Differential Geometry and its Applications

DGA2025

Programme and Abstracts

Sep 7–12
Masaryk University
Brno, Czech Republic

https://conference.math.muni.cz/dga2025/

The 16^{th} Conference on Differential Geometry and its Applications
Programme and Abstracts
Brno 2025

1. Conference Schedule

The scientific programme will run from 9:00 on Monday, Sep 8, to around 18:00 on Friday, Sep 12; it is composed of plenary talks and seven programme sections.

Along with the invited talks, there are also contributions by the participants in the form of contributed talks or posters, as decided by the chairs of the individual sections.

The plenary lectures will be in the Aula (Building 12). The programme in sections will be in Aula and the lecture rooms F1 (Building 06), G12 (Building 11) and M1 (Building 08).

2. General Information

About the conference The tradition of the international conference

Differential Geometry and its Applications goes back more than 43 years and the current DGA meeting is the 15th one in the series.

The conferences take place regularly at one of the Czech universities every three years. The previous two meetings were in Hradec Králové preceded by meetings in Brno in 2016, 2013 and 2010, Olomouc in 2007, Prague in 2004, Opava in 2001, Brno in 1998 and 1995, etc.

Social Programme

During the conference week three social events are planned: the Welcome Party, trips to various parts of South Moravia Region, and the Farewell Party.

Welcome Party, Sep 8, 2025, from 6pm till 11pm. It will take place at the Faculty of Social Studies, Masaryk University. Address: Joštova 218/10, Brno.

Farewell Party, Sep 12, 2025, from 6:30pm till 11pm. It will take place at the Old Brno Abbey of the St. Augustine Order. Address: Mendlovo nam. 1, Brno.

Conference trips (excursions), Sep 10, 2025

The excursions are fully covered in the conference fees, including the registered accompanying persons. Participants will be asked to fix the choice of one of the excursions during their registration at the desk. The individual excursions have limited capacity. Buses will depart on Sep 20 at 13pm (option B) and 13:15 (option A) from the bus stop “Sušilova”.

Option A) Pálava Trip includes a scenic hike through the picturesque Pálava landscape and wine tasting and dinner in Němčičky.

Option B) Pernštejn Trip includes excursion of the impressive Pernštejn Castle and a dinner in Doubravník.

Option C) Brno Tour is a guided tour through Brno which includes a visit of the underground cellars beneath the Zelný trh and dinner at the traditional Brno brewery restaurant.

3. Programme

Registration: during the welcome party and on Monday (8:30–9:00) in the room M4

Plenary Section

Invited Talks

Monday • 9:00-12:20 • Room: Aula

- *Frédéric Bourgeois* (9:00–9:50)
  Legendrian submanifolds, their homological invariants and their geography

Coffee break

- *Giuseppe Tinaglia* (10:30–11:20)
  The geometry of constant mean curvature surfaces in Euclidean space
- *Rod Gover* (11:30–12:20)
  Conformal submanifolds, invariants, geometric holography, and a big bang

Lunch (12:25–13:25)

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Section B

Geometric Structures and Representation Theory: Jan Slovák Birthday Session

Monday • 14:00–18:10 • Room: Aula

- *Peter Michor* (14:00–14:40)
  Unbalanced Riemannian Metric Transport and the Wasserstein-Ebin Metric
- *Vojtěch Žádník* (14:45–15:10)
  How to move along a trajectory

- *Josef Šilhan* (15:10–15:35)
  On a compatibility complex in conformal geometry

Coffee break

- *Michael Eastwood* (16:00–16:40)
  Calculus on complex projective space
- *Andreas Čap* (16:45–17:25)
  The Riemannian deformation sequence revisited
- *Vladimír Souček* (17:30–18:10)
  Strongly invariant differential operators on $Gr(3, 3)$

Section E
Poisson Geometry

Monday • 14:00–18:10 • Room: F1

- *Pedro Henrique Carvalho Silva* (14:00–14:40)
  Homological reduction of Courant algebroids
- *Cornelia Vizman* (14:50–15:30)
  Weighted loops, coadjoint orbits, and characters

Coffee break

- *Dan Aguero* (16:00–16:40)
  On the geometry of complex Poisson bivectors
- *Shizhuo Yu* (16:45–17:25)
  Configuration Poisson groupoids of flags
- *Alfonso Tortorella* (17:30–18:10)
  A rigidity result for coisotropic submanifolds in contact geometry

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Section A
Riemannian Geometry and Geometric Analysis

Monday • 14:00–18:15 • Room: G2

- *Makiko Tanaka* (14:00–14:40)
  Polars of compact Lie groups and antipodal sets
- *Naoya Ando* (14:45–15:25)
  Surfaces with flat normal connection in 4-dimensional space forms

