NOTRE DAME UNIVERSITY-LOUAIZE

CONFERENCE ON DIFFERENTIAL GEOMETRY

TITLES AND ABSTRACTS

1. MINI-COURSES

Guofang Wang

Department of Mathematics, University of Freiburg, Germany

Title: The Gauss-Bonnet-Chern curvature and its related problems.

Abstract: In this minicourse I will first introduce the Gauss-Bonnet-Chern curvature and discuss its properties. It is a natural generalization of the scalar curvature and has two interesting special cases: If the manifold is a hypersurface in the euclidean space, it is the higher order mean curvature; if the manifold is locally conformally flat, it is the so-called sigma-k scalar curvature, which has been intensively studied in the field of fully nonlinear equations. Then I will use it to define a geometric invariant for asymptotically flat and asymptotically hyperbolic manifolds, which is a natural generalization of the ADM mass. Its corresponding Penrose inequality is closely related to the classical inequalities, the Alexandrov-Fenchel inequalities, which I will talk about at the end of this minicourse.

Vicente Cortes

Department of Mathematics, University of Hamburg, Germany

Title: Complete quaternionic Kähler manifolds from supergravity construction.

Abstract: Generalising work of Haydys, I will present a method, known as the HK/QKcorrespondence, for the construction of quaternionic Kähler manifolds starting from possibly indefinite hyper-Kähler manifolds with an appropriate Killing vector field. I will show how this method can be used to prove that certain explicit Riemannian metrics (known as one-loop deformations of Ferrara-Sabharwal metrics) arising in theoretical high energy physics are indeed quaternionic Kähler. Finally, I will present some effective criteria which ensure the completeness of the resulting metrics. The mini course covers results obtained in several collaborations.

2. TALKS

Ahmad El Soufi

University of Tours, France

Title: The effect of geometry on the eigenvalues of the laplacian.

Abstract: The sequence of eigenvalues of the Dirichlet Laplacian on a bounded Euclidean domain satisfies several restrictive conditions such as: Faber-Krahn isoperimetric inequality, Li-Yau inequality, Payne Polya-Weinberger universal inequalities, etc. The situation changes completely as soon as Euclidean domains are replaced by compact surfaces. For example, according to results by Colin de Verdière and Lohkamp, any finite increasing sequence of numbers is the beginning of the spectrum of the Laplacian of a compact surface of unit area. Hence, Faber-Krahn, Li-Yau and Payne-Polya-Weinberger inequalities have no analogue in this context. In this talk, we will discuss the effect of the geometry on the eigenvalues, trying to understand what geometric situations can lead to the existence of large eigenvalues.

Andrea Sambusetti

Dipartimento di Matematica, Sapienza Università di Roma-Italy

Title: Boundaries of Riemannian manifolds.

Abstract: The idea of compactifying Riemannian manifolds by adding a "boundary at infinity'' has old roots and many interesting applications: it helped to understand the global topology in non-negative curvature, it is a basic tool in the study of dynamics of Kleinian groups in negative curvature, it led to wonderful insights in the function theory of harmonic and symmetric spaces, etc. One of the first approaches is by adding ``directions of divergence'': the notion of Busemann function was originally introduced by Herbert Busemann in the fifties as a tool to develop a theory of parallels on geodesic spaces (e.g. complete Riemannian manifolds) and captures the idea of angle at infinity between infinite geodesic rays. For a Hadamard manifold X, the picture is well-known: Busemann functions yield a useful compactification of the space (known as the Gromov compactification) which has the topology of a sphere and is easily understood in terms of rays. This nice picture breaks down in variable sign curvature (e.g. the Heisenberg group), or for non-simply connected manifolds. The aim of the talk is to present some recent examples where this kind of compactification has been fully understood, and where the visual description breaks down, as well as the pathologies which can occur in the non-simply connected case.

Asma Hassannezhad

Max Planck Institute for Mathematics, Bonn, Germany

Title: Multiplicity of the Laplacian eigenvalues.

Abstract: The eigenvalues of the Laplacian are important invariants in Riemannian geometry. Spectral geometry aims at revealing the deep relationships between these eigenvalues and geometry of the underlying manifold. The focus of this talk would be on the multiplicity of these eigenvalues. Multiplicity bounds on Riemannian surfaces have been extensively studied started with the work of Cheng in 1976. However, there are only some isolated results on higher dimensional manifolds. In higher dimensions, we obtain new multiplicity upper bounds depending on some geometric scale--invariant quantities which improve and extend the previous known results. This is joint work with G. Kokarev and I. Polterovich.

Clara Aldana

Department of Mathematics, University of Luxembourg

Title: A Polyakov formula for surfaces with conical singularities and angular sectors.

Abstract: In this talk I consider surfaces with conical singularities and finite area convex angular sectors in the plane. I start motivating the study of determinants of Laplacians in dimension two. After that, I restrict to the study of the determinant on finite convex sectors and cones. I explain how to use conformal transformations to differentiate the determinant of the Laplacian with respect to the corresponding opening angle. This leads to a variational Polyakov formula, when the variation is taken in the direction of a conformal factor with a logarithmic singularity. I will show the main analytical tools necessary to obtain this formula. The results presented are in collaboration with Julie Rowlett and Werner Mueller.

Ghina El Mir

University of Balamand and University of Saint Joseph, Lebanon

Title: Conformal Clifford algebras and image viewpoints orbit.

Abstract: Our purpose in this work is to introduce representations of image viewpoints and viewpoint changes of a planar object in conformal Clifford algebras. Our important preliminary contribution is a generalization of the conformal model of the Euclidean space through a twoparameter family of horospheres. Each one of these is embedded into the space R4 equipped with a metric equivalent to the Minkowski metric. We describe two approaches that make use of these generalized conformal models for image representations. These are based on modeling of perspective distortions of the object caused by a variation of the latitude angle of the camera through the horosphere parameters

Georges Habib

Lebanese University, Lebanon

Title: Rigidity results for spin manifolds with foliated boundary

Abstract: In this talk, we consider a compact Riemannian manifold whose boundary is endowed with a Riemannian flow. Under a suitable curvature assumption depending on the O'Neill tensor of the flow, we prove that any solution of the basic Dirac equation is the restriction of a parallel spinor field defined on the whole manifold. As a consequence, we show that the flow is a local product. In particular, in the case where solutions of the basic Dirac equation are given by basic Killing spinors, we characterize the geometry of the manifold and the flow.

Nancy Abdallah

University of Nice, France

Title: Cohomology of algebraic plane curves and of their complement.

Abstract: Let $C \subseteq P^2$ be a curve given by $f = 0$ where $f \in S = C[x, y, z]$. Denote by J_f the Jacobian ideal of f; i.e. the ideal generated by the partial derivatives of f. We describe the relations between the Milnor algebra $M(f) = S / J_f$ of f and the singularities of Cwhich can be done by a study of the cohomology of the Koszul complex of the partial derivatives of f. We also give a description of the Hodge filtration on the cohomology groups $H^*(U)$ of the complement $U = P^2 / C$ of C.

Yael Fregier

Max Planck Institute for Mathematics, Bonn, Germany

Title: algebras governing simultaneous deformations in geometry.

Abstract: We will explain how simultaneous deformations problems in geometry are naturally governed by nonquadratic algebras and how such algebras can be constructed by supergeometry. This will be illustrated with examples. We will consider simultaneous deformations of pairs such as coisotropic/Poisson, Dirac/Courant, generalized complex/Courant.