Contents

Sze Lim Lecture

Jean-Pierre Serre: Number of Solutions mod p of Polynomial Equations: How does that Number Vary with p?

Jean-Pierre Serre, Collège de France

Time: 20:30-21:30, April 21, 2017

Address: West Lecture Hall

Abstract: I shall discuss the topic mentioned in the title by giving numerical examples, and stating several results and conjectures.

John Coates: The Oldest Problem

John Coates, The University of Cambridge

Time: 20:30-21:30, April 24, 2017

Address: Lecture Hall, Main Building

Abstract: In my lecture, I plan to discuss the ancient congruent number problem, whose written history goes back at least a thousand years, and which today still remains the oldest unsolved major problem in number theory, and perhaps in the whole of mathematics. I hope to explain some recent progress on the problem, in which Chinese mathematicians have played an important role.

Saturday, April 22th

13:00-13:45

John Coates: Some Open Problems in Number Theory

John Coates, The University of Cambridge

Address: Room 401, No.2 Teaching Building

Abstract: In my lecture, I plan to discuss several important open problems in number theory, on which hopefully real progress can be made in the not too distant future.

Bjorn Engquist: Seismic Imaging and the Monge-Ampère Equation

Bjorn Engquist, The University of Texas at Austin

Address: Room 402, No.2 Teaching Building

Abstract: A fundamental inverse problem in seismic imaging can be formulated as PDE constrained minimization where the miss-match between measured and computed signals plays an important role. The purpose is to find properties such as wave velocity and location of reflecting sub layers in the earth, which are represented by coefficients in the PDE. We propose using optimal transport and the Wasserstein metric for this miss-match. The optimal transport can be given by the gradient of the solution to a MongeCAmpère equation. We will discuss numerical approximations of viscosity solution to MongeCAmpère equations and the application to exploration seismology. Numerical examples comparing different techniques will be presented.

Wilfried Schmid: B-functions and Hodge Modules

Wilfried Schmid, Harvard University

Address: Room 403, No.2 Teaching Building

Abstract: After recalling the definition and uses of b-functions, I shall describe the calculations of certain b-functions arising in the theory of Mixed Hodge Modules.This is joint work with Kari Vilonen.

Werner Ballmann: Small Eigenvalues and Analytic Systole of Surfaces

Werner Ballmann, Max Planck Institute for Mathematics

Address: Room 201, No.1 Teaching Building

Abstract: Eigenvalues of complete Riemannian manifolds are called small if they lie below the bottom of the spectrum of their respective universal covering spaces. For example, eigenvalues of hyperbolic surfaces below a quarter are small. I will discuss small eigenvalues of Riemannian surfaces and a new related invariant, the analytic systole of the surface. This is joint work with Henrik Matthiesen and Sugata Mondal.

Eduard Looijenga: From Hirzebruch Proportionality to Tate Extensions

Eduard Looijenga, YMSC, Tsinghua University

Address: Room 205, No.1 Teaching Building

Abstract: This talk will be about an automorphic vector bundle E on a locally symmetric variety X (for instance the Hodge bundle on a moduli space of polarized abelian varieties). For the (rare) case that X is compact, Hirzebruch (1958) found proportionality relations among the Chern numbers of E. In general, X has a natural projective compactification X^* (the Baily-Borel compactification) and although an automorphic bundle will in general not extend to X^*, Mumford (1977) was able to make sense of the Chern numbers of E and prove a generalization of Hirzebruch's proportionality theorem. In 2002 Goresky and Pardon went a step further and found a natural extension of the Chern classes of E to X^*. They asked whether their classes are rational (or real for that matter). We shall answer that question and show how certain Tate extensions enter the story. We will see this happening in its purest form in the stable cohomology of the Baily-Borel compactification of the moduli spaces of principally polarized abelian varieties.

Jun Liu: On Statistical Learning: from Linear to Nonlinear

Jun Liu, Harvard University

Address: Room 104, No.1 Teaching Building

Abstract: I will discuss a few recent results and examples from my group aiming at the detection of non-linear dependence between two random variables, or one response variable and a set of predictor variations. Two main ideas of our approaches are (a) discretization of the continuous response variable, and (b) dynamic programming to optimize the discretization. Our test statistic for pairwise dependence detection gives rise to a relationship measure, which takes value in $[0, 1]$, and can be viewed as a direct extension of the standard R-square. When we have multiple predictor variables, the discretization idea links to the well-known sliced inverse regression and the classic logistic regression. The resulting algorithms (SIRI and SODA) are surprisingly powerful and can deal with high-dimensional data with the number of predictors much larger than the sample size. It does not require the joint normality assumption on predictors, leading to much enhanced robustness.

Stanislav Smirnov: TBA

Stanislav Smirnov, Université de Genève

Address: West Lecture Hall

Abstract: TBA

13:50-14:35

Shouwu Zhang: On the Heights of Abelian Varieties

Shouwu Zhang, Priceton University

Address: Room 401, No.2 Teaching Building

Abstract: I will talk about some new questions and results about the Faltings heights of abelian varieties of $GL(2)$ type and CM type with applications to Diophantine geometry and class groups.

Chi-Wang Shu: High Order Numerical Methods for Hyperbolic Equations

Chi-Wang Shu, Brown University

Address: Room 402, No.2 Teaching Building

Abstract: Hyperbolic equations are used extensively in applications including fluid dynamics, astrophysics, electro-magnetism, semi-conductor devices, and biological sciences. High order accurate numerical methods are efficient for solving such partial differential equations, however they are difficult to design because solutions may contain discontinuities. In this talk we will survey several types of high order numerical methods for such problems, including weighted essentially non-oscillatory (WENO) finite difference and finite volume methods, discontinuous Galerkin finite element methods, and spectral methods. We will discuss essential ingredients, properties and relative advantages of each method, and provide comparisons among these methods. Recent development and applications of these methods, as well as challenging open problems, will also be discussed.

Nanhua Xi: Kazhdan-Lusztig Theory, Retrospect and Prospect

Nanhua Xi, AMSS, CAS

Address: Room 403, No.2 Teaching Building

Abstract: Kazhdan-Lusztig theory is concerned with Coxeter groups and their role in geometric representation. In this talk I will give a brief introduction to this theory.

Thomas Farrell: Manifold Topology

Thomas Farrell, YMSC, Tsinghua University

Address: Room 201, No.1 Teaching Building

Abstract: This talk will discuss the state of some basic structure questions concerning compact manifolds of dimension greater than 4 together with some hopefully fruitful future directions for research.

Huaidong Cao: Geometry of Steady Ricci Solitons

Huaidong Cao, Lehigh University

Address: Room 205, No.1 Teaching Building

Abstract: Ricci solitons, introduced by R. Hamilton in the mid-1980s, are self-similar solutions to the Ricci flow and often appear as singularity models. They are also natural extensions of Einstein metrics and are critical

points of certain functionals defined by Perelman and others. In this talk, I shall survey some recent developments on gradient steady Ricci solitons and describe some open problems.

Jie Xiao: Ringel-Hall Algebras beyond Their Quantum Groups

Jie Xiao, Tsinghua Univerisy

Address: Room 104, No.1 Teaching Building

Abstract: This talk is my recent joint work with Fan Xu and Minghui Zhao. We generalize the categorical constructions of a quantum group and its canonical basis introduced by Lusztig to the generic form of the whole Ringel-Hall algebra. We clarify the explicit relation between the Green formula and the restriction functor. By a geometric way to prove the Green formula, we show that the Hopf structure of a Ringel-Hall algebra can be categoried under Lusztig's framework.

Stephen Yau: Non-existence of Negative Weight Derivations of Isolated Singularities

Stephen Yau, Tsinghua University

Address: West Lecture Hall

Abstract: Let $R = C[x_1, x_2, ..., x_n]/(f_1, ..., f_m)$ be a positively graded Artinian algebra. A long-standing open problem in algebraic geometry, commutative algebra and rational homotopy theory is whether there is no negative weight derivations on R. Alexsandrov conjectured that there is no negative weight derivation when R is a zero dimensional 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. This problem is also important in rational homotopy theory and differential geometry. Wahl conjectured that non-existence of negative weight derivations is still true for positive dimensional positively graded R. In this talk we present our recent progress on these problems. This is a joint work with Hao Chen and Huaiqing Zuo.

14:40-15:25

Dipendra Prasad: A Relative Langlands Program

Dipendra Prasad, Tata Institute of Fundamental Research

Address: Room 401, No.2 Teaching Building

Abstract: In this lecture we consider the question of classifying irreducible admissible representations of $G(E)$ which carry a $G(F)$-inv. linear form where E/F is a quadratic extension of finite finite or local fields. Although in a certain generic sense, one expects a simple answer—- multiplicity 1, and exact characterization, the full answer is rather complicated—-and interesting, involving geometry of Langlands parameters.

Fan Chung Graham: Graph Theory in the Information Age – Old and New Problems in Graph Theory

Fan Chung Graham, University of California

Address: Room 402, No.2 Teaching Building

Abstract: Nowadays we are surrounded by numerous large information networks, such as the WWW graph, the Facebook graph and various social networks. Many new questions arise. How are these graphs formed? What are basic structures of such large networks? How do they evolve? What are the underlying principles that dictate their behavior? How are subgraphs related to the large host graph? What are the main graph invariants that capture the myriad properties of such large sparse graphs and subgraphs. In this talk, we discuss some recent developments in the study of large dynamic graphs, with roots in random graph theory tracing back to Erdös and in spectral graph theory initiated by Fiedler. We will speculate about future directions in graph theory and describe a number of old and new problems.

