Abstracts

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Jean-Michel Bismut
Université Paris-Saclay, France

IMS Distinguished Lecture Series

Hypoelliptic Laplacian and the trace formula

The heat equation method in index theory gives an explicit local formula for the index of a Dirac operator.

Similar methods can be developed to give a geometric formula for semisimple orbital integrals associated with the Casimir operator of a reductive group, this computation being related to Selberg's trace formula. The analogue of the heat equation method is a suitable deformation of the Laplacian by a family of Fokker-Planck operators Lb|b>0 that interpolates between the Casimir operator and the geodesic flow.

Finally, we will explain results obtained by Shu SHEN and ourselves when the Casimir operator is replaced by an arbitrary element of the center of the Lie algebra.

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Qing-Ming Cheng
Fukuoka University, Japan

Critical points of functionals and their geometry

It is well-known that self-shrinkers of mean curvature flow are critical points of weighted area functional. Furthermore, we consider critical points of weighted area functional for the weighted volume-preserving variations, which are called λ-hypersurface of weighted volume-preserving mean curvature flow. For λ=0, they become self-shrinkers of mean curvature flow. Since there exists embedded self-shrinkers with genus one which is not isometric to Angenent example on self-shrinkers with genus one, it is known that for embedded self-shrinkers with genus one, one cannot expect to have Lawson type conjecture on embedded minimal surfaces with genus one or Pinkall- Sterling type conjecture on embedded surfaces with constant mean curvature and genus one. We will construct examples of compact and complete non-compact embedded λ-hypersurfaces with different topological types. Thus, we know that for λ-hypersurface, one cannot expect to have Alexandrov type theorem on compact hypersurfaces with constant mean curvature and Brendle type theorem on self-shrinkers and planar domain conjecture on self-shrinkers. Furthermore, geometry of complete λ-hypersurfaces are discussed.

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Xianzhe Dai
University of California, Santa Barbara, USA

Positive mass theorem and positive scalar curvature for singular metrics

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The positive mass theorem of Schoen-Yau and Witten is one of the most important results about scalar curvature. Various motivations lead to consideration of singular metrics. I will review these and present our recent work with Yukai Sun and Changliang Wang on positive mass theorem and Geroch type theorem for isolated conical singularity.

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Jixiang Fu
Fudan University, China

A deformed Hermitian Yang-Mills flow

We talk about a new deformed Hermitian Yang-Mills flow on a compact Kahler manifold, including the existence and convergence of its longtime solution, and its application to the degenerate case on a compact Kahler surface. This is a joint work with Shing-Tung Yau and Dekai Zhang.

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Sebastian Goette
Universität Freiburg, Germany

Classifying Compact G_2-Manifolds

By results of Joyce, the moduli space of metrics with holonomy G_2 on a closed 7-manifold M is an orbifold of dimension $b_3(M)$. Not much is known about its global structure. We review the ν-invariant devised by Crowley and Nordström to distinguish different such metrics and show how to deÀine itusing η-invariants. We then compute this invariant for so-called extra twisted connected sums and exhibit examples of 7-manifolds where the moduli space of G_2-metrics is disconnected. The computation relies on several older results on η-invariants and some input from analytic number theory.

Joint with D. Crowley and J. Nordstrom

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Bo Liu
East China Normal University, China

Recent progress on Bismut-Cheeger eta forms

The Bismut-Cheeger eta form is the family extension of the Atiyah-Patodi-Singer eta invariant. In this talk, we will discuss our recent results on generalizing the properties of the eta invariants to the Bismut-Cheeger eta forms.

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Kefeng Liu
University of California, Los Angeles, USA

Logarithmic vanishing theorems on compact Kahler manifolds

I will discuss joint work with C.-L. Huang, X.-Y. Wan and X.-K. Yang about a number of new vanishing theorems for sheaves of logarithmic differential sheaves on compact Kahler manifolds with simple normal crossing divisors which generalize various classical vanishing theorems.

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Xiaonan Ma
Institut de Mathématiques de Jussieu-Paris Rive Gauche, France

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A glimpse into Weiping Zhang's mathematical work

Kindly view recorded talk.

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Paul-Emile Paradan
Université de Montpellier, France

Multiplicities of discrete series with respect to a symmetric pair and index theory

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A standard problem in harmonic analysis is to understand how a representation V of the discrete series of a reductive Lie group G decomposes into irreducible representations of a reductive subgroup H. A few years ago, using a method based on the Atiyah-Singer index theory, I showed that when the restriction V|_H is admissible, its multiplicities satisfy the rule [Q,R]=0 predicted by the Kirillov orbit method. In this talk, we focus on the case where (G,H) is a symmetric pair, and we will explain how our method allows us to answer part of the Gan-Gross-Prasad conjecture for the pair U = (U(p+1,q) ; U(p,q)) and SO = (SO(2p+1,2q) ; SO(2p, 2q)). Recall that complete proofs of the GGP conjecture for U and SO pairs have recently been obtained in the work of R. Beuzart-Plessis, H. He and H. Xue.