Coffee break

- *Hiroyasu Satoh* (15:50–16:30)
  Conformal Vector Fields on Complex Hyperbolic Space
- *Jonas Martin Henkel* (16:35–17:05)
  The Laplace-Beltrami spectrum on Naturally Reductive Homogeneous Spaces
- *Diego Mojón-Álvarez* (17:10–17:40)
  Uniqueness of weighted Einstein manifolds in a conformal class
- *Mehmood Ur Rehman* (17:45–18:15)
  Primitive immersion of constant curvature of surfaces into flag manifolds

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Section B
Geometric Structures and Representation Theory

Tuesday • 9:00–12:20 • Room: Aula

- *Dennis The* (9:00–9:30)
  Geometry of $(3, 6)$-distributions: structure and models
- *Aleksandra Borówka* (9:30–10:00)
  Complex quaternionic manifolds

Coffee break

- *Pawel Nurowski* (10:30–11:10)
  deSitter space and G_2
- *Katharina Neusser* (11:15–11:45)
  Cone structures and conic connections
- *Zhangwen Guo* (11:50—12:20)
  Fefferman-type constructions from path geometries to almost Grassmann structures

Section C
Geometry and Physics
Tuesday • 9:00–12:20 • Room: F1

- *Marcella Palese* (9:00–9:30)
  Symmetry transformations of extremals and higher conserved quantities
- *Ekkehart Winterroth* (9:30–10:00)
  Variational cohomology and topological solitons in Yang–Mills–Chern–Simons theories

Coffee break

- *Yuichiro Sato* (10:30–11:10)
  Construction of vacuum solutions in general dimensions using almost abelian Lie groups
- *Wijnand Steneker* (11:15–11:45)
  Variationality of conformal geodesics in dimension 3
- *Giorgi Khimshiashvili* (11:50—12:20)
  Maxwell"s conjecture for collinear point charges

Section A
Riemannian Geometry and Geometric Analysis
Tuesday • 9:00–11:45 • Room: G2

- *Homare Tadano* (9:00–9:30)
  An improvement of the Myers theorem via m-Bakry–Émery Ricci curvature with ε-range
- *Genki Ishikawa* (9:30–10:00)
  Stability analysis for the pseudo-Riemannian geodesic flows of step-two nilpotent Lie groups

Coffee break

- *Hiroshi Iriyeh* (10:30–11:10)
  The intersection of two real flag manifolds in a complex flag manifold

- *Mario Julián Rodríguez Sánchez-Toca* (11:15–11:45)
  Curvature-adapted hypersurfaces in symmetric spaces of non-compact type

Lunch (12:25–13:25)

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Section B

Geometric Structures and Representation Theory

Tuesday • 13:30–14:00 • Room: Aula

- *Diego Artacho* (13:30–14:00)
  Generalised Spin Structures

Section C

Geometry and Physics

Tuesday • 13:30–14:00 • Room: F1

- *Jaroslaw Kopinski* (13:30–14:00)
  Conformal geometry of spacetimes with prescribed asymptotic behavior

Section D

Finsler Geometry

Tuesday • 13:30–14:00 • Room: G2

- *Qiaoling Xia* (13:30–14:00)
  On almost square Ricci solitons

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Poster Session

Tuesday • 14:00–15:00 • Room: M3

Hamza Benachour, Weighted flat translation surfaces in Minkowski 3-space with radial density
Martin Doležal, Cartan connection of 3-link snake robot model
Steven Greenwood, Lorenzian homogeneous structures with indecomposable holonomy
Chen-Hsu Chien, Dressing Field Method and Cartan Geometry
Elias Knack, Invariant Spinors on S^{15} as a Homogeneous Sphere
Hubert Kołcz, Lie Algebraic Structures in Quantum Error Correction for Measurement-Based Quantum Computing: A Poisson Geometric Approach to Prototype Validation
Mauro Mantegazza, Jets in Noncommutative Geometry
Abdelmalek Mohammed, Some geometric properties of the Newton transformations in space forms
Kinga Słowik, Basic Albanese maps of regular Riemannian foliations
Petr Vlachopulos, The Cheeger constant of curved tubes in space forms
Lenka Zalabová, Nilpotent algebras, control, and nonholonomic mechanisms

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Section B
Geometric Structures and Representation Theory

Tuesday • 15:00–17:50 • Room: Aula

- *Giulia Dileo* (15:00–15:30)
  Anti-quasi-Sasakian manifolds as transversely Kähler manifolds

Coffee break

- *Igor Zelenko* (16:00–16:40)
  Generalized Pseudo-Product structures and Finiteness of Type
- *Nicklas Day* (16:45–17:15)
  Rank 2 Distributions of Maximal Class: Harmonic Curvatures and Syzygies
- *Stefan Haller* (17:20–17:50)
  The eta invariant of $(2, 3, 5)$-distributions