Xiangyu Zhou: On Optimal L^2 Extension Theorem

Xiangyu Zhou, AMSS, CAS

Address: Room 403, No.2 Teaching Building

Abstract: In this talk, we'll give an overview about the optimal L^2 extension theorem: its backgrounds, contents and applications.

Duong Hong Phong: Supersymmetric String Vacua with Torsion and Geometric Flows

Duong Hong Phong, Columbia University

Address: Room 201, No.1 Teaching Building

Abstract: In 1986, a system of equations for compactifications of the heterotic string which preserve supersymmetry was proposed independently by C. Hull and A. Strominger. They are more complicated than the Calabi-Yau compactifications proposed earlier by P. Candelas, G. Horowitz, A. Strominger, and E. Witten, because they allow 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 non-linear partial differential equations.

While the complete solution of such partial differential equations seems out of reach at the present time, we describe progress in developing a new general approach based on geometric flows which shares some features with the Ricci flow. In particular, this approach can recover the non-perturbative solutions found in 2006 by J.X. Fu and S.T. Yau.

This is joint work with S. Picard and X.W. Zhang.

Qiang Du: Nonlocal Modeling of Anomalous Diffusion and Crack Propagation

Qiang Du, Columbia University

Address: Room 205, No.1 Teaching Building

Abstract: Anomalous diffusion phenomena in heterogeneous media have intrigued scientists working in many fields, while propagating cracks are material interfaces that raise serious concerns with engineers. Some recent development of nonlocal mathematical models have provided a new and common framework to study these different processes. In this lecture, we will present some basic elements of this framework such as the nonlocal vector calculus and asymptotically compatible discretization. We discuss how the nonlocal in time memory effect may impact the propagation of cracks and the statistics of diffusion processes. Moreover, we will also show some recent results on heterogeneous localization of nonlocal spaces including extensions of classical trace theorems to nonlocal spaces of functions having significantly weaker regularity.

Chenyang Xu: Stability Theory of a klt Singularity

Chenyang Xu, Peking University

Address: Room 104, No.1 Teaching Building

Abstract: In higher dimensional geometry, it has been known that from many perspectives a Kawamata log terminal (klt) singularity is a local analogue of Fano varieties. Thus many statements of Fano varieties have a counterpart for log terminal singularities. One central topic on the geometry of a Fano variety is its stability which in particular reflects whether the Fano variety carries a canonical metric. In the talks, we will discuss a joint work wit Chi Li, in which we want to establish an algebro-geometric stability theory of a fixed log terminal singularity. Inspired by the study from differential geometry, (e.g. metric tangent cone, Sasakian-Einstein metric), for any log terminal singularity, we investigate the valuation which has the minimal normalized volume. Our goal is to prove various properties of this valuation which enable us to degenerate the singularity to a K-semistable T-singularity (with a torus action) in the Sasakian-Einstein sense.

Weizhu Bao: Multiscale Methods and Analysis for the Dirac Equation in the Nonrelativistic Limit Regime

Weizhu Bao, National University of Singapore

Address: West Lecture Hall

Abstract: In this talk, I will review our recent works on numerical methods and analysis for solving the Dirac 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 and indefinite, 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 the time splitting Fourier pseudospectral (TSFP) method 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 Dirac equation. Rigorious error estimates show that the EWI spectral method has much better temporal resolution than the FDTD methods for the Dirac equation in the nonrelativistic lim-

it regime. Based on a multiscale expansion of the solution, we present a multiscale time integrator Fourier pseudospectral (MTI-FP) method for the Dirac equation and establish its error bound which uniformly accurate in term of the small dimensionless parameter. Numerical results demonstrate that our error estimates are sharp and optimal. Finally, these methods and results are then extended to the nonlinear Dirac eqaution in the nonrelativistic limit regime. This is a joint work with Yongyong Cai, Xiaowei Jia, Qinglin Tang and Jia Yin.

15:45-16:30

Xinwen Zhu: Geometric Satake and Applications

Xinwen Zhu, California Institute of Technology

Address: Room 401, No.2 Teaching Building

Abstract: The Satake isomorphism, which is the starting point of the Langlands duality, admits a categorification, known as the geometric Satake correspondence. In recent years, it has been found some deep applications in representations theory, topology, and number theory. I will discuss some of these applications.

Raymond Chan: Point-spread Function Reconstruction in Ground-based Astronomy

Raymond Chan, The Chinese University of Hong Kong

Address: Room 402, No.2 Teaching Building

Abstract: Because of atmospheric turbulence, images of objects in outer space acquired via ground-based telescopes are usually blurry. One way to estimate the blurring kernel or point spread function (PSF) is to make use of the aberration of wavefront received at the telescope, i.e., the phase. However only the low-resolution wavefront gradients can be collected by wavefront sensors. In this talk, I will discuss how to use regularization methods to reconstruct high-resolution phase gradients and then use them to recover the phase and the PSF in high accuracy.

Siu-Cheong Lau: SYZ Mirror of Atiyah Flop in Symplectic Geometry

Siu-Cheong Lau, Boston University

Address: Room 403, No.2 Teaching Building

Abstract: Flop is an important birational transformation used in the minimal model program. By Kollar, any two crepant resolutions of a threefold with at worst terminal singularities are related by a finite chain of flops.

By mirror symmetry, complex geometry is dual to symplectic geometry. It is natural to ask what the dual notion of flop is in symplectic geometry. In this talk, we shall focus on the Atiyah flop, and study its dual notion via SYZ mirror symmetry. In contrast to complex geometry, the mirror dual of Atiyah flop just gives a symplectomorphism; it does not produce a new symplectic manifold from a given one unfortunately. We discuss two geometric approaches to make sense of the mirror flop, namely Lagrangian fibrations, and stability conditions on the derived Fukaya category.

This is a joint work with Yu-Wei Fan, Hansol Hong and Shing-Tung Yau.

Changshou Lin: Lame Equation, Modular Forms and KdV Hierarchy

Changshou Lin, National Taiwan University

Address: Room 201, No.1 Teaching Building

Abstract: The classic Lame equation is the second order ODE defined on a torus E_τ with two periods $\omega_1 = 1$ and $\omega_2 = \tau$, where $\mathrm{Im}\tau > 0$. The equation in the Weierstrass form can be written as

$$\frac{d^2}{dz^2}y = (n(n+1)\wp(z) + B)y, z \in E_\tau, n \in \mathbb{N}$$

where $\wp(z)$ is the Weierstrass elliptic function of order 2. Associated with the Lame equation, there exists a premodular $Z^{(n)}_{r,s}(\tau)$ which is holomorphic function of and defined for all $(r,s) \in \mathbb{C}^2\backslash(\frac{1}{2}\mathbb{Z})^2$. If (r,s) is a N-torsion point, then $Z^{(n)}_{r,s}(\tau)$ is a modular form of weight $\frac{n(n+1)}{2}$ with respect to Γ_N.

Theorem 1. Suppose $(r,s) \in \mathbb{R}^2\backslash(\frac{1}{2}\mathbb{Z})^2$ and $\tau = ib, b > 0$. Then $Z^{(n)}_{r,s}(\tau) \neq 0$.

Equivalently, Theorem 1 can be rephrased as the PDE result:

Consider the curvature equation

$$\Delta u + e^u = 8\pi n\delta_0 \text{ in } E_\tau \qquad (1)$$

Theorem 2. Suppose $\tau = ib, b > 0$. Then (1) has no solution.

In this talk, we shall briefly review the Floquet theory, and the theory of the finite band poten-tials and the construction of $Z^{(n)}_{r,s}(\tau)$. If time permits, we should discuss some related questions.

F. Alberto Grunbaum: Time-and-band Limiting: From Signal Processing to Some Open Problems in Algebraic Geometry

F. Alberto Grunbaum, University of California

Address: Room 205, No.1 Teaching Building

Abstract: When C. Shannon was setting up the foundations of communication theory he considered the problem of how to best use "bandlimited" information of a "timelimited" signal. This was solved by D. Slepian, H. Landau and H. Pollak at Bell Labs by exploiting a mathematical miracle: a certain integral operator commutes with an explicitly given second order differential one. The search for a good explanation of this miracle continues to this day and has made contacts with several parts of mathematics including the "bispectral problem" which I considered jointly with Hans Duistermaat. When dealing with matrix valued "signals" it gives rise to new questions in algebraic geometry. In the scalar valued case these questions lie at the connections between integrable systems (such as KdV) and algebraic curves (such as the elliptic curve).

Yuefei Wang: Holomorphic Motions and Geometry of Polynomial Maps

Yuefei Wang, AMSS, CAS

Address: Room 104, No.1 Teaching Building

Abstract: Holomorphic motions were introduced by Mane, Sad and Sullivan in 1980's to solve the density problem of the structural stability of rational maps. Since then holomorphic motions have many important applications in complex dynamics, quasiconformal geometry, Teichmuller spaces, etc. In this talk, I will talk about a new application in the geometry of polynomial maps.

