Title and Abstract

Part A: Frontier Talks

Some Mathematical Problems on the Thin Film Equations

Kai-Seng Chou
The Chinese University of Hong Kong

Abstract

The thin film equation, which is derived from the Navier-Stokes equations, is a degenerate fourth order parabolic equation describing the motion of thin films on a plate. In this talk we shall give an introductory talk on various mathematical results known to this equations. The issue of singularity formation (rupture) will be emphasized. The talk is good for those who have some previous knowledge of parabolic equations.

Langlands Functoriality for Classical Groups

Dihua Jiang
University of Minnesota

Abstract

The Langlands functoriality conjecture is the main problem in modern theory of automorphic forms, the significance of which has been observed from the intrinsic connections with number theory and arithmetic geometry, including Wiles' proof of the Fermat Last Theorem. In this talk, I will explain the recent progress for classical groups.

From Radix Expansion to Fractal Tiling

Ka-Sing Lau
The Chinese University of Hong Kong

Abstract

Tiling is an art as old as human history, but there is no systematic study in mathematics until recently. No doubt the simplest tile is the interval $[0, 1]$ in $\mathbb{R}$, which can be obtained by radix expansion (e.g., with base $2, 3$ or 10). This basic idea extended to $\mathbb{R}^n$ yields a lot of interesting tiles called *self-affine* tiles, and most surprisingly they are fractal in nature. In this talk we will survey some development of this class of tiles and raise some open problems. The techniques used include number theory, real analysis and Fourier analysis.

Generalized Kepler Problems

Guowu Meng
Hong Kong University of Science and Technology

Abstract

The Kepler problem is the physics problem about two bodies which attract each other by a force proportional to the inverse square of the distance. The solution of this problem leads to the explanation of bot.

Extension of local holomorphic isometries with respect to the Bergman metric

Ngaiming Mok
Hong Kong University

Random Polynomials, Random Determinants and Self-normalized Limit Theorems

Qi-Man Shao
Hong Kong University of Science and Technology

Abstract

This talk consists of two parts: (i) random polynomials and random determinants and (ii) limit theorems for self-normalized sums. We will focus on some histories and recent developments in these areas.

Multiplier Ideal Sheaves and their Applications

Yum-Tong Siu
Harvard University

Harmonic Maps and Application to Riemann Surface Theory

Tom Wan
The Chinese University of Hong Kong

Abstract

In this talk, we will start with the basic facts about harmonic maps between manifolds and discuss its application to Teichmuller theory of Riemann surfaces. Recent results on harmonic maps between noncompact surfaces will also be discussed.

Title to be announced.

Xiao-Ping Wang
Hong Kong University of Science and Technology

Moment Map and Scalar Curvature

Xiaowei Wang
The Chinese University of Hong Kong

Abstract

In this talk, I will discuss the relationship between the moment map in symplectic geometry and the scalar curvatures from various geometric problem.

Some Thoughts on the Boltzmann Equation

Tong Yang
City University of Hong Kong

Abstract

After introducing some basic concepts and history of the Boltzmann equation, we will present some of our recent results on the well-posedness theories, hypocoercivity, time periodic solutions, boundary layers, wave patterns, solutions in infinite vacuum and some other physical models.

Characteristic Classes in Index Theory

Weiping Zhang
Nankai University

Abstract

The Atiyah-Singer index theorem is one of the central theorems in mathematics. We will give a historical introduction to this famous result, and describe the role of characteristic classes (via Chern-Weil geometric theory) in it.

Part B: Main Lectures

An Equivariant Riemannian Geometric Approach to the 3-body Problem in Celestial Mechanics

Wu-Yi Hsiang
University of California, Berkeley
&
Hong Kong University of Science and Technology

Abstract

In the setting of Jacobi's reformulation of Lagrange's least action principle, 3-body motions are characterized as geodesics in the configuration space equipped with suitable SO(3) invariant metric. Therefore, equivariant Riemannian geometry provides a natural and advantageous framework for an in depth analysis of the interplay between the symmetry and the least action principle that Nature endows to the 3-body problem.

Introduction to representations of p-adic groups

Dihua Jiang
University of Minnesota

Abstract

This course consists of ten one-hour lectures. I will start with basic facts on p-adic fields and the representations of GL(1). The general theory of representations of p-adic groups will be discussed through the case of GL(n) or even GL(2).

Infinite Dimensional Lie Algebras

Naihuan Jing
North Carolina State University

Outline

1. Simple Lie algebras over complex numbers: sl_n, o_n, sp_2n (ABCD) and $gl(\infty)$ Use examples to explain the complex simple Lie algebra. Basis elements, bracket relations, root space decompositions. Root systems and Weyl group.