Section C

Geometry and Physics

Tuesday • 15:00–17:50 • Room: F1

- *Timothy Moy* (15:00–15:30)
  Isomonodromic deformations and twistor geometry

Coffee break

- *Andrew Waldron* (16:00–16:40)
  Quantum Mechanics and Quantization
- *Hartwig Winterroth* (16:45–17:15)
  A constructive approach to generalized principal connections
- *Ioannis Chrysikos* (17:20–17:50)
  Decomposable solutions in eleven-dimensional supergravity

Section A

Riemannian Geometry and Geometric Analysis

Tuesday • 15:00–17:15 • Room: G2

- *Ángel Cidre Díaz* (15:00–15:30)
  Index of symmetry of 2-isotropy irreducible spaces

Coffee break

- *Ana Cristina Ferreira* (16:00–16:40)
  G_2^*-structures and their holonomy
- *Kyoji Sugimoto* (16:45–17:15)
  Antipodal sets of pseudo-Riemannian symmetric R-spaces

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Plenary Section

Invited Talks

Wednesday • 9:00-12:20 • Room: Aula

- *Jeffrey Case* (9:00–9:50)
  Invariants of conformal manifolds and their submanifolds

Coffee break

- *Chiara Esposito* (10:30–11:20)
  Global Homotopies for HKR Theorems in Differential Geometry
- *Anton Galaev* (11:30–12:20)
  Holonomy of K-contact sub-Riemannian manifolds

Lunch (12:25–13:25)

FREE AFTERNOON – EXCURSIONS

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SECTION B
Geometric Structures and Representation Theory

THURSDAY • 9:00–12:20 • ROOM: M1

- *Alexander Zuevsky* (9:00–9:30)
  Recent developments in cohomology methods associated with vertex algebras
- *Jarah Fluxman* (9:30–10:00)
  The Unitary Irreducible Representations of the canonical Lifshitz Groups and their central extensions

Coffee break

- *Boris Kruglikov* (10:30–11:10)
  Global relative differential invariants are finitely generated (or perhaps not?)
- *Omid Makhmali* (11:15–11:45)
  The Beltrami theorem in three-dimensional sub-Riemannian geometry
- *Zhixiang Wu* (11:50–12:20)
  On pseudotensor categories

Section E

Poisson Geometry

Thursday • 9:00–12:30 • Room: F1

- *Naoki Kimura* (9:00–9:30)
  Correspondence between Koszul-Vinberg structures and Poisson structures
- *Filip Moučka* (9:30–10:00)
  Beyond Poisson geometry: when a bivector field is symmetric

Coffee break

- *Tomoya Nakamura* (10:30–11:10)
  A generalization of Koszul-Vinberg manifolds
- *Martha Valentina Guarin Escudero* (11:15–11:45)
  Homotopy algebras associated with dg-manifolds
- *Chiara Esposito* (11:50–12:30)
  Equivariant formality and reduction

Section A

Riemannian Geometry and Geometric Analysis

Thursday • 9:00–12:20 • Room: G2

- *Alex Colling* (9:00–9:30)
  Quasi-Einstein manifolds and extremal horizons
- *Rosalia Rodriguez-Gigirey Villar* (9:30–10:00)
  Ricci solitons on four-dimensional Lorentzian Lie groups

Coffee break

- *Rui Albuquerque* (10:30–11:10)
  Geometry of G_2 and $Spin(7)$ twistor space
- *Tomasz Zawadzki* (11:15–11:45)
  Variations of metric that preserve a Riemannian submersion and geometry of its fibers
- *Mohammad Aamir Qayyoom* (11:50–12:20)
  On warped product pointwise semi-slant submanifolds of locally golden Riemannian manifolds

Lunch (12:25–13:25)

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Section B

Geometric Structures and Representation Theory

Thursday • 14:00–15:50 • Room: M1

- *Ilka Agricola* (14:00–14:40)
  A new approach to the classification of almost contact metric manifolds via intrinsic endomorphisms
- *Malte Schulz* (14:45–15:15)
  Representation theory of curvature tensors and applications to GR
- *Efrain Basurto Arzate* (15:20–15:50)
  Prescribing the curvature tensor of torsion-free connections

Section G

Geometry of Information

Thursday • 14:00–15:50 • Room: G2

- *Daisuke Tarama* (14:00–14:30)
  Geodesic flows of Lie groups associated to statistical transformation models
- *Subrahamanian Moosath Karickamadom Sreekumara* (14:35–15:05)
  Geodesic-Based Interpolation using Gaussian Mixture Models
- *Dmitry Alekseevskiy* (15:10–15:50)
  Functional Architecture of Early Vision

Section F

Quantum Geometry

Thursday • 14:00–15:50 • Room: F1

- *Rita Fioresi* (14:00–14:40)
  Reductions of Quantum Principal Bundles
- *Henrik Winther* (14:45–15:15)
  Higher order connections in noncommutative geometry
- *Alessandro Carotenuto* (15:20–15:50)
  Convex orders and quantum tangent spaces