Xu Yang: Frozen Gaussian Approximation with Applications in Seismology

Xu Yang, University of California, Santa Barbara

Address: West Lecture Hall

Abstract: We propose the frozen Gaussian approximation (FGA) for the computation of high frequency wave propagation. This method approximates the solution to the wave equation by an integral representation. We

also present a systematic introduction on applying FGA to compute synthetic seismograms in three-dimensional earth models. In the method, seismic wavefield is decomposed into frozen (fixed-width) Gaussian functions, which propagate along ray paths. Rather than the coherent state solution to the wave equation, this method is rigorously derived by asymptotic expansion on phase plane, with analysis of its accuracy determined by the ratio of short wavelength over large domain size. Similar to other ray-based beam methods (e.g. Gaussian beam methods), one can use relatively small number of Gaussians to get accurate approximations of high-frequency wavefield. The algorithm is embarrassingly parallel, which can drastically speed up the computation with a multicore-processor computer station. Furthermore, we incorporate the Snell's law into the FGA formulation, and asymptotically derive reflection, transmission and free surface conditions for FGA to compute high-frequency seismic wave propagation in high contrast media. We numerically test these conditions by computing traveltime kernels of different phases in the 3D crust-over-mantle model.

16:00-17:30

Jean-Pierre Serre: Cohomological Invariants Mod 2 of Weyl Groups

Jean-Pierre Serre, Collège de France

Address: Room 101, No.1 Teaching Building

Abstract: The first lecture will give an introduction to the notion of cohomological invariant, with emphasis on the case of the symmetric and alternating groups. The other two will describe (with some indications on the proofs) how these invariants can be computed, when the symmetric group is replaced by an arbitrary Weyl group.

16:35-17:20

Ye Tian: Horizontal Variation of Shafarevich-Tate Groups

Ye Tian, AMSS, CAS

Address: Room 401, No.2 Teaching Building

Abstract: Tate-Shafarevich group is a mysterious arithmetic invariant of an elliptic curve E over a number field K. We discuss the horizontal behavior of its p-part as K varies for a prime p. The approach is based on arithmetic

of toric periods on Shimura set and CM pointsShimura curves. This is joint work with A. Burungale and H. Hida.

Zhouping Xin: Free Boundaries and Subsonic Jets

Zhouping Xin, The Chinese University of Hong Kong

Address: Room 402, No.2 Teaching Building

Abstract: In this talk, I will discuss some issues concerning free boundary value problems associated with steady compressible subsonic jets forming from finite nozzle with given ambient pressure. Such a phenomena has important applications in sciences. Yet the mathematical formulation and analysis of such problems are quite subtle. I will present some recent progress on this problem for a two-dimensional finitely long convergent nozzle with straight solid wall. For such a nozzle, the jet problem can be formulated as follows: for the given ambient pressure and an incoming mass flux, one looks for a subsonic jet flow in a suitable space with the given incoming mass flux such that the flow velocity is in the normal direction at the inlet, the flow satisfies no-flow condition in the nozzle walls, and the flow reaches the ambient pressure at the free boundary. In general, the free boundary consist two distinct parts: one part is the partical path connecting the wall of the nozzle, and other part is a level set of the velocity potential. Such a free boundary value problem does not have a variational structure and there is no background free to purturb. We will show that there is an optimal interval such that the jet problem has a unique solution when the length of the nozzle belongs to this interval and there is no such a solution otherwise. This talk is based joint work with Chunpeng Wang. This research is partially supported by Hong Kong RGC Earmarked Research grants CUHK-14305315 and CUHK-4048/13P, NSFC/RGC Joint Research Scheme N-CUHK443/14, and Focused Innovations Scheme from The Chinese University of Hong Kong.

Kefeng Liu: Riemannian Metric of Positive Scalar Curvature on Moduli of Curves

Kefeng Liu, University of California, Los Angeles

Address: Room 403, No.2 Teaching Building

Abstract: I will present our proofs that there is no complete Riemannian metric of nonnegative scalar curvature on the moduli space of curves which dominates the Teichmuller metric, and that there is no complete Riemannian

metric of uniform positive scalar curvature in the quasi-isometry class of the Teichmuller metric. This is joint works with Yunhui Wu.

Jiaxing Hong: On Alexandroff-Nirenberg Surfaces

Jiaxing Hong, Fudan University

Address: Room 201, No.1 Teaching Building

Abstract: Suppose that g is a smooth metric defined on a domainΩ where $\Omega \subset R^2$ and $\Omega = B_1(0)\backslash \bigcup_{j=1}^{j=m} B_{r_j}(z_j)$ with $z_j \in B_1(0)$, $r_j \in (0,1)$ and $B_{r_j}(z_j) \cap B_{r_k}(z_k) = \emptyset$ as $j \neq k$. We call (Ω, g) an Alexandroff-Nirenberg surface if its Gaussian curvature are subject to : $K > 0$ in Ω, $K = 0 \neq |\nabla K|$ on $\partial\Omega$ and its total Gaussian curvature equal to 4π. The problem of isometric embedding of such Alexandroff-Nirenberg surfaces into R^3 is very challenge to us. As a modest step, in this talk the compactness of such Alexandroff-Nirenberg surfaces are presented.

Wen-Wei Lin: Structure-Preserving Algorithms for Palindromic Quadratic Eigenvalue Problems and Its Applications

Wen-Wei Lin, National Chiao Tung University

Address: Room 205, No.1 Teaching Building

Abstract: In this talk, we study the palindromic quadratic eigenvalue problems (P-QEPs) and the associated nonlinear matrix equations (NMEs) with applications arising in the vibration analysis for fast trains and the Green's function approach in nano research. We show the existence and uniqueness of the corresponding NME and develop the structure-preserving (doubling) algorithms for solving the NME and the P-QEP. Theoretical issues involved in the solvent approach are settled satisfactorily and numerical results show the efficiency, reliability and robustness of the proposed structure-preserving algorithms.

Chongqing Cheng: Arnold Diffusion: Dynamical Instability in Nearly Integrable Hamiltonian Systems

Chongqing Cheng, Nanjing Universiy

Address: Room 104, No.1 Teaching Building

Abstract: In this talk, I shall birefly describe the problem of Arnold diffusion, the recent rogresses in the study of this problem and what remains open for the study in future.

Sunday, April 23th

8:45-9:30

Akito Futaki: Volume Minimization Principle and Conformally Kähler Einstein-Maxwell Geometry

Akito Futaki, University of Tokyo

Address: Room 401, No.2 Teaching Building

Abstract: We discuss on the volume minimization principle for conformally Kaehler Einstei-Maxwell metrics in the similar spirit as the Kaehler-Ricci solitons and Sasaki-Einstein metrics. This talk is base on a joint work with Hajime Ono.

Zaijiu Shang: Long Time Integration of Hamiltonian Systems

Zaijiu Shang, AMSS, CAS

Address: Room 402, No.2 Teaching Building

Abstract: Very long time integration is needed in many problems described by Hamiltonian systems. For example, simulating stable or chaotic motions of the planets in the solar system and computing trajectory samples in the molecular dynamics are two typical challenging problems of scientific computing. Due to the conservative nature of Hamiltonian systems, most of time integration methods such as the well known Runge-Kutta methods and linear multi-step methods as well as others based on the Lyapunov's stability analysis for dissipative systems are not successful for Hamiltonian systems. Under this background the symplectic numerical approach was systematically proposed in 1980's, which opened a way to tackle long time integration challenges of conservative systems.

Boyong Chen: Bergman Kernel and Hyperconvexity Index

Boyong Chen, Fudan University

Address: Room 403, No.2 Teaching Building

Abstract: Let $\Omega \subset \mathbb{C}^n$ be a bounded domain with the hyperconvexity index $\alpha(\Omega) > 0$. Let ϱ be the relative extremal function of a fixed closed ball in Ω and set $\mu := |\varrho|(1 + |\log|\varrho||)^{-1}$, $\nu := |\varrho|(1 + |\log|\varrho||)^n$. We obtain the following estimates for the Bergman kernel: (1) For every $0 < \alpha < \alpha(\Omega)$ and $2 \leq p < 2 + \frac{2\alpha(\Omega)}{2n - \alpha(\Omega)}$, there exists a constant $C > 0$ such that $\int_\Omega |\frac{K_\Omega(\cdot, w)}{\sqrt{K_\Omega(w)}}|^p \leq C|\mu(w)|^{-\frac{(p-2)n}{\alpha}}$ for all $w \in \Omega$. (2) For every $0 < r < 1$, there exists a constant $C > 0$ such that $\frac{|K_\Omega(z,w)|^2}{K_\Omega(z)K_\Omega(w)} \leq C(\min\{\frac{\nu(z)}{\mu(w)}, \frac{\nu(w)}{\mu(z)}\})^r$ for all $z, w \in \Omega$. Various application of these estimates are given.

Jing Yu: Progress on Multiple Zeta Values in Positive Characteristic

Jing Yu, National Taiwan University

Address: Room 201, No.1 Teaching Building

Abstract: I will survey the last decade progress on the study of multiple zeta values in positive characteristic. We focus on two fronts of this research. One is the transcendence theoretic aspect, building on a motivic theory (after Anderson-Thakur, and Chang-Papanikolas-Yu), we know that all these values are transcendental over function fields, as is quite different from the situation for classical characteristic zero multiple zeta values. The other front is the determination of all algebraic relations among these special zeta values (after Thakur, Chen, Chang-Papanikolas-Yu, and Kuan-Lin). Recently effective criterions, and algorithms are developed in order to find specific relations. and computing dimensions of relations. Open problems will also be discussed.