2. Kac-Moody Lie algebras: Generalized Cartan matrix, Killing form, Weyl group

3. Affine Lie algebras: Loop algebras, central realizations, affine Weyl group, and affine root system. Witt algebras and Virasoro algebras

4. Representations of Kac-Moody algebras: Highest weight representations, Weyl-Kac character formulas Jacobi triple product

5. Vertex representations of $gl(\infty)$ and affine Lie algebras: infinite dimensional Heisenberg algebra, vertex operators constructions for $gl(\infty)$, affine Lie algebras of ADE type.

6. An introduction to Tits syetems. Algebraic loop groups and the associated Tits system. Bruhat decomposition. Iwasawa decompositions.

7. Steinberg group for SL_n. Central extention of algebraic loop group given by powers of the tame symbol. Representations of algebraic loop groups constructed from dominant integrable highest weight representations of the affine Lie algebras.

Geometric Structures on Manifolds

Conan Leung
The Chinese University of Hong Kong

Abstract

We will discuss various geometric structures on manifolds and study their relationships. These includes Riemannian, Symplectic, Kahler, Calabi-Yau and G_2 structures. If time permits, we will also discuss basic aspects of Mirror Symmetry.

Modular Forms and Related Topics

Jian-Shu Li
Hong Kong University of Science and Technology

Abstract

There is a deep and as yet not completely understood connection between arithmetic properties of smooth projective varieties and automorphic forms on Shimura varieties. This course will provide an elementary introduction to the classical theory of modular forms — forms on the simplest kind of non-trivial Shimura varieties — with an eye on connections to elliptic curves. In the late part of the course we will try to explain the first indication of this connection, namely Eichler-Shimura Theory.

Introduction to Symplectic and Poisson Geometry via Examples from Lie Theory

Jianghua Lu
Hong Kong University

Abstract

Symplectic geometry is the geometry of a certain 2-form on a manifold, and Poisson geometry is the geometry of a certain 2-vector field. They are related by the fact that a Poisson manifold is a disjoint union of symplectic manifolds.

Both symplectic and Poisson geometry are rapidly expanding and evolving fields, marked by current research activities in symplectic topology, quantum theory, and applications to mathematical physics and Lie theory. A set of fundamental concepts and constructions in symplectic and Poisson geometry is essential to all the more advanced topics mentioned above. The purpose of this course is to introduce some of these basic materials via examples from Lie theory. We will work with concrete examples such as projective spaces and conjugacy classes of matrices. Some basic knowledge on differential manifolds is required.

Evolution Equations on Complete Noncompact Kähler Manifolds with Nonnegative Curvature

Luen-Fai Tam
The Chinese University of Hong Kong

Abstract

We will discuss heat equation and Kähler-Ricci flow on complete noncompact Käher manifolds with nonnegative curvature. We will first prove that Kähler condition and positivity of curvature are preserved under Kähler-Ricci flow. We will discuss long time existence. In order to prove long time existence, we will first construct a potential for the Ricci form, which may have independent interest. We will also give estimates for the curvature of the flow. Some results on the complex structures of Kähler manifolds will be derived. We may also discuss some application of the heat equation. For example, we will prove that plurisubbarmoncity is preserved under the heat equation on Kähler manifolds with nonnegative curvature.

Basic Techniques in Nonlinear Analysis

Jun-Cheng Wei
The Chinese University of Hong Kong

Infinite Dimensional Lie Algebras

Yongchang Zhu
Hong Kong University of Science and Technology

Outline

1. Simple Lie algebras over complex numbers: sl_n, o_n, sp_2n (ABCD) and $gl(\infty)$ Use examples to explain the complex simple Lie algebra. Basis elements, bracket relations, root space decompositions. Root systems and Weyl group.

2. Kac-Moody Lie algebras: Generalized Cartan matrix, Killing form, Weyl group

3. Affine Lie algebras: Loop algebras, central realizations, affine Weyl group, and affine root system. Witt algebras and Virasoro algebras

4. Representations of Kac-Moody algebras: Highest weight representations, Weyl-Kac character formulas Jacobi triple product

5. Vertex representations of $gl(\infty)$ and affine Lie algebras: infinite dimensional Heisenberg algebra, vertex operators constructions for $gl(\infty)$, affine Lie algebras of ADE type.

6. An introduction to Tits syetems. Algebraic loop groups and the associated Tits system. Bruhat decomposition. Iwasawa decompositions.

7. Steinberg group for SL_n. Central extention of algebraic loop group given by powers of the tame symbol. Representations of algebraic loop groups constructed from dominant integrable highest weight representations of the affine Lie algebras.

Finite Element Methods for PDEs

Jun Zou
The Chinese University of Hong Kong

Abstract

In this short course, we will have a systematical introduction to finite element methods for solving partial differential equations (PDEs) and their applications to some mathematically ill-posed problems as well as some nonlinear PDE problems arising from geophysics and electromagnetism.