Coffee break

Special section

Public lecture

Thursday • 17:00-18:00 • Room: M1

- *Jean-Pierre Bourguignon* (17:00–18:00)
  Geometry and Physics: a Long History of Mutual Inspiration and Missed Opportunities (online streaming)

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Plenary Section

Invited Talks

Friday • 9:00-12:20 • Room: Aula

- *Alekseev* (9:00–9:50)
  Symplectic structures and Virasoro actions on infinite dimensional Teichmüller spaces

Coffee break

- *Réamonn Ó Buachalla* (10:30–11:20)
  Quantum exterior algebras and torsion-free bimodule connections
- *Uwe Semmelmann* (11:30–12:20)
  Integrability of infinitesimal Einstein deformations on Kähler manifolds and symmetric spaces

Lunch (12:25–13:25)

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Section B
Geometric Structures and Representation Theory

Friday • 14:00–18:05 • Room: M1

- *Boris Doubrov* (14:00–14:40)
  Cartan connections for scalar ODEs under point and fiber-preserving transformations
- *Andrey Krutov* (14:50–15:20)
  Clifford algebra analogue of Cartan's theorem for symmetric pairs

Coffee break

- *Arman Taghavi-Chabert* (15:50–16:20)
  Almost complex structures in projective and conformal geometries
- *Jan Gregorovič* (16:25–16:55)
  Models of 2-nondegerate CR hypersurfaces
- *Dario Di Pinto* (17:00–17:30)
  Anti-quasi-Sasakian manifolds: homogeneous structures and topological constraints
- *Svatopluk Krýsl* (17:35–18:05)
  Lefschetz map on symplectic spinor-valued forms

Section C
Geometry and Physics

Friday • 14:00–18:05 • Room: F1

- *Ozgur Kelekci* (14:00–14:30)
  Effect of T-duality with Torsion on Killing-Yano Forms
- *Evgeny Ferapontov* (14:40–15:20)
  Involutive scroll structures on solutions of 4D dispersionless integrable hierarchies

Coffee break

- *Owen Dearricott* (15:50–16:20)
  Edge-cone singularities on anti-self-dual Einstein spaces in dimension four and 3-Sasakian spaces in dimension seven
- *Henrik Naujoks* (16:25–16:55)
  Higher-power Harmonic Maps, Instantons and Yang-Mills Theory
- *Can Görmez* (17:00–17:30)
  Seven Sphere Quantization
- *Michal Marvan* (17:35–18:05)
  Voss surfaces in sine-Gordon hierarchies

Section F
Quantum Geometry

Friday • 14:00–17:30 • Room: G2

- *Keegan Flood* (14:00–14:30)
  Constructing Canonical Calculi
- *Fredy Díaz García* (14:40–15:10)
  The Dolbeault-Dirac operator for the irreducible quantum flag manifolds

Coffee break

- *Arnab Kumar Bhattacharjee* (15:50–16:20)
  q-deformation of Kostant differential for A-series irreducible quantum flag manifolds
- *Antonio Del Donno* (16:25–16:55)
  Principal bundles and differential structures in noncommutative geometry
- *Julius Benner* (17:00–17:30)
  Codifferential calculi and quantum homogeneous spaces

4. Abstracts

Plenary Lectures

Anton Alekseev

Symplectic structures and Virasoro actions on infinite dimensional Teichmüller spaces

FRIDAY • 9:00–9:50 • ROOM: AULA

A hyperbolic 0-metric on a surface with boundary is a hyperbolic metric on its interior, exhibiting the boundary behavior of the standard metric on the Poincaré disk. In this talk, we consider infinite-dimensional Teichmüller spaces of hyperbolic 0-metrics on oriented surfaces with boundary, up to diffeomorphisms fixing the boundary and homotopic to the identity. We explain that these spaces have natural symplectic structures, and that they carry Hamiltonian actions of the universal cover of the group of diffeomorphisms of the boundary. For a surface being the Poincaré disk, the corresponding Teichmüller space can be identified with the first exceptional coadjoint orbit of the Virasoro algebra. If time permits, we will speculate that Teichmüller spaces associated to the punctured disk correspond to other exceptional orbits. The talk is based on the joint work with E. Meinrenken (see arXiv:2401.03029), and on a work in progress with R. Dalipi and S. Shatashvili.

Frédéric Bourgeois

Legendrian submanifolds, their homological invariants and their geography

MONDAY • 9:00–9:50 • ROOM: AULA

Legendrian submanifolds are central objects in contact geometry. Their study is analogous to a generalization to higher dimensions of a refined version of knot theory in dimension 3. It is therefore crucial to use (homological) invariants in order to distinguish their isotopy classes. Those can be constructed using holomorphic curves, generating families or sheaf theory. The properties of these invariants will be illustrated with our current knowledge about their geography. The most recent results were obtained jointly with Salammbo Connolly.