Juncheng Wei: Singularity Formation in the Two-dimensional Harmonic Map Flow into S^2

Juncheng Wei, University of British Columbia

Address: Room 205, No.1 Teaching Building

Abstract: We construct finite time blow-up solutions to the 2-dimensional

harmonic map flow into the sphere S^2,

$$\begin{aligned} u_t &= \Delta u + |\nabla u|^2 u \quad \text{in } \Omega \times (0,T) \\ u &= \varphi \quad \text{on } \partial\Omega \times (0,T) \\ u(\cdot,0) &= u_0 \quad \text{in } \Omega, \end{aligned}$$

where Ω is a smooth domain in $\mathbb{R}^2$, $u : \Omega \times (0,T) \to S^2$, $u_0 : \bar{\Omega} \to S^2$ is smooth, and $\varphi = u_0\big|_{\partial\Omega}$. No symmetry condition is assumed. Given any points $q_1, \ldots, q_k$ in the domain, we find initial and boundary data so that the solution blows-up precisely at those points. The profile around each point is close to an asymptotically singular scaling of a 1-corrotational harmonic map. The blow-up rate is shown to be

$$\lambda(t) \sim \frac{T-t}{|\log(T-t)|^2}$$

and the blow-up mechanism is shown to be co-dimension k stable. We also build a continuation after blow-up as a H^1-weak solution with a finite number of discontinuities in space-time by "reverse bubbling", which preserves the homotopy class and the blow-up rate of the solution after blow-up. An instantaneous blow-up at k points can also be built with a generic blow-up rate

$$\lambda(t) \sim \frac{T-t}{|\log(T-t)|}$$

We develop a general approach, parabolic in nature, which we call inner-outer gluing. A major difficulty we have to overcome is the coupled nonlocal ODE satisfied by the scaling and rotation parameter. This approach is quite robust and has been used to study point vortex dynamics in Euler, infinite time blow-up for critical mass Keller-Segel and critical heat equations. (Joint work with Juan Davila and Manuel del Pino.)

Sergiu Klainerman: On the Nonlinear Stability of Black Holes in General Relativity

Sergiu Klainerman, Priceton University

Address: Room 104, No.1 Teaching Building

Abstract: TBA

9:35-10:20

Baohua Fu: In Search of Isolated Symplectic Singularities

Baohua Fu, AMSS, CAS

Address: Room 401, No.2 Teaching Building

Abstract: An isolated symplectic singularity is either an ADE surface singularity or a normal isolated singularity of dimension at least four whose smooth part carries a symplectic form. Previous known examples are nite quotient of C2n or minimal nipotent orbit closures in simple Lie algebras. These singularities have strong relationship with for example the LeBrun-Salomon conjecture on Fano contact manifolds. I'll report on our attempts (joint with D. Juteau, P. Levy and E. Sommers) in search of new isolated symplectic singularities.

Shicheng Wang: Minimal Surfaces in the 3-sphere with High Symmetry

Shicheng Wang, Peking University

Address: Room 402, No.2 Teaching Building

Abstract: Let (S^3, F_g) denotes the 3-sphere with an embedded closed surface of genus $g > 1$.

First we will recall some interactions between symmetry and minimal surface in 1970s: symmetry is used to find minimal F_g in S^3, and the minimal surface theory is used to study the symmetry of (S^3, F_g).

Then we will report some recent results along this direction:

1. for each $g > 1$, we determine maximal symmetries of (S^3, F_g) among all possible embeddings of F_g,

2. we address when those maximal symmetries can be realized by minimal surfaces and we find some new minimal surfaces.

This represents joint work with S. Bai, C. Wang, Y. Zhang, B. Zimmermann.

Yi Zhang: Some Remarks on Weakly Positivity for Family Geometry

Yi Zhang, Fudan University

Address: Room 403, No.2 Teaching Building

Abstract: The motivation of our study is the hyperbolic problem for general families of algebraic manifolds. We study Viehweg's weakly positivity of the quasi-projective base of a general family via Saito's theory of polarized Hodge Modules. In this talk, I will explain the relation between the hyperbolic problem for families and the theory of Hodge Module. In particular, the problem can be reduced to a family with each fiber has at most one double singularity by Deligne-Katz's theory of Lefschetz pencils , then we get some new results.

Hong-Wei Xu: Optimal Differentiable Sphere Theorem Via Geometric Analysis

Hong-Wei Xu, Zhejiang University

Address: Room 201, No.1 Teaching Building

Abstract: In 1995, Grove and Wilhelm [Ann. of Math.,**142**(1995)] first verified an optimal differentiable sphere theorem for a class of Riemannian n-manifolds with positive sectional curvature. Using the Ricci flow and stable currents, Gu and I [Math. Res. Lett.,**17**(2010)] proved another optimal differentiable sphere theorem for certain manifolds with positive sectional curvature. An important problem is: is it possible to prove an optimal differentiable sphere theorem for certain manifolds whose sectional curvature need not to be positive? Recently Lei and I proved an optimal convergence theorem for the mean curvature flow of arbitrary codimension in hyperbolic spaces. As a consequence, we obtained an optimal differentiable sphere theorem for a class of n-manifolds ($n \geq 6$) with positive Ricci curvature, whose sectional curvature need not to be positive.

Lothar Göttsche: Refined Curve Counting

Lothar Göttsche, International Centre for Theoretical Physics

Address: Room 205, No.1 Teaching Building

Abstract: Enumerative geometry is a classical topic of algebraic geometry with many interesting connections to other parts of mathematics, but also to theoretical physics. Here we are concerned with enumerative geometry of algebraic curves on algebraic surfaces. A node of a curve is a transversal self-intersection. The Severi degrees count degree d curves with a given number of nodes in the complex projective plane through the appropriate number of general points, or more generally curves in a linear system on

a projective surface. The Welschinger invariants count the corresponding numbers of real algebraic curves.

We define and study two different refinements of the Severi degrees. The first is via complex algebraic geometry and the second is via tropical geometry, a piecewise linear version of algebraic geometry.

These two refinements are Laurent polynomials in a variable y instead of integers. They are expected to coincide under suitable assumptions. The refined Severi degrees, defined via tropical geometry, interpolate between the Severi degrees (at $y = 1$) and the Welschinger invariants (at $y = -1$), giving a new link between real and complex enumerative geometry.

Wen-Wei Li: On the Representations of Covers of Symplectic Groups of Higher Degrees

Wen-Wei Li, CAS

Address: Room 104, No.1 Teaching Building

Abstract: The Langlands program for Brylinski–Deligne covering groups is being developed by Weissman, Gan, Gao et al. One of the main hurdle is the lack of a good notion of stable conjugacy that played a crucial role in Langlands' theory for linear reductive groups. In this talk, I will propose such a formalism for BD-covers of symplectic groups of arbitrary degree m, which generalizes both the well-known case of metaplectic groups ($m = 2$) and the case over $SL(2)$ studied by Hiraga and Ikeda. I will also discuss the construction of epipelagic supercuspidal L-packets in this setting.

10:40-11:25

Minxian Zhu: On the Hyperplane Conjecture for Periods of Calabi-Yau Hypersurfaces in $\mathbb{P}^n$

Minxian Zhu, YMSC, Tsinghua University

Address: Room 401, No.2 Teaching Building

Abstract: Hosono, Lian, and Yau made a conjecture in the 90s describing the solutions to the Gelfand-Kapranov-Zelevinsky hypergeometric equations which arise as periods of CY hypersurfaces in a Gorenstein Fano toric variety. We will prove this conjecture for projective spaces. This is joint work with Bong Lian.

Fuquan Fang: Dual Submanifolds in Rational Homology Spheres

Fuquan Fang, Capital Normal University

Address: Room 402, No.2 Teaching Building

Abstract: Let Σ be a rational homology sphere. A pair of disjoint closed submanifolds $M_+, M_- \subset \Sigma$ are called *dual* to each other if the complements $\Sigma - M_+$ strongly homotopy retracts onto M_- or vice-versa. In this paper we are concerned with the basic problem of which integral triples $(n; m_+, m_-) \in \mathbb{N}^3$ can appear, where $n = \dim\Sigma - 1$, $m_\pm = \mathrm{codim} M_\pm - 1$. The problem is motivated by several fundamental aspects in differential geometry:

(i) the theory of isoparametric hypersurfaces and Dupin hypersurfaces in the unit sphere $\mathbb{S}^{n+1}$ initiated by Élie Cartan, where $M_\pm$ are the focal manifolds of the hypersurface $M \subset \mathbb{S}^{n+1}$, and $m_\pm$ coincide with the multiplicities of principal curvatures of M.

(ii) the Grove-Ziller construction of non-negatively curved riemannian metrics on exotic spheres, where $M_\pm$ are the singular orbits of a cohomogeneity one action on Σ.

