# Geometry and Analysis in Hannover and Magdeburg

23–24 January, 2025
Leibniz Universität Hannover

# Timetable

## Thursday, 23 January

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|---|---|---|---|
| 14:15–15:00 | BB | **Giuseppe Gentile**<br>R016 | A brief introduction to stochastically complete manifolds |
| 15:00–15:45 | BB | **Balázs Márk Békési**<br>R016 | Non-existence results for harmonic maps |
| 15:45–16:15 | **Break** | | |
| 16:15-17:00 | BB | **Jørgen Olsen Lye**<br>R016 | Generalized Yamabe Flow |
| 17:00-17:45 | BB | **Florian Litzinger**<br>R016 | Curve shortening flow in high codimension |
| 18:30 | **Dinner (Location TBD)** | | |

## Friday, 24 January

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| 9:00-9:45 | S | **Nikolas Eptaminitakis**<br>G123 | Geometric Inverse Problems on Asymptotically Hyperbolic Manifolds |
| 9:45–10:15 | **Break / Room change** | | |
| 10:15–11:00 | S | **Boris Gulyak**<br>R141 | Graphical Willmore Flow |
| 11:00–11:45 | S | **Jahne Meyer**<br>R141 | Evolving polygons via semi-discrete linear geometric flows |
| 11:45–12:15 | **Break / Room change** | | |
| 12:15–13:00 | BB | **Alessandro Pietro Contini**<br>R016 | Asymptotically Euclidian geometry and symplectic structures |
| 13:30 | **Lunch at Andronaco** | | |

The talks take place in the following rooms:

- Room 016, Building 3110 (Mensa), Callinstraße 23 (**R016**)
- Room G123, Building 1101 (Hauptgebäude), Welfengarten 1 (**G123**)
- Room 141 (Herrmann-Windel-Hörsaal), Building 1105, Welfengarten 1A (**R141**)

# List of Abstracts

## Non-existence results for harmonic maps

***Balázs Márk Békési***

In this talk, I will report on joint work with R. Assimos and G. Gentile on non-existence results for harmonic maps. These results extend the classical Liouville theorem from complex analysis to broader settings, particularly to (possibly) non-compact Riemannian manifolds. A key element of our approach is an adapted notion of convexity, which we term pullvexity, combined with maximum principles tailored for non-compact manifolds.

## Asymptotically Euclidian geometry and symplectic structures

***Alessandro Pietro Contini***

Many problems in mathematical physics are solved under the assumption that the geometric background is asymptotically flat. For stationary problems (say, time-independent) this often reduces to questions on Riemannian manifolds whose metric is Euclidian outside a compact set. At the same time, the problem of covariance of quantisation of an Hamiltonian system requires to understand what corresponds, in the quantised picture, to a canonical transformation. In this talk we show that there is a natural notion of symplectic map that allows to study such questions all the way to “infinity”.

## Geometric Inverse Problems on Asymptotically Hyperbolic Manifolds

***Nikolas Eptaminitakis***

The term geometric inverse problems usually refers to problems related to extracting information about unknown objects defined in a Riemannian manifold from external measurements. Such objects can be a function, a tensor field, a connection defined on a vector bundle, or the metric itself. The most basic among these problems is perhaps that of determining an unknown function on a manifold from its geodesic X-ray transform, that is, from its integrals along geodesics of the metric. In general, the information that one can extract about the unknown object depends strongly on the geometry on the underlying space. In this talk we will focus on asymptotically hyperbolic manifolds, a class of non-compact manifolds which are generally of non-constant curvature, but admit a certain structure at infinity that makes their curvature asymptotically approach a negative constant there. The most important example is hyperbolic space. We will discuss some results regarding the X-ray transform acting on scalar functions, and comment on ongoing work and future directions regarding the X-ray transform acting on symmetric tensors and the non-Abelian X-ray transform.

## A brief introduction to stochastically complete manifolds

***Giuseppe Gentile***

The analysis of elliptic and parabolic PDE’s on non-compact manifolds is extremely challenging. Nonetheless, stochastic completeness seems to provide the right framework to pursue such an analysis. Although the setting is known by most geometric analysts, it seems that its full potential is yet to be explored. The aim of this talk is to give a gentle introduction to the setup and see some basic applications to elliptic PDE’s. I will also hint to how to approach parabolic PDE’s. Finally I will present the basic idea leading to a possible more general setup for the analysis of harmonic maps, minimal immersions and mean curvature flows of non compact manifolds.

## Graphical Willmore Flow: Existence, Regularity, and Convergence under Low Regularity Assumptions on Boundary Data

***Boris Gulyak***

In this talk, we focus on the graphical representation of the Willmore flow, particularly for surfaces represented as graphs over bounded domains. The flow is reformulated as a fourth-order parabolic equation, and its behavior is analyzed within both time-weighted and unweighted parabolic Hölder spaces. This approach accommodates fixed Dirichlet boundary conditions and initial data with low Hölder regularity.

Key results include the establishment of short-term existence and the reduction of compatibility conditions between initial and boundary data. Furthermore, we demonstrate long-term existence and convergence toward critical points of the Willmore energy under smallness constraints on the initial data. Special attention is given to the divergence structure of the equation, which enables advanced regularity results through Schauder estimates.

## Curve shortening flow in high codimension

***Florian Litzinger***

While the singularity formation of the flow by curvature of curves in the plane is well understood, much less is known about the flow of curves in higher codimension. In particular, closed embedded planar curves stay embedded, eventually become convex and shrink to a round point in finite time, but this is not necessarily the case for curves in codimension two and higher. However, it turns out that these curves in fact become asymptotically planar in the vicinity of a singularity; and combined with a bound on a suitably defined entropy of the initial curve we can show that such curves do become circular and thus shrink to a point.

## Generalized Yamabe Flow

***Jørgen Olsen Lye***

I will briefly recall the Yamabe flow on a compact manifold. I will then introduce the concept of generalized Yamabe flow, which is a class of conformal flows extending the Yamabe flow. Finally, I will present existence and convergence results for this flow. This is joint work with Boris Vertman and Mannaim Gennaro Vitti, arXiv:2412.02593.

## Evolving polygons via semi-discrete linear geometric flows

***Jahne Meyer***

Chow and Glickenstein presented a linear semi-discrete analogue of the curve shortening flow for closed polygons. Motivated by higher order polyharmonic evolution equations on smooth curves, this talk presents comparable semi-discrete geometric flows that evolve and continuously untangle closed polygons (that can be planar or exist in higher co-dimensions). Setup and properties will be introduced and behaviour of explicit solutions demonstrated and explored. As an application, a semi-discrete analogue of the Yau problem is given, where any closed polygon flows to another via curvature flow.

# List of Participants

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