Jeffrey Case

Invariants of conformal manifolds and their submanifolds

WEDNESDAY • 9:00–9:50 • ROOM: AULA

A fundamental objective in conformal geometry is to classify all invariants of a conformal manifolds and of its immersed submanifolds. Major steps in this direction were made by Fefferman and Graham, who systematically produced conformal invariants via their ambient space construction, and by Alexakis, who proved a decomposition theorem for the space of integral conformal invariants. In this talk I will focus on a refinement of Alexakis' result and a generalization of these results to submanifolds of conformal manifolds. First, I will discuss a procedure for explicitly computing integral conformal invariants at Einstein manifolds; this also computes global invariants of Poincare-Einstein manifolds. As an application, I will exhibit the first example of a scalar conformal invariant of weight $-n$ which integrates to zero on every compact n-manifold. Second, I will describe an extrinsic analogue of the Fefferman-Graham ambient space and use it to explicitly compute integral conformal invariants of minimal submanifolds of Einstein manifolds. As an application, I will give an explicit formula for the Euler characteristic of a properly embedded minimal submanifold of an Einstein manifolds, with a proof that bypasses the (still conjectural) Alexakis-type decomposition theorem.

Chiara Esposito

Global Homotopies for HKR Theorems in Differential Geometry

Wednesday • 10:30–11:20 • Room: Aula

The classical Hochschild-Kostant-Rosenberg (HKR) Theorem in Differential Geometry gives a quasi-isomorphism between the differentiable Hochschild complex of the algebra of smooth functions on a manifold and the multivector fields on it. The HKR morphism plays an important role in deformation theory, as it allows us to study existence and classification of deformations of associative algebras. Even though the HKR Theorem has been known for a long time, available proofs are often of a local nature and are hard to generalize to more structured situations. We will present a novel proof for the HKR Theorem using a symbol calculus and a van Est-double complex. This strategy will allow for an explicit global homotopy and can easily be adapted to various situations.

Anton Galaev

Holonomy of K-contact sub-Riemannian manifolds

Wednesday • 11:30–12:20 • Room: Aula

Given a contact sub-Riemannian manifold (M, θ, g), where θ is a contact form on M, and g is a metric on the contact distribution $D = \ker \theta$, there is the Schouten connection, which defines parallel transport of vectors tangent to D along curves tangent to D. The holonomy group of this connection is called the horizontal holonomy group. The adapted connection is an extension of the horizontal connection to a connection on TM. I will show that in the K-contact case (which means that the Reeb vector field is a Killing one), the holonomy of the adapted connection is the holonomy of some Riemannian manifold, and the horizontal holonomy either coincides with the holonomy of the adapted connection, or it is a codimension-one normal subgroup of the later group. I will discuss the question of existence of parallel horizontal spinors, examples, and consequences.

Rod Gover

Conformal submanifolds, invariants, geometric holography, and a big bang

Monday • 11:30–12:20 • Room: Aula

We review, from scratch, the problem of developing an invariant way to treat conformal hypersurfaces (meaning submanifolds of codimension 1) and construct their invariants. In this context, we review the idea of geometric holography, which involves capturing the data of the hypersurface in the solution of a canonically associated PDE boundary type problem. This leads to the conformal Einstein condition, conformal tractors, and a perspective on Fefferman and Graham's Poincare-Einstein manifolds as a basic prototype for the holographic idea. The latter are linked naturally to a singular Yamabe problem that gives a holographic approach to conformal submanifolds and a notion of higher Willmore invariants, higher fundamental forms, and objects that generalise extrinsically the GJMS operators and their Q-curvatures. Finally we explain what this has to do with a class of space-time initial singularities.

Réamonn Ó Buachalla

Quantum exterior algebras and torsion-free bimodule connections

Friday • 11:30–11:20 • Room: Aula

Noncommutative geometry explores algebras that, while noncommutative, often mirror the behavior of the algebra of smooth functions on a differential manifold. A key objective is to construct a differential graded algebra over such a noncommutative algebra—serving as an analogue of the classical de Rham complex. A central class of examples comes from Drinfeld–Jimbo quantum groups, which are q-deformations of the coordinate algebras of compact Lie groups originating in the study of integrable systems. Among these, quantum flag manifolds—quantum homogeneous spaces that q-deform classical flag manifolds—provide particularly fruitful ground for developing noncommutative differential geometry. In this talk, we demonstrate that the q-deformed de Rham complexes of quantum flag manifolds can be described using quantum exterior algebras. Here, the generalized flip map is derived from a torsion-free bimodule connection on the space of first-order differential forms. (Joint work with Alessandro Carotenuto and Junaid Razzaq)

Uwe Semmelmann

Integrability of infinitesimal Einstein deformations on Kähler manifolds and symmetric spaces

Friday • 11:30–12:20 • Room: Aula

Infinitesimal Einstein deformations are solutions of the linearised Einstein equation. They can be considered as potential tangent vectors to curves of Einstein metrics. An important question is to decide for a given infinitesimal Einstein deformations whether it is integrable, i.e. indeed tangent to such a curve. In 1981 Koiso introduced an obstruction against integrability of infinitesimal Einstein deformations. However, so far the obstruction was computed only in very few cases. In my talk I will present a new formulation of Koiso's obstruction which makes it more accessible to calculations, in particular on Kähler manifolds and symmetric spaces. I will demonstrate this for Kähler-Einstein metrics of negative scalar curvature and the symmetric metric on the complex Grassmannians. For the Grassmannians it turns out that in half of the cases all infinitesimal Einstein deformations are obstructed, i.e. the metric is isolated in the space of Einstein metrics.