Our main result provides a surprising simple answer, namely, if and only if one of the following holds true:

- $m_+ = m_- = n$,
- $m_+ = m_- = \frac{1}{3}n \in \{1, 2, 4, 8\}$,
- $m_+ = m_- = \frac{1}{6}n \in \{1, 2\}$,
- $\frac{n}{m_+ + m_-} \in \{1, 2\}$. Moreover, assuming $\frac{n}{m_+ + m_-} = 2$, if $m_+ = m_-$, then $m_+ = m_- \in \{1, 2\}$; if $m_+ > m_- \geq 2$, then $m_+ + m_-$ is odd.

In addition, if Σ is a homotopy sphere and the ratio $\frac{n}{m_+ + m_-} = 2$ (for simplicity let us assume $2 \leq m_- < m_+$), we observe that, the proof of Stephan Stolz's paper applies almost identically to conclude that, the pair can be realized if and only if, either $(m_+, m_-) = (5, 4)$ or $m_+ + m_- + 1$ is divisible by the integer $\delta(m_- - 1)$ (cf. the table on page 2), which is equivalent to the existence of $(m_- - 1)$ linearly independent vector fields on the sphere $\mathbb{S}^{m_+ + m_-}$ by Adams' celebrated work. In contrast, infinitely many counterexamples are given if Σ is a rational homology sphere.

Sen Hu: Feynman Geometries

Sen Hu, University of Science and Technology of China

Address: Room 403, No.2 Teaching Building

Abstract: In this talk we explain a notion of Feynman geometry on which quantum field theories could be properly defined. A strong Feynman ge-

ometry is a geometry when the vector space of A_∞ structures is finite dimensional. A weak Feynman geometry is a geometry when the vector space of A_∞ structures is infinite dimensional while the relevant operators are of trace-class. We construct families of Feynman geometries with "continuum" as their limit.

Hao Wu: Critical Planar Ising Model: Conformal Invariance and Domain Markov Property

Hao Wu, Geneva University

Address: Room 201, No.1 Teaching Building

Abstract: Conformal invariance and critical phenomena in two-dimensional lattice models play the central role in mathematical physics in the last few decades. In this talk, we first explain the critical phenomena in ferromagnet and introduce Ising model. We explain the conformal invariance and domain Markov property in critical Ising model. Second, we introduce Schramm-Loewner Evolution process which is a random process satisfies conformal Markov property, and explain the convergence of interface in critical Ising model with Dobrushin boundary conditions, and other know results concerning the convergence of interfaces in critical lattice models. Finally, we discuss the critical Ising model with alternating boundary conditions. Under such condition, the interface converges to Hypergeometric SLE_3.

Kestutis Cesnavicius: The Manin Constant in the Semistable Case

Kestutis Cesnavicius, University of California Berkeley

Address: Room 205, No.1 Teaching Building

Abstract: For an optimal modular parametrization $J_0(n) \twoheadrightarrow E$ of an elliptic curve E over $\mathbb{Q}$ of conductor n, Manin conjectured the agreement of two natural $\mathbb{Z}$-lattices in the $\mathbb{Q}$-vector space $H^0(E, \Omega^1)$. Multiple authors generalized his conjecture to higher dimensional newform quotients. We will discuss the semistable cases of the Manin conjecture and of its generalizations using a technique that establishes general relations between the integral p-adic etale and de Rham cohomologies of abelian varieties over p-adic fields.

Si Li: Vertex Algebras, Quantum Master Equation and Mirror Symmetry

Si Li, YMSC, Tsinghua University

Address: Room 104, No.1 Teaching Building

Abstract: We study the effective BV quantization theory for chiral deformation of two dimensional conformal field theories. We establish an exact correspondence between renormalized quantum master equations for effective functionals and Maurer-Cartan equations for chiral vertex operators. The generating functions are proven to be almost holomorphic modular forms. As an application, we construct an exact solution of quantum B-model (BCOV theory) in complex one dimension that solves the higher genus mirror symmetry conjecture on elliptic curves.

11:30-12:15

Chin-Lung Wang: Aspects on Calabi-Yau Moduli

Chin-Lung Wang, National Taiwan University

Address: Room 401, No.2 Teaching Building

Abstract: This is a personal update on some recent advances on the geometry of moduli spaces of CalabiCYau manifolds, especially along the finite distance boundary with respect to the WeilCPetersson metric. Two main themes are metric completion and extremal transitions. Besides reviewing the known results, I will also raise some related questions, including a preliminary discussion on the geometry along the general boundary points of moduli.

Jorgen Andersen: The Verlinde Formula for Higgs Bundle Moduli Spaces

Jorgen Andersen: Universitas Arhusiensis

Address: Room 402, No.2 Teaching Building

Abstract: In this talk we will present a Verlinde formula for the quantization of the Higgs bundle moduli spaces and stacks for any simple and simply-connected group. We further present a Verlinde formula for the quantization of parabolic Higgs bundle moduli spaces and stacks. We will explain how all these dimensions fit into a one parameter family of 2D TQFT's, encoded in a one parameter family of Frobenius algebras, which we will construct.

Weiping Li: Mixed Spin Fields on the Quintic

Weiping Li, Hong Kong University of Science and Technology

Address: Room 403, No.2 Teaching Building

Abstract: The Gromov-Witten invariants of the quintic is one of the most famous research topics from the very first day of mirror symmetry to today. There is another physical theory for the quintic polynomial, called Landau-Ginzburg theory. Physicists conjectured that these two theories can be identified via some mysterious transformations. The analytical construction of enumerative invariants in the affine LG-space was given by Fan, Jarvis and Ruan (FJRW invariants). Mixed spin field theory is a mathematical attempt to unlock the mysterious link between GW-invariants and FJRW-invariants. It uses the newly developed technologies such as the cosection localization by Kiem and J.Li and the P-fields theory of Chang and J. Li. It is an on-going joint work with H.L. Chang, J. Li and Melissa Liu.

Weizhe Zheng: Nearby Cycles over General Bases and Duality

Weizhe Zheng, CAS

Address: Room 201, No.1 Teaching Building

Abstract: Over one-dimensional bases, Gabber and Beilinson proved theorems on the commutation of the nearby cycle functor and the vanishing cycle functor with duality. In this talk, I will explain a way to unify the two theorems, confirming a prediction of Deligne. I will also discuss the case of higher-dimensional bases, following a suggestion of Illusie.

Damin Wu: Negatively Curved Complex Geometry

Damin Wu, University of Connecticut

Address: Room 205, No.1 Teaching Building

Abstract: In this talk we shall discuss the geometry determined by the negative holomorphic curvature, and its connection to the invariant metrics and nonlinear partial differential equations.

Huihui Zeng: Physical Vacuum Free Boundary Problem of Compressible Euler Equations with Damping

Huihui Zeng, YMSC, Tsinghua University

Address: Room 104, No.1 Teaching Building

Abstract: In this talk, I will present some results on the global-in-time smooth solutions to the free boundary problem of compressible Euler equations with damping featuring the physical vacuum singularity that the sound speed is only $\frac{1}{2}$-Hölder but not Lipschitzian continuous across the vacuum boundary. Due to this low regularity of the sound speed near vacuum boundaries, the system is highly degenerate near vacuum states and the standard symmetrization methods do not apply. The time-asymptotic equivalence of those global solutions to the Barenblatt self-similar solutions will be discussed. Some results presented here are based on joint work with Tao Luo.

13:30-14:15

Lizhen Ji: From the Borel-Serre Compactification to the Curve Complex of Surfaces

Lizhen Ji, University of Michigan

Address: Room 401, No.2 Teaching Building

Abstract: Arithmetic subgroups of Lie groups arise naturally in number theory, geometric group theory, differential geometry and algebraic geometry. The most basic example is the modular group $SL(2,\mathbb{Z})$ in $SL(2,\mathbb{R})$, which admits two important families of generalization: $SL(n,\mathbb{Z})$ and $Sp(2g,\mathbb{Z})$. Arithmetic subgroups of semisimple Lie groups are lattices and give rise to locally symmetric spaces of finite volume which enjoy various rigidity properties and are often moduli spaces.

In a seminal paper, Borel and Serre constructed the Borel-Serre compactification of locally symmetric spaces which was used to compute, for the first time, the (virtual) cohomological dimension of arithmetic subgroups and showed that they are generalized Poincare duality groups. One crucial property of the Borel-Serre compactification is that its boundary is homotopy equivalent to the rational Tits building and hence to a bouquet of spheres.

Motivated by the analogy between locally symmetric spaces and moduli spaces of Riemann surfaces, Harvey constructed the Borel-Serre compactification of the moduli spaces of Riemann surfaces and introduced the curve complex of surfaces as an analogue of Tits buildings to describe the boundary of this Borel-Serre compactification of moduli spaces. As a consequence, the (virtual) cohomological dimension and generalized Poincare duality property of mapping class groups was computed/proved by Harer.

In the recent decades, the curve complex of surfaces has played a central role in the study of low dimensional topology and geometric group theory. In this talk, I will explain the above results and some more recent developments.

Yongquan Hu: On the Cohen-Macaulayness of Crystabelline Galois Deformation Rings

Yongquan Hu, AMSS, CAS

Address: Room 402, No.2 Teaching Building

Abstract: In this talk, we will prove that certain crystabelline Galois deformation rings of two dimensional residual representations of $\mathrm{Gal}(\overline{\mathbb{Q}}_p/\mathbb{Q}_p)$ are Cohen-Macaulay, when $p > 3$ and the residual representation has only scalar endomorphisms. The proof uses the p-adic local Langlands correspondence for $\mathrm{GL}_2(\mathbb{Q}_p)$. As a consequence, we improve Kisin's $(R[1/p])^{\mathrm{red}} = \mathbb{T}[1/p]$ theorem to an $R = \mathbb{T}$ theorem. This is a joint work with Vytautas Paškūnas.

