Abstracts

Bruno Klingler (Jussieu):
Chern's conjecture for special affine manifolds

Abstract: An affine manifold X is a manifold admitting an atlas of charts with value in an affine space V with locally constant change of coordinates in the affine group Aff(V) of V. Equivalently, it is a manifold admitting a flat torsion free connection on its tangent bundle. Around 1955 Chern asked if there is any topological obstruction to the existence of an affine structure on a compact manifold X. He conjectured that the Euler characteristic e(TX) of any compact affine manifold has to vanish. I will discuss this conjecture and a proof when X is special affine (i.e. X is affine and moreover admits a parallel volume form).

Felix Finster (Regensburg):
Space, time and matter in the theory of causal fermion systems

Abstract: The theory of causal fermion systems is a recent approach to describe fundamental physics. Giving quantum mechanics, general relativity and quantum field theory as limiting cases, it is a candidate for a unified physical theory. The dynamics is described by a novel variational principle, the so-called causal action principle. From the mathematical perspective, causal fermion systems provide a general framework for desribing and analyzing non-smooth geometries. In the talk I will explain how space, time and matter arise in a causal fermion system and how these notions are interrelated.

Albrecht Klemm (Bonn):
Geometric Engineering of 6d Super Conformal Field Theories

Abstract: We show that BPS states of 6d super conformal field theories are calculated by a ring of generalized Jacobi-forms and geometric constraints on refined Pandharipande-Thomas invariants for stable pairs.

Jean-Michel Bismut (Paris Sud):
Analytic torsion, the hypoelliptic Laplacian and the trace formula

Abstract: On a compact odd dimensional manifold equipped with a flat unimodular vector bundle, the Reidemeister torsion is a combinatorial invariant. Analytic torsion is a spectral invariant of the corresponding Hodge Laplacian. The Cheeger-Müller theorem asserts that these two invariants coincide.
A proof was given by Zhang and ourselves based on the Witten deformation of Hodge theory that is associated with a Morse function f. In a first part of the talk, we will review some aspects of the proof.
In a second part, when replacing f by the energy functional on the loop space, the corresponding Hodge Laplacian is a hypoelliptic operator acting on the total space of the tangent bundle. A result by Lebeau and ourselves asserts that elliptic and hypoelliptic torsion coincide.
If one pushes the deformation parameter to infinity, on manifolds with negative curvature, one obtains a formal version of the Fried conjecture, that relates the values at 0 of the Ruelle zeta function associated with the geodesic flow and analytic torsion.
In a last part of our talk, we will describe our approach to Selberg's trace formula as a form of a Lefschetz formula. Using the corresponding formulas, Shu Shen was able to provide a complete proof of the Fried conjecture on compact locally symmetric spaces.

Werner Ballmann (Bonn):
Small Eigenvalues and analytic systole of surfaces

Abstract: Eigenvalues of a Riemannian manifolds M are called small if they lie below the bottom of the spectrum of the universal covering of M . For example, eigenvalues of hyperbolic surfaces below a quarter are small. I will explain some of the results of Buser and others on small eigenvalues of hyperbolic surfaces. In my recent joint work with Matthiesen and Mondal on small eigenvalues of Riemannian surfaces, a new invariant, the analytic systole Λ of S, arises naturally. I will discuss Λ and its relation to small eigenvalues of S.

Johannes Henn (Mainz):
Feynman integrals from Fuchsian differential equations

Abstract: It is well known that Feynman integrals satisfy Fuchsian differential equations. In general, solving the latter in closed form is a difficult problem. However, when the equations can be cast into a certain canonical form, identifying the solution in terms of special functions, such as multiple polylogarithms, becomes straightforward. In recent years, much progress was made in understanding how to find such a canonical form can be reached.
A key tool are so-called leading singularities, i.e. multidimensional residues of the Feynman loop integrand. In this talk I will review these developments and mention open problems.