My talk is based on joint work with Paul-Andi Nagy and a follow-up project with Stuart Hall and Paul Schwahn.

Giuseppe Tinaglia

The geometry of constant mean curvature surfaces in Euclidean space

Monday • 10:30–11:20 • Room: Aula

I will begin by reviewing classical geometric properties of minimal and constant mean curvature surfaces in $\mathbb{R}^3$. I will then talk about several more recent results for surfaces embedded in $\mathbb{R}^3$ with constant mean curvature, such as curvature and radius estimates for simply-connected surfaces. I will show applications of such estimates including a characterisation of the round sphere as the only simply-connected complete surface embedded in $\mathbb{R}^3$ with constant mean curvature and area estimates for compact surfaces embedded in a flat torus with constant mean curvature and finite genus. This is joint work with Meeks.

Public Lecture

Jean-Pierre Bourguignon

Geometry and Physics: a Long History of Mutual Inspiration and Missed Opportunities

Thursday • 17:00–18:00 • Room: M1

Geometry and Physics have been interacting in a very positive way for centuries but probably this never happened with the intensity it enjoyed in the 20th century and continues to enjoy it in the 21st.

Several major parts of Theoretical Physics cannot be really separated from major developments in Mathematics: this is the case for General Relativity, for the Dirac Operator in Quantum Physics, for the development of String Theory and Calabi-Yau metrics, giving important spaces for stimulating very significant new frontiers for Differential Geometry.

The purpose of the lecture is to highlight some exceptional moments in these interactions, stressing the variety of situations and of processes by which this could happen with their ups and downs, as some opportunities were first missed. This will also allow to show that it takes time for some concepts to be recognised as fundamental, as well as the role played by some leading mathematicians and physicists in these developments.

A. Riemannian Geometry and Geometric Analysis

Rui Albuquerque

Geometry of G_2 and $Spin(7)$ twistor space

Thursday • 10:30–11:10 • Room: G2

We start by showing the existence of a fundamental differential system on the tangent bundle of any given smooth manifold. Indeed one only needs a p-form and an affine connection. This has many applications and further consequences in Riemannian geometry, say with an orientation-form. The construction of natural G_2 and $Spin(7)$ structures on unit shere tangent bundles and tangent bundles, respectively, are two of those applications.

Naoya Ando

Surfaces with flat normal connection in 4-dimensional space forms

MONDAY • 14:45–15:25 • ROOM: G2

The purpose of this talk is to introduce results obtained in "N. Ando and R. Hatanaka, Surfaces with flat normal connection in 4-dimensional space forms, preprint, arXiv:2501.15780". Let N be a 4-dimensional Riemannian space form with constant sectional curvature L_0. Let M be a Riemann surface and $F : M \longrightarrow N$ a conformal immersion of M into N. If F has a parallel normal vector field, then the second fundamental form σ satisfies the linearly dependent condition and then the normal connection $\nabla^{\perp}$ of F is flat. Suppose that the curvature K of the induced metric g by F is nowhere equal to L_0. Then F has a parallel normal vector field if and only if σ satisfies the linearly dependent condition. On the other hand, if we suppose $K = L_0$, then the linearly dependent condition of σ does not necessarily mean the existence of parallel normal vector fields. Based on the rewrites of the equations of Gauss, Codazzi and Ricci in terms of the curvature tensors of the two-fold exterior powers of the pull-back bundles on surfaces, we obtain a generic characterization of surfaces in N with flat normal conne ction and $K = L_0$ such that the second fundamental forms do not satisfy the linearly dependent condition. In the case where N is a 4-dimensional Lorentzian or neutral space form, for space-like or time-like surfaces in N, we can have similar discussions and obtain analogous results.

Hamza Benachour

Weighted flat translation surfaces in Minkowski 3-space with radial density

TUESDAY • 14:00–15:00 • POSTER

In this work, we investigate flat translation surfaces in the 3-dimensional Minkowski space endowed with a radial density. We provide a classification of such surfaces, emphasizing the interplay between the geometry induced by the Minkowski metric and the weighted measure determined by the density. Our results extend previous studies on translation surfaces in classical spaces to the weighted Lorentzian setting.