Xiaokui Yang: Characterizations of Projective Spaces and Quadrics by Strictly Nef Bundles

Xiaokui Yang, AMSS, CAS

Address: Room 403, No.2 Teaching Building

Abstract: In this talk, we show that if the tangent bundle of a smooth projective variety is strictly nef, then it is isomorphic to a projective space; if a projective variety X^n $(n \geq 3)$ has strictly nef $\Lambda^2 TX$, then it is isomorphic to the projective space P^n or the quadric Q^n. We also prove that on elliptic curves, strictly nef vector bundles are ample, whereas there exist Hermitian flat and strictly nef vector bundles on any smooth curve with genus $g \geq 2$.

Zhijie Chen: From a PDE Result to a Modular Form and Basic Quantities in Classical Elliptic Function Theory

Zhijie Chen, YMSC, Tsinghua University

Address: Room 201, No.1 Teaching Building

Abstract: Recall the basic quantities $e_k(\tau)$ in the classical elliptic function theory:

$$\wp'(z|\tau)^2 = 4\prod_{k=1}^{3}(\wp(z|\tau) - e_k(\tau)),$$

where $\wp(z|\tau)$ is the Weierstrass elliptic function with periods 1 and τ. In this talk, starting from a non-existence result of mean field equations on flat tori, I will talk about the application of this PDE result to a special modular form of weight 3 and these $e_k(\tau)$'s. This talk is based on joint work with Prof. Chang-Shou Lin and Ting-Jung Kuo.

Chunxiong Zheng: Extended WKB Analysis for the High-frequency Wave Equations

Chunxiong Zheng, Tsinghua University

Address: Room 205, No.1 Teaching Building

Abstract: WKB analysis plays an important role in the high-frequency asymptotics for wave equations. However, it faces the break-down problem due to the appearance of caustics. In the last few years, we have developed a novel high-frequency asymptotic theory, called extended WKB analysis. This method is blind to the traditional caustics, and works for any kind of linear wave equations, either scalar or vectorial. It presents an asymptotic approximation of the wave field with uniform accuracy. In this talk, we will report the basic idea and some main results.

Binglong Chen: TBA

Binglong Chen, Sun Yat-Sen University

Address: Room 104, No.1 Teaching Building

Abstract: TBA

14:20-15:05

Michael E. Zieve: Geometric Invariants of Rational Functions

Michael E. Zieve, University of Michigan

Address: Room 401, No.2 Teaching Building

Abstract: The two main geometric invariants of a complex rational function are its monodromy group and ramification type. I will explain the progress made in the past 125 years towards determining all possibilities for these invariants, including contributions by Hurwitz, Zariski, Thom, Guralnick, Thompson, and Aschbacher. I will also present applications to number theory, complex analysis, topology, and dynamics.

Wenjia Jing: Flat Pieces of the Effective Burning Rate Function in a Turbulent Convection Model

Wenjia Jing, YMSC, Tsinghua University

Address: Room 402, No.2 Teaching Building

Abstract: Front propagation phenomena with multi-scale convecting velocity, where the length scale of the velocity variations is much larger than the thickness of the fronts, appear very often in applied sciences, namely in turbulent combustion and ecological applications. It is important to understand such front propagations viewed at large scales. Majda and Souganidis started with a reaction-diffusion-convection equation with periodic multi-scale convecting velocity, and developed a mathematically rigorous theory that captures the large scale geometric propagation of the fronts. In particular, the effective burning rate function is obtained through a minimization that involves the effective Hamiltonian, the latter coming from the cell problem of an underlying Hamilton-Jacobi equation. We will present some fine properties of this effective burning rate function, such as for what type of velocity fields can it be isotropic, can it be strictly convex, etc. Such studies, apart from applications in combustion theory, is closely related to Bangerts work on the rigidity of the stable norms of Riemannian metrics on the 2-torus. This talk is based on a joint work with Hung V. Tran and Yifeng Yu.

Hao Xu: Heat Kernels Coefficients and Spectral Geometry

Hao Xu, University of Pittsburgh

Address: Room 403, No.2 Teaching Building

Abstract: Short-time asymptotic expansion of the heat kernel played an important role in spectral geometry. We survey methods of computing the asymptotic expansion coefficients of heat kernels and their applications in spectral geometry. We will present our work on Feynman diagram formulas for the coefficients in the asymptotic expansion of heat kernels on Kahler manifolds.

Qi'an Guan: Effectiveness of Demailly's Strong Openness Conjecture and Related Problems

Qi'an Guan, Peking University

Address: Room 201, No.1 Teaching Building

Abstract: In this talk, we discuss conditions to guarantee the effectiveness of Demailly's strong openness conjecture and establish such an effectiveness result. We also present our solutions of the conjectures posed by Demailly-Kollár and Jonsson-Mustată respectively with optimal effectiveness results. This is joint work with Professor Xiangyu Zhou.

Huijun Fan: Landau-Ginzburg Model in Mirror Symmetry

Huijun Fan, Peking University

Address: Room 205, No.1 Teaching Building

Abstract: In this talk, I will review the research progress of Landau-Ginzburg model in the study of 2-d topological field theory and mirror symmetry, which includes FJRW theory in A side, deformation theory of LG model in B side, LG/CY correspondence and the open string version of the LG model. Some main concerned problems will be proposed for future research.

Jie Lin: An Introduction to the Deligne Conjecture

Jie Lin, IHES

Address: Room 104, No.1 Teaching Building

Abstract: The Deligne conjecture relates special values of (motivic) L-functions with some periods. This generates the fact that the value of the Riemann zeta function at a positive even integer is a rational multiple of a power of $2\pi i$. In this talk, we shall introduce at first Dirichlet L-functions and their special values. We then present the Deligne conjecture. If time permits, we will talk about its automorphic variant.

15:15-16:00

Tianjun Li: Topology of Symplectic Four Manifolds

Tianjun Li, Univeristy of Minnesota

Address: Room 401, No.2 Teaching Building

Abstract: Classifying topological and smooth manifolds has been the ultimate goal of algebraic topology and geometric topology for the past century. The case of dimension 4 turns out to be the most unusual and chanlleng-ing. It has been gradually realized that symplectic 4-manifolds constitute

the most important class of smooth manifolds in dimension 4. In this talk I will discuss the topology of symplectic 4-manifolds, and the connections to algebraic surfaces, Kähler surfaces and contact 3-manifolds.

You Qi: Categorification at Prime Roots of Unity

You Qi, Yale University

Address: Room 402, No.2 Teaching Building

Abstract: We sketch an algebraic approach to categorification of quantum groups at a prime root of unity, with the outlook towards eventually categorifying Witten-Reshetikhin-Turaev 3-manifold invariants. This is based on joint work of the speaker with B. Elias, M. Khovanov and J. Sussan.

Xinxin Chen: Long Brownian Bridges in Hyperbolic Spaces Converge to Brownian Trees

Xinxin Chen, Institut Camille Jordan, University Lyon 1

Address: Room 403, No.2 Teaching Building

Abstract: We consider the long Brownian bridge started from the origin in hyperbolic space H^d and show that its range, after being suitably renormalised, converges in law to a Brownian continuum tree in the sense of Gromov-Hausdorff. The rough idea of the proof will be talked about, by presenting the convergence, obtained by Bougerol and Jeulin [1], of the radial part; the invariance property of re-rooting and the hyperbolicity property. The similar idea will be applied to obtain the local convergence of the infinite Brownian loop in hyperbolic space.

Lei Fu: Deformations and Rigidity of ℓ-adic Sheaves

Lei Fu, YMSC, Tsinghua University

Address: Room 201, No.1 Teaching Building

Abstract: Let X be a smooth connected algebraic curve over an algebraically closed field, and let S be a finite closed subset in X. A lisse $\overline{\mathbf{Q}}_\ell$-sheaf $\mathcal{F}$ on $X-S$ is called physically rigid if for any lisse $\overline{\mathbf{Q}}_\ell$-sheaf $\mathcal{G}$ on $X-S$ with the same local monodromy as $\mathcal{F}$ at each $s \in S$, we have $\mathcal{F} \cong \mathcal{G}$. Katz proves that if $\mathcal{F}$ is irreducible and $H^1(X, j_*\mathcal{E}nd(\mathcal{F})) = 0$, where $j : X - S \to X$ is the canonical open immersion, then $\mathcal{F}$ is physically rigid. He proves the converse in the context of complex local systems on complex curves. We sketch a proof of the converse in the general case. Our idea is to study

deformations of lisse ℓ-torsion sheaves on $X - S$. The universal deformation space is a formal scheme. Its generic fiber has a rigid analytic space structure. By studying this rigid analytic space, we solve Katz's problem in the general case.

