universität innsbruck
Fakultät für Mathematik, Informatik und Physik

BERUFUNGSVORTRÄGE: „Applied Mathematics with focus on Differential Geometry“

Tuesday, 16.12.2025	
Thomas KÖRBER	
08:30 – 09:00 **Viktor-Franz-Hess Haus, HS F**	**Lehrevortrag und Diskussion**
09:00 – 09:45 **Viktor-Franz-Hess Haus, HS F**	**Forschungsvortrag und Diskussion: „The Penrose inequality in extrinsic geometry“** *A surface in Euclidean 3-space is called minimal if its area cannot be decreased to first order by local perturbations. The plane, the catenoid, and the helicoid are classical examples. Understanding the geometry of minimal surfaces has been and continues to be one of the central themes in differential geometry.* *In this talk, I will present recent joint work with M. Eichmair that establishes a new characterization of the catenoid in terms of its extrinsic geometry among complete embedded minimal surfaces with integrable Gauss curvature. Our result confirms a conjecture of G. Huisken and can be viewed as an analog in extrinsic geometry of the Riemannian Penrose inequality in mathematical relativity. The proof introduces a novel analysis of so-called minimal capillary surfaces, which I expect will have further applications. I will conclude by outlining how this approach may shed new light on long-standing questions in extrinsic geometry and mathematical relativity.*
N. N.	
11:00 – 11:30 **Viktor-Franz-Hess Haus, HS F**	**Lehrevortrag und Diskussion**
11:30 – 12:15 **Viktor-Franz-Hess Haus, HS F**	**Forschungsvortrag und Diskussion: „Discrete geometric analysis and its applications“** *This talk will introduce the field of discrete geometric analysis, a discrete counterpart to classical geometric analysis. We will explore key notions such as discrete harmonic functions, discrete curvatures, and discrete Ricci flows. Several applications will be presented to illustrate recent progress.*
N. N.	
14:00 – 14:30 **Viktor-Franz-Hess Haus, HS F**	**Lehrevortrag und Diskussion**
14:30 – 15:15 **Viktor-Franz-Hess Haus, HS F**	**Forschungsvortrag und Diskussion: „The Geometry of Black Hole Interiors: Singularity Formation and Cosmic Censorship“** *The nature of spacetime singularities inside black holes is a fundamental question in General Relativity, central to Penrose's Strong Cosmic Censorship Conjecture. In this talk, I will present recent results on the interior geometry of dynamical black holes.* *We prove that, contrary to classical expectations, the global singularity structure consists of a weak null singularity (where the metric extends continuously) coexisting with a strong spacelike singularity (where the metric is inextendible), thereby resolving a long-standing open problem in the literature. I will discuss why this configuration is conjectured to be generic and outline the future of this research program.*

*) Die Veröffentlichung von Namen und Titel erfolgt nur auf Zustimmung der Vortragenden. Stellungnahmen zu den Vorträgen der Hearing-Teilnehmer:innen richten Sie bitte bis längstens 14:00 Uhr des letzten Vortragstages an Fakultaet-MIP@uibk.ac.at.

Wednesday, 17.12.2025	
David FAJMAN	
08:30 – 09:00 **Viktor-Franz-Hess Haus, HS F**	**Lehrevortrag und Diskussion**
09:00 – 09:45 **Viktor-Franz-Hess Haus, HS F**	**Forschungsvortrag und Diskussion: „The Einstein Flow - Nonlinear Dynamics of Gravitation and Matter“** *Einstein's equations can be interpreted as a geometric flow, recasting the time evolution of spacetime geometry as a geometric initial-value problem. Over the past three decades, sophisticated methods from geometric analysis have been developed to study this flow rigorously across a variety of regimes, with applications ranging from the phenomenology of gravitational waves and strongly gravitating astrophysical systems to cosmology.* *The parallel rise of high-precision gravitational-wave measurements and the advent of gravitational-wave astronomy has sharply increased the need for a deep understanding of the nonlinear dynamics of gravitation and its interplay with matter.* *I will present geometric-analytic techniques for analyzing the behavior of gravitational waves, the dynamics of matter in curved spacetime, and their mutual interactions. Furthermore, I will discuss how these results advance our understanding of gravitation and the formation of large-scale structures in the universe.*
Ralf ZIMMERMANN	
11:00 – 11:30 **Viktor-Franz-Hess Haus, HS F**	**Lehrevortrag und Diskussion**
11:30 – 12:15 **Viktor-Franz-Hess Haus, HS F**	**Forschungsvortrag und Diskussion:** **„Matrix analysis meets Riemannian geometry: The worlds of orthogonal frames and subspaces”** *Orthogonal frames –column-orthogonal matrices– play a crucial role in a wide range of numerical applications. They appear prominently in machine learning and data science, model reduction, and optimization. The collection of all column-orthogonal matrices constitutes the Stiefel manifold. Closely related is the Grassmann manifold, which represents the set of all subspaces of a fixed dimension. The Riemannian structure of these sets allows for combining matrix-analytic and geometric techniques.* *Starting from a short introduction, we will explore new theoretical insights into the geometric properties of Stiefel manifold and their impact on numerical algorithms. We focus on three key aspects: the degree of curvature of the manifold, the length of its shortest closed geodesics, and the distance from a base point to its antipodal point. The latter can be interpreted as defining the boundary of computability within a Riemannian coordinate domain.* *On the Grassmann manifold, we will investigate classical aspects of numerical interpolation in a new set of coordinate charts.* *The theoretical concepts will be illustrated and demonstrated by numerical experiments. We will conclude the talk by outlining possible future research directions.*