Ángel Cidre Díaz

Index of symmetry of 2-isotropy irreducible spaces

Tuesday • 15:00–15:30 • Room: G2

Symmetric spaces are among the best-understood classes of Riemannian manifolds and can be seen as a natural generalization of space forms. The index of symmetry is a geometric invariant that, in a certain sense, measures how far a Riemannian metric is from being that of a symmetric space, since it attains its maximum value (equal to the dimension of the manifold) if and only if the manifold is a locally symmetric space. The index and co-index of symmetry have been mainly studied in the context of compact, irreducible, and simply connected homogeneous Riemannian manifolds, where several general structural results have been obtained. Among compact homogeneous spaces, it is known that when the isotropy representation is irreducible, the index of symmetry is either zero or maximal. A particular case of such spaces is given by symmetric spaces, when viewed as quotients by the identity component of their isometry group. Thus, studying the index of symmetry in isotropy irreducible homogeneous spaces essentially reduces to the well-known theory of symmetric pairs. This naturally raises the question of what happens when the space is no longer isotropy irreducible. In this talk, we explore the simplest nontrivial case: when the isotropy representation decomposes into exactly two irreducible modules. These spaces are known as 2-isotropy irreducible spaces, providing a natural next step beyond the classical isotropy irreducible case. This is joint work with Carlos Enrique Olmos (Universidad Nacional de Córdoba) and Alberto Rodríguez Vázquez (Université Libre de Bruxelles).

Alex Colling

Quasi-Einstein manifolds and extremal horizons

Thursday • 9:00–9:30 • Room: G2

A quasi-Einstein manifold is a Riemannian manifold equipped with a vector field satisfying a system of equations generalising the Einstein equations. We prove that a class of compact quasi-Einstein manifolds must admit a Killing vector field, extending a rigidity theorem obtained by Dunajski and Lucietti. In two dimensions, we exclude non-trivial solutions on higher genus surfaces and complete the classification of compact quasi-Einstein surfaces in this class. In an important special case, quasi-Einstein manifolds are related to extremal horizons in General Relativity. In this case one can associate a spacetime, the near-horizon geometry, satisfying the (Lorentzian) Einstein equations to a quasi-Einstein manifold. We discuss the implications of the rigidity results for the near-horizon geometry.

Ana Cristina Ferreira

G_2^*-structures and their holonomy

Tuesday • 16:00–16:40 • Room: G2

In this talk, we will start with a brief overview on the topic of holonomy groups in pseudo-Riemannian geometry. We will then focus on the non-compact exceptional Lie group G2* and discuss holonomy subgroups in the presence of a left-invariant structure. Joint work with Viviana del Barco (U. Campinas) and Ines Kath (U. Greifswalf).

Steven Greenwood

Lorenzian homogeneous structures with indecomposable holonomy

Tuesday • 14:00–15:00 • Poster

For a Lorentzian homogeneous space, we study how algebraic conditions on the isotropy group affect the geometry and curvature of the homogeneous space. More specifically, we prove that a Lorentzian locally homogeneous space is locally isometric to a plane wave if it admits an Ambrose–Singer connection with indecomposable, non-irreducible holonomy. This generalises several existing results that require a certain algebraic type of the torsion of the Ambrose–Singer connection and moreover is in analogy to the fact that a Lorentzian homogeneous space with irreducible isotropy has constant sectional curvature. In addition, we prove results about Lorentzian connections with parallel torsion and for 2-symmetric connections.

Jonas Martin Henkel

The Laplace-Beltrami spectrum on Naturally Reductive Homogeneous Spaces

Monday • 16:35–17:05 • Room: G2

Calculating the spectrum of the Laplace-Beltrami operator is a fundamental problem in geometric analysis, explicitly solvable mainly for normal homogeneous spaces. This talk addresses the broader class of compact naturally reductive homogeneous spaces. We present a Freudenthal-type formula for the Laplacian's spectrum in this setting. This framework provides a powerful tool to analyze how the spectrum behaves under metric deformations, particularly for canonical variations of normal homogeneous metrics. Applications will demonstrate how these methods, particularly when combined with refined branching techniques, lead towards an understanding of the spectrum for 3-(α, δ)-Sasaki manifolds. This is joint work with Ilka Agricola.

Hiroshi Iriyeh

The intersection of two real flag manifolds in a complex flag manifold

Tuesday • 10:30–11:10 • Room: G2

An orbit of the adjoint representation of a compact connected semisimple Lie group G admits a G-invariant Kähler structure, and it is called a complex flag manifold. In this talk, we first give the notion of antipodal set of a complex flag manifold and show that a maximal antipodal set of a complex flag manifold M is given as an orbit of a Weyl group of G. Next, we consider a symmetric pair (G, K) of compact type. An orbit of the linear isotropy representation of K is called a real flag manifold or an R-space, which can be embedded as a totally geodesic Lagrangian submanifold of M. We give a necessary and sufficient condition for two real flag manifolds, which are not necessarily congruent, in a complex flag manifold to intersect transversally in terms of the symmetric triad. Then we see that the discrete intersection is antipodal. This talk is based on a joint work with Osamu Ikawa, Takayuki Okuda, Takashi Sakai and Hiroyuki Tasaki.