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Paolo Piazza
Sapienza Università di Roma, Italy

Analytic transfer in K-homology for Witt stratified spaces

In this talk I will present results about Dirac operators on stratified pseudomanifolds. I will concentrate mainly on the signature operator but I will also talk briefly of the spin-Dirac operator. After giving a survey of the main theorems concerning the K-homology classes defined by these operators under the so-called Witt assumption. I will report on recent results in collaboration with Pierre Albin and Markus Banagl. I will first explain the challenges one has to face in order to define, analytically, wrong-way maps in K-homology for normally non-singular inclusions and for fibrations of pseudomanifolds (these maps in K-homology are also known as Gysin maps or transfer maps). I will then move on and illustrate a fundamental property of these wrong-way maps, namely that they preserve the analytic signature class. I will end my talk discussing the relationship between this analytic approach and a purely topological one developed by Banagl and others.

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Xiang Tang
Washington University, USA

Symplectic Morse Theory and Witten Deformation

In this talk, we will introduce a Morse type cohomology for symplectic manifolds using gradient flows and integration of the symplectic form over spaces of gradient flow lines. We will study this symplectic Morse cohomology using the Witten deformation method. In particular, we will explain that the symplectic Morse cohomology is isomorphic to the cohomology of differential forms introduced by Tsai, Tseng, and Yau for symplectic manifolds.

This talk is based on joint works with David Clausen and Li-Sheng Tseng.

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Zizhou Tang
Nankai University, China

Orthogonal almost complex structure and its Nijenhuis tensor

On an almost Hermitian manifold M^{2n}, a canonical 2-form is proved to be non-degenerate if the squared norm |N|^2 of the Nijenhuis tensor is less than 64/5. As a corollary, there exists no orthogonal almost complex structure on the standard 6-sphere with |N|^2 < 64/5 everywhere.

This is a joint work with Prof. Wenjiao Yan.

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Guofang Wang
Universität Freiburg, Germany

A higher order mass

In the talk I will first introduce a mass, which we call Gauss-Bonnet-Chern mass, for asymptotically flat manifolds by using a higher order scalar curvature that is closely related to the integrand in the Gauss-Bonnet-Chern formula. In fact, the magic formula in Chern's proof provides an equivalent definition for this mass. We will also talk about a Penrose type inequality for this mass and related geometric inequalities.

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Siye Wu
National Tsing Hua University, Hsinchu

Classical Aspects of Higher-Form Symmetry

Variational bicomplex, originated from the work of Gelfand et al on characteristic classes in the 1970s, has been a key in understanding the geometric structure of classical field theory. In this talk, we use it to explore the classical root of the higher-form symmetry introduced by Gaiotto-Kapustin-Seiberg-Willett. Applying Noether's first and second theorems in a geometric context, we establish the existence of continuous higher-form symmetry when there is redundancy in gauge transformations.

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Ping Xu
The Pennsylvania State University, USA

Duflo-Kontsevich type theorem for dg manifolds

Dg manifolds are a useful geometric notion which unifies many important structures such as homotopy Lie algebras, foliations and complex manifolds. In this talk, we describe a Duflo-Kontsevich type theorem for dg manifolds. The Duflo theorem of Lie theory and the Kontsevich theorem regarding the Hoschschild cohomology of complex manifolds can both be derived as special cases of this Duflo--Kontsevich type theorem for dg manifolds.

This is a joint work with Hsuan-Yi Liao and Mathieu Stienon.

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Kenichi Yoshikawa
Kyoto University, Japan

Degenerations of Riemann surfaces and small eigenvalues of Laplacian

We consider a degeneration of compact Riemann surfaces over a complex curve, whose total space is a smooth K\"ahler surface. Then the fibers are endowed with the metric induced by the K\"ahler metric on the total space. In this situation, it is known that each eigenvalue of the Laplacian is a continuous function on the base curve. In particular, for a reducible singular fiber, some eigenvalues of the Laplacian of the regular fiber converge to zero as the regular fiber approaches the singular fiber. Such eigenvalues are called small eigenvalues. In this talk, I report on work in progress with X. Dai on the asymptotic behaviour of the small eigenvalues of the Laplacian when the singular fiber is reduced.

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Guoliang Yu
Texas A&M University, USA

An index theorem for manifolds with polyhedral boundary and scalar curvature rigidity

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I will explain how to apply an index theorem for Dirac operators on manifolds with polyhedral boundary to solve Gromov's dihedral extremality conjecture on scalar curvature for polyhedra. This is joint work with Jinmin Wang and Zhizhang Xie.

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