Zhongyi Huang: Bloch Decomposition-based Stochastic Galerkin/Collocation Method for Schrödinger Equation with Random Inputs

Zhongyi Huang, Tsinghua University

Address: Room 205, No.1 Teaching Building

Abstract: In this talk, we focus on the analysis and numerical methods for the Schrödinger equation with lattice potential and random inputs. This is an important model in solid state physics where randomness is involved to describe some complicated phenomena that are not exactly known. Here we recall the well-known Bloch decomposition-based split-step pseudospectral method where we diagonalize the periodic part of the Hamilton operator so that the effects from dispersion and periodic lattice potential are computed together. Meanwhile, for the random nonperiodic external potential, we utilize the generalize polynomial chaos with Galerkin procedure to form an ode system which can be solved analytically. Furthermore, we analyse the convergence theory of the stochastic collocation method for the linear Schrödinger equation with random inputs. Based on the interpolation theories, the convergence rate depends on the regularity of the solution with respect to the random variables. Hence, we investigate the dependence of the regularity of the solution on that of the random potential and initial data. We provide sufficient conditions on the random potential and initial data to ensure the spectral convergence.

Zhi Jiang: Recent Advances in Generic Vanishing

Zhi Jiang, Fudan University

Address: Room 104, No.1 Teaching Building

Abstract: We will give a survey of some recent advances in generic vanishing and discuss their applications in the classification problem of irregular varieties.

16:00-17:30

Jean-Pierre Serre: Cohomological Invariants Mod 2 of Weyl Groups

Jean-Pierre Serre, Collège de France

Address: Room 101, No.1 Teaching Building

Abstract: The first lecture will give an introduction to the notion of cohomological invariant, with emphasis on the case of the symmetric and alternating groups. The other two will describe (with some indications on the proofs) how these invariants can be computed, when the symmetric group is replaced by an arbitrary Weyl group.

16:05-16:50

Xiaobo Liu: Connecting the Kontsevich-Witten and Hodge Tau-functions by the Virasoro Operators

Xiaobo Liu, Peking University

Address: Room 401, No.2 Teaching Building

Abstract: Kontsevich-Witten tau-function and the Hodge tau-function are generating functions for two types of intersection numbers on moduli spaces of stable curves. Both of them are tau functions for the KP hierarchy. In this talk, I will describe how to connect these two tau-functions by differential operators belonging to the $\widehat{GL(\infty)}$ group. Indeed, these two tau-functions can be connected using Virasoro operators. This proves a conjecture posted by Alexandrov. This is a joint work with Gehao Wang.

Yichao Tian: Geometric Level Raising and Applications

Yichao Tian, University of Bonn/Chinese Academy of Sciences

Address: Room 402, No.2 Teaching Building

Abstract: In this talk, I will explain Ribets level-raising results for classical modular forms in a geometric way. Then I will discuss some recent generalizations to higher dimensional Shimura varieties, and its arithmetic applications to some special cases of Bloch-Kato conjecture.

Gang Liu: On Yau's Uniformization Conjecture

Gang Liu, Northwestern University

Address: Room 403, No.2 Teaching Building

Abstract: Let M be a complete noncompact Kähler manifold with nonnegative bisectional curvature and maximal volume growth, we prove M is biholomorphic to $\mathbb{C}^n$. This confirms Yau's uniformization conjecture when M has maximal volume growth.

Tonghai Yang: L-function and Eisenstein Series as Bridges between Arithmetic and Analysis

Tonghai Yang, University of Wisconsin-Madison

Address: Room 201, No.1 Teaching Building

Abstract: In this talk, we will describe informally how the leading and other terms of L-functions and Eisenstein series encode the deep connection between analysis and arithmetic of significance in number theory. It will include famous examples (such as class number formula and BSD conjecture) and recent progress (such as Colmez conjecture, arithmetic Siegel-Weil, and Yun-Zhang formula).

Zhengyu Zong: All Genus Open-Closed Mirror Symmetry for Toric Calabi-Yau 3-folds/3-orbifolds

Zhengyu Zong, YMSC, Tsinghua University

Address: Room 205, No.1 Teaching Building

Abstract: In this talk, I will discuss the connection between the all genus open-closed Gromov-Witten invariants of a toric Calabi-Yau 3-fold/3-orbifold and the topological recursion on its mirror curve. This can be viewed as an all genus open-closed mirror symmetry for toric Calabi-Yau 3-folds/3-orbifolds. When the Lagrangian is chosen to be an Aganagic-Vafa brane, this mirror symmetry is the well known Remodeling Conjecture which is conjectured by Bouchard-Klemm-Mariño-Pasquetti in 2007. This conjecture is finally proved by Bohan Fang, Chiu-Chu Melissa Liu and myself in 2016. On the other hand, when restrict ourself to the case of the resolved conifold (which is a toric Calabi-Yau 3-fold), we can consider more general Lagrangians in the target space which come from torus knots under the conifold transition (The usual Aganagic-Vafa brane corresponds to the trivial knot). In this case, we can still build all genus mirror symmetry for

open-closed Gromov-Witten invariants with respect to these more interesting Lagrangians. This is a joint work with Bohan Fang.

Lingbing He: Estimates for the Large Time Behavior of the Landau Equation in the Coulomb Case

Lingbing He, Tsinghua University

Address: Room 104, No.1 Teaching Building

Abstract: This talk deals with the large time behaviour of the spatially homogeneous Landau equation with Coulomb potential. Firstly, we obtain a bound from below of the entropy dissipation $D(f)$ by a weighted relative Fisher information of f with respect to the associated Maxwellian distribution, which leads to a variant of Cercignanis conjecture thanks to a logarithmic Sobolev inequality. Secondly, we prove the propagation of polynomial and stretched exponential moments with an at most linearly growing in time rate. As an application of these estimates, we show the convergence of any (H- or weak) solution to the Landau equation with Coulomb potential to the associated Maxwellian equilibrium with an explicitly computable rate, assuming initial data with finite mass, energy, entropy and some higher L^1-moment. More precisely, if the initial data have some (large enough) polynomial L^1-moment, then we obtain an algebraic decay. If the initial data have a stretched exponential L^1-moment, then we recover a stretched exponential decay. This is a joint work with K. Carrapatoso and L.Desvillettes.

16:55-17:40

Kwok-Wai Chan: SYZ Mirror Symmetry for Toric Varieties

Kwok Wai Chan, The Chinese University of Hong Kong

Address: Room 401, No.2 Teaching Building

Abstract: In this talk, I will survey recent developments in the study of the geometry of mirror symmetry for toric varieties from the point of view of the influential Strominger-Yau-Zaslow (SYZ) conjecture. Most of the content will be based on joint works with Cheol-Hyun Cho, Siu-Cheong Lau, Conan Leung and Hsian-Hua Tseng. The research reported in this talk was substantially supported by grants from the Research Grants Council of the Hong Kong Special Administrative Region, China (Project No. CUHK14302015 & CUHK14314516).

Peng Shan: On the Center of G1T-modules

Peng Shan, CNRS-Université Paris Sud

Address: Room 402, No.2 Teaching Building

Abstract: I will explain a link between the center of G1T-modules and cohomology of certain affine Springer fibre, and also relationship with a recent conjecture of Lachowska-Qi on the center of small quantum groups. This is based on a joint work with R. Bezrukavnikov, Y. Qi and E. Vasserot.

Lechao Xiao: Oscillatory Integrals, Newton's polyhedra and Stability

Lechao Xiao, University of Pennsylvania

Address: Room 403, No.2 Teaching Building

Abstract: Finding roots for polynomials is a basic problem in algebra. A central topic in modern harmonic analysis is to prove (sharp, stable) estimates for various oscillatory integrals. In the 17th century, Newton introduced a method, known as the Newton-Puiseux algorithm, for solving a bi-variable polynomial $f(x, y) = 0$ by a fractional power series, $y = y(x^{\frac{1}{m}})$. In this talk, we will illustrate how one can upgrade this algorithm to prove sharp estimates for oscillatory integrals in various settings.

Babak Haghighat: ADE Quivers and Quantum Field Theory

Babak Haghighat, YMSC, Tsinghua University

Address: Room 201, No.1 Teaching Building

Abstract: In this talk we show how four-dimensional quiver gauge theories can be obtained from six-dimensional superconformal quantum field theories. We focus on the BPS sector of the corresponding partition functions and show how they can be deduced from instanton string contributions. We then proceed to take the thermodynamic limit of the strings which leads to the emergent geometry of the quantum vacua of the theory. This geometry is then interpreted as the geometry of a mirror family of Calabi-Yau manifolds.

Zuoqiang Shi: Interpolation on High Dimensional Point Cloud

Zuoqiang Shi, YMSC, Tsinghua University

Address: Room 205, No.1 Teaching Building

Abstract: Interpolation on high dimensional point cloud provides a fundamental model in many data analysis and machine learning problems. In this talk, we will present some PDE based methods to do interpolation on point cloud. Applications in image processing and data analysis are shown to demonstrate the performance of our methods.

Bing Wang: Smooth Convergence of Some Geometric Flows

Bing Wang, University of Wisconsin-Madison

Address: Room 104, No.1 Teaching Building

Abstract: In the study of geometric flows(e.g. Ricci flow, Mean curvature flow and the Calabi flow), it is an essential problem to understand the smooth convergence. Without the positive curvature assumption, we describe an approach to obtain smooth convergence via weak compactness and removing singularity by stability. As examples, we show the smooth convergence of the Fano Kähler Ricci flow when the underlying manifold is K-stable and the smooth convergence of the rescaled Mean curvature flow when the limit surface is L-unstable.