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Wednesday, 17.12.2025	
Annegret BURTSCHER	
14:00 – 14:30 **Viktor-Franz-Hess Haus, HS F**	**Lehrevortrag und Diskussion**
14:30 – 15:15 **Viktor-Franz-Hess Haus, HS F**	**Forschungsvortrag und Diskussion: „Beyond Smoothness: Rethinking Geometry for Relativity and Applications“** *What happens when smoothness—the cornerstone of classical differential geometry—breaks down? This question drives major challenges in general relativity, where singularities, horizons, and low-regularity phenomena expose the limits of traditional approaches. In this talk, I present a synthetic framework for Riemannian and Lorentzian manifolds that pushes geometry beyond the smooth category, integrating ideas from metric geometry, causality theory, and generalized curvature. I will highlight my recent key results, from establishing the null distance as a versatile tool in general relativity to advances on conformal structures and boundaries. While these developments already advance our understanding of gravitational phenomena, they also lay the groundwork for applying non-smooth geometry to future challenges in theoretical physics and data science.*

Thursday, 18.12.2025	
Thomas TAKACS	
08:30 – 09:00 **Viktor-Franz-Hess Haus, HS F**	**Lehrevortrag und Diskussion**
09:00 – 09:45 **Viktor-Franz-Hess Haus, HS F**	**Forschungsvortrag und Diskussion: „Bridging Geometry and Simulation: Isogeometric Analysis and Beyond“** *A tight coupling of geometry and simulation is essential to facilitate the interplay between the two. This becomes particularly important when the geometry of the domain is evolving during the simulation process, as is the case in structural dynamics, fluid-structure interaction, shape optimization, and geometric partial differential equations (PDEs). In such scenarios, geometric features, layers, or singularities, whether they are present in the initial model or emerge in the simulation process, need to be represented accurately. The framework of Isogeometric Analysis (IGA) addresses this challenge by employing a spline-based discretization - as it is used in Computer-Aided Design (CAD) - to represent both the geometry and the solution field of a PDE.* *Consequently, the discrete solution is a spline hypersurface embedded in a higher dimensional ambient space, enabling the use of CAD technologies to process it. The use of splines is advantageous for many applications, due to their high approximation order and high smoothness, which allow, e.g., efficient, explicit time-stepping schemes for time-dependent problems and to directly solve higher-order PDEs. Creating and adaptively refining spline-based models for complex geometries remains challenging, particularly when global smoothness is required. The development and analysis of efficient, reliable, and scalable techniques for geometry processing, simulation set-up and solution continues to be a central focus of research, leading to innovation in both computational geometry and scientific computing. We highlight recent advances in these directions and outline ongoing efforts towards integrated geometric modeling and simulation frameworks, also discussing alternatives to IGA, such as immersed boundary methods and subdivision-based simulation methods.*
Simon BLATT	
11:00 – 11:30 **Viktor-Franz-Hess Haus, HS F**	**Lehrevortrag und Diskussion**
11:30 – 12:15 **Viktor-Franz-Hess Haus, HS F**	**Forschungsvortrag und Diskussion: „From cell membranes, knotted DNA, and sphere eversions“** *Since the work of Euler and Bernoulli, elastic energy has been a central topic in mathematics. In this lecture, we will take a journey through different variants of elastic energies for curves and surfaces. We present research results in the context of the Willmore energy and the Canham-Helfrich model for red blood cells and focus on novel energies that model self-repulsive forces.* *The lecture concludes with an outlook on current research questions concerning multi-phase biomembranes, optimal eversion of spheres, and self-repulsive potentials.*