe some recent progress towards its resolution, highlighting the work of Waldspurger, Beuzart-Plessis, Wei Zhang, Ichino and myself.

Furstenberg Conjecture and intersections of Cantor sets

HUANG Wen, University of Science and Technology of China

We will review some results on Furstenberg Conjecture and discuss some related problems with intersections of Cantor sets.

Wavelet Frames, Sparse Approximation and Mathematical Methods for Image Recovery

JI Hui, National University of Singapore

In recent years, there have been great processes on the development of innovative mathematical models and new mathematical methods applied to many challenging problems arising in image recovery. In this talk, I will discuss the theory and numerical methods of wavelet frames, sparse approximation and related applications in image recovery.

First Passage Times of Two-Dimensional Brownian Motion

Steven KOU, National University of Singapore

First passage times (FPTs) of two-dimensional Brownian motion have been used to study correlated defaults under structural models of credit risk. However, despite various attempts since 1960's, there are few analytical solutions to the mathematical problems relating to FPTs. By solving a non-homogeneous, modified Helmholtz equation in an infinite wedge, we find analytical solutions for the Laplace transforms of FPTs. We show that these Laplace transforms can be numerically inverted. The FPT problems lead to a class of bivariate exponential distributions which are absolute continuous but do not have memoryless property. We also prove that the density of the absolute difference of FPTs tends to infinity if and only if the correlation between Brownian motions is positive. This is a joint work with Haowen Zhong.

Asymptotic behavior of the YMH flow

LI Jiayu, University of Science and Technology of China

In this talk, we will introduce our recent work on the existence of approximate Hermitian-Einstein structures on semi-stable Higgs bundles, and the asymptotic behavior of the Yang-Mills-Higgs flow for Higgs pairs at infinity.

This is a joint work with Zhang Xi.

Irreducible Diffusion Brings Uniform Propagation

LIANG Xing, University of Science and Technology of China

It is known that the continuous diffusion in spatial periodic media can yield the existence of the uniform spreading speeds. However, the diffusion or dispersal can be discontinuous. We will show that the irreducibility of diffusion can also bring the existence of uniform spreading speeds. The main mathematical tools we used are the theory of principal eigenvalue and its application.

On the Spacetime Quasiconcave Solutions of the Heat Equation

MA Xinan, University of Science and Technology of China

In this paper we first obtain a constant rank theorem for the second fundamental form of the convex spacetime level sets of the solution of the heat equation. If the initial data is subharmonic and its level set is convex, we can combine the deformation process to get the spatial convexity and spacetime convexity of the level sets of the solution of the heat equation on convex rings in $\mathbb{R}^n$.

This is a joint work with Chuanqiang Chen (USTC) and P.Salani (Firenze).

A Dilogarithm Identity on Moduli Spaces of Curves

TAN Ser Peow, National University of Singapore

We will talk about a new identity for closed hyperbolic surfaces which involves the dilogarithm of the lengths of simple closed geodesics on the surface, and also relate it to some previously known identities by Basmajian, McShane and Bridgeman. The identity also generalizes in a natural way to surfaces with boundary and non-orientable hyperbolic surfaces. This is joint work with Feng Luo.

Complex Manifolds with the Maximal Number of Automorphisms of Positive Entropy

ZHANG De-Qi, National University of Singapore

This talk surveys our recent results on automorphism groups G of compact Kahler manifolds X of dimension n > 2. We show that X has at most n-1 independent commutative automorphisms of positive entropy,and X has n-1 such automorphisms only when X is birational to the quotient space of a complex torus, unless X is rationally connected, i.e., any two points of X are connected by a rational curve.