Monday, April 24th

8:45-9:30

Xin Zhou: Min-Max Minimal Hypersurfaces with Free Boundary

Xin Zhou, University of California, Santa Barbara

Address: A112, The Science Building

Abstract: I will present a joint work with Martin Li. Minimal surfaces with free boundary are natural critical points of the area functional in compact smooth manifolds with boundary. In this talk, I will describe a general existence theory for minimal surfaces with free boundary. In particular, I will show the existence of a smooth embedded minimal hypersurface with free boundary in any compact smooth Euclidean domain. The minimal surfaces with free boundary were constructed using the min-max method. I will explain the basic ideas behind the min-max theory as well as our new contributions.

Junyi Xie: The Existence of Zariski Dense Orbits for Polynomial Endomorphisms of the Affine Plane

Junyi Xie, CNRS-Université Paris Sud

Address: Cheng Yu Tung Lecture Hall

Abstract: In this talk we prove the following theorem. Let f be a dominant polynomial endomorphism of the affine plane defined over an algebraically closed field of characteristic 0. If there is no nonconstant invariant rational function under f, then there exists a closed point in the plane whose orbit under f is Zariski dense.

This result gives us a positive answer to a conjecture proposed by Medvedev and Scanlon, by Amerik, Bogomolov and Rovinsky, and by Zhang, for

polyno-mial endomorphisms of the a ne plane.

9:35-10:20

Di Yang: Classical Hurwitz Numbers and Related Combinatorics

Di Yang, Max Planck Institute for Mathematics

Address: A112, The Science Building

Abstract: We study several combinatorial properties of classical Hurwitz numbers, as well as their connections to other counting problems in ordinary graphs, moduli space of curves, and ribbon graphs. The talk is based on a joint work with Boris Dubrovin and Don Zagier.

Rui Han: Spectral Theory of the Extended Harper's Model

Rui Han, University of California, Irvine

Address: Cheng Yu Tung Lecture Hall

Abstract: The extended Harper model (EHM) describes a 2d crystal with magnetic field perpendicular to the lattice plane. The model generalizes the well-known almost Mathieu operator (or Harper's equation) by taking into account both nearest and next-nearest neighbour interaction between lattice sites, and was originally popularized by D.J. Thouless. In this talk we will describe the general spectral decomposition of the EHM as well as recent advances on sharp arithmetic spectral transitions. We will also address results on the measure and the Cantor structure of the spectrum. This talk is based on joint works with Svetlana Jitomirskaya.

10:40-11:25

Xiaoqun Wang: Computational Challenges in Quantitative Finance: High Dimensionality and Discontinuity

Xiaoqun Wang, Tsinghua University

Address: A112, The Science Building

Abstract: High dimensionality and discontinuities are two important challenges in computational finance, such as in the problems of pricing and hedging of complex financial derivatives. We show how these challenges can

be overcome by cleverly simulating the underlying processes and by suitably smoothing the payoff functions via transformations or preintegration. Numerical experiments demonstrate the extreme high performance of the proposed method for pricing options and estimating Greeks (or sensitivities).

Tengren Zhang: Positively Ratioed Representations

Tengren Zhang, California Institute of Technology

Address: Cheng Yu Tung Lecture Hall

Abstract: Let S be a closed orientable surface of genus at least 2, and let G be a semisimple Lie group of non-compact type. Positively ratioed representations are Anosov representations from the fundamental group of S to G, that satisfy an additional cross ratio condition. In this talk, I will explain what are positively ratioed representations, give examples of such representations, and explain a systolic inequality that we proved using geodesic currents. This is joint work with Giuseppe Martone.

11:30-12:15

Yuxiang Li: Metrics in a Fixed Conformal Class with Bounded Volumes and $\|R\|_{L^p}$

Yuxiang Li, Tsinghua University

Address: A112, The Science Building

Abstract: Let (M, g) be a smooth compact Riemiannian manifold without boundary. Let $g_k = u_k^{\frac{4}{n-2}} g$, and R_k be the scalar curvature of g_k. We assume $vol(M, g_k) + \|R_k\|_{L^p(M,g_k)} < C$, where $p > \frac{n}{2}$. We will use the 3-circle theorem and the John-Nirenburg inequality to study the bubble tree convergence of g_k.

Lei Wu: Multiplier Subsheaves and Hodge Modules

Lei Wu, Northwestern University

Address: Cheng Yu Tung Lecture Hall

Abstract: I will define the notion of multiplier subsheaves for generically defined variations of Hodge structures on smooth complex varieties (and

more precisely for Hodge modules). I will present both algebraic and analytic constructions, inspired by those for multiplier ideals. Using Kodaira-Saito vanishing, I will prove a Nadel-type vanishing theorem for multiplier subsheaves, generalizing a number vanishing theorems in algebraic geometry. If time permits, I will present an application to a Fujita-type freeness result for the lowest term in the Hodge filtration.

13:30-14:15

Zhouli Xu: Computing Stable Homotopy Groups of Spheres - Two Methods

Zhouli Xu, The University of Chicago

Address: A112, The Science building

Abstract: I will report recent progress of computing stable stems, joint with Dan Isaksen and Guozhen Wang. I will review known methods and explain two new methods that we recently developed. The first one uses the Kahn-Priddy theorem and has applications on smooth structures on spheres. The second one uses motivic homotopy theory in a fundamental way, and gives a connection to chromatic homotopy theory. Combining with known methods, I will describe a project towards solving the open case of the Kervaire invariant problem in dimension 126.

Jixiang Fu: Canonical Metrics on Non-compact Kähler Manifolds

Jixiang Fu, Fudan University

Address: Cheng Yu Tung Lecture Hall

Abstract: I will talk about the canonical metrics on non-compact Kähler manifolds $M - N$, where M is a compact Kähler manifold with a canonical metric and N is a higher codimensional subvariety on M. I will present some existence and non-existence results. This is a joint wok with Shing-Tung Yau and Wubin Zhou.

14:20-15:05

Zhuohui Zhang: Wigner $3j$ Symbols and $(\mathfrak{g}, K)$-module Structure of Principal Series

Zhuohui Zhang, Rutgers University

Address: A112, The Science Building

Abstract: I will describe the differential action of $\mathfrak{g}$ on the principal series representations of $G = SU(2,1)$ and $Sp(4,\mathbb{R})$. The structure of the principal series for G can be described explicitly by the $\mathfrak{g}$-action on the matrix coefficients of the maximal compact subgroup $K \subset G$. The computation, based on the Wigner $3j$ symbols of the representations of K, is algorithmic and generalizable to the real reductive groups with a maximal compact subgroup isogenous to a product of multiple copies of $SU(2)$ and $U(1)$. As an application of the machinery, I will describe some subquotients of the principal series, their restrictions to K, and the intertwining operators.

This is a joint work with Stephen D. Miller of Rutgers University.

Yu Yuan: TBA

Yu Yuan, University of Washington

Address: Cheng Yu Tung Lecture Hall

Abstract: TBA

15:15-16:00

Liping Zhang: M-tensor and Tensor Absolute Value Equations

Liping Zhang, Tsinghua University

Address: A112, The Science Building

Abstract: In this talk, we first introduce M-tensor and establish some properties of M-tensor. An identifying algorithm is proposed for M-tensor. We next concern with solving some structured multi-linear systems, which are called tensor absolute value equations. This kind of absolute value equations is closely related to tensor complementarity problems and is a generalization of the well-known absolute value equations in the matrix case. We prove that tensor absolute value equations are equivalent to some special structured tensor complementary problems. Some sufficient conditions are given

to guarantee the existence of solutions for tensor absolute value equations. We also propose a Levenberg-Marquardt-type algorithm for solving some given tensor absolute value equations and preliminary numerical results are reported to indicate the efficiency of the proposed algorithm.

Yong Lin: Curvature Dimension Condition and Heat Semigroup Operator on Graphs

Yong Lin, Renmin University of China

Address: Cheng Yu Tung Lecture Hall

Abstract: In this talk, we derive that if a graph has non-negative curvature then it has the volume doubling property, from this we can prove the Gaussian estimate for heat kernel, and then Poincaré inequality and Harnack inequality. Under the assumption of positive curvature on graphs, we derive the Bonnet-Myers type theorem that the diameter of graphs is finite and bounded above in terms of the positive curvature.

The proof used the heat semigroup technique. Using the similar heat semigroup method, we also proved the stochastic completeness for graphs satisfying the curvature dimension condition.

The talk is based on the joint works with Horn, Hua, Liu and Yau.

16:00-17:30

Jean-Pierre Serre: Cohomological Invariants Mod 2 of Weyl Groups

Jean-Pierre Serre, Collège de France

Address: Room 101, No. 1 Teaching Building

Abstract: The first lecture will give an introduction to the notion of cohomological invariant, with emphasis on the case of the symmetric and alternating groups. The other two will describe (with some indications on the proofs) how these invariants can be computed, when the symmetric group is replaced by an arbitrary Weyl group.

16:05-16:50

Weiping Zhang: On the Chern Conjecture for Affine Manifolds

Weiping Zhang, Nankai University

Address: A112, The Science Building

Abstract: We will present our joint work with Huitao Feng on the proof of the following conjecture due to Professor Chern: the Euler characteristic of a closed affine manifold equals to zero.