Genki Ishikawa

Stability analysis for the pseudo-Riemannian geodesic flows of step-two nilpotent Lie groups

Tuesday • 9:30–10:00 • Room: G2

This talk deals with the geodesic flows of step-two nilpotent Lie groups equipped with a left-invariant pseudo-Riemannian metric. The left-invariant geodesic flow of a Lie group can be formulated as the Lie-Poisson equation on the dual space of its Lie algebra. In particular, in the case of step-two nilpotent Lie groups, the Lie-Poisson equation can be described in terms of the so-called j-mapping, a linear operator associated to the step-two nilpotent Lie algebras equipped with the induced scalar product. In this talk, the stability of equilibrium points for the Hamilton equation is determined in terms of their Williamson types. This talk is based on a joint work with Daisuke Tarama (Ritsumeikan Univ.).

Abdelmalek Mohammed

Some geometric properties of the Newton transformations in space forms

TUESDAY • 14:00–15:00 • POSTER

Let M an n-dimensional closed oriented hypersurface in an oriented space form M^{n+1}. Denoting by A the shape operator of the second fundamental form with respect to the unit vector field N normal to M in M^{n+1}. Associate to A, we define the Newton transformations as : $T_0 = I$, $T_k = S_k.I - A.T_{k-1}$ where S_k are the elementary symmetric functions. In this work, we give some properties of the Newton transformations. We use them to prove some rigidity results for hypersurfaces embedded in space forms.

Diego Mojón-Álvarez

Uniqueness of weighted Einstein manifolds in a conformal class

MONDAY • 17:10–17:40 • ROOM: G2

A classical problem in Riemannian geometry is that of determining the manifolds admitting several Einstein representatives of the same conformal class. In the context of smooth metric measure spaces (Riemannian manifolds endowed with a weighted measure given by a smooth density function), the geometric objects of interest are modified so that they incorporate information on the density. This process gives rise to weighted Einstein manifolds and weighted conformal classes.

We discuss smooth metric measure spaces admitting two weighted Einstein representatives of the same weighted conformal class, completing partial results in literature [2,3]. First, we describe the local geometries of such manifolds in terms of certain Einstein and quasi-Einstein warped products, as well as the form of the density function. Secondly, a global classification result is obtained when one of the underlying metrics is complete, showing that either it is a weighted analogue of a space form, a certain kind of Einstein warped product, or it belongs to a specific family of quasi-Einstein warped products. As a consequence, in the compact case, it must be a weighted sphere.

References:

[1] M. Brozos-Vázquez, E. García-Río and D. Mojón-Álvarez; Conformally weighted Einstein manifolds: the uniqueness problem. arXiv:2504.07860 [math.DG].

[2] J. S. Case; The weighted σ_k-curvature of a smooth metric measure space. *Pacific. J. Math.* **299** (2) (2019), 339–399.

[3] J. S. Case; A Yamabe-type problem on smooth metric measure spaces. *J. Differential Geom.*, **101** (3) (2015), 467–505.

Mohammad Aamir Qayyoom

On warped product pointwise semi-slant submanifolds of locally golden Riemannian manifolds

Thursday • 11:50–12:20 • Room: G2

In this work, we present the concept of pointwise semi-slant submanifolds of locally golden Riemannian manifolds . We use this idea to study the geometry of point-wise semi-slant submanifolds with warped products. We prove a characteristic theorem for such submanifolds and give several non-trivial examples. In terms of the warping function, an inequality is established for the squared norm of second fundamental form.

Mehmood Ur Rehman

Primitive immersion of constant curvature of surfaces into flag manifolds

Monday • 17:45–18:15 • Room: G2

Following the seminal result by E. Calabi which establishes the local classification of complex submanifolds with constant holomorphic sectional curvature in complex space forms, several researchers have investigated minimal immersions with constant curvature of Riemann surfaces into symmetric spaces. For isometric immersions, minimality is equivalent to harmonicity, hence the rich theory of harmonic maps becomes here highly relevant. In recent years, the method of harmonic maps has been intensively used to classify such minimal immersions. There exists a well-established theory of twistor constructions of harmonic maps from Riemann surfaces into symmetric spaces. An important class of twistor lifts is that of primitive maps into k-symmetric spaces G/K. For $k > 2$, primitive maps are harmonic with respect to all G-invariant metrics. Thus, a natural problem arising from these observations is to classify primitive immersions of constant curvature of Riemann surfaces into k-symmetric spaces, when these are equipped with G-invariant metrics. In this talk, I address this problem. This is a joint work with Rui Pacheco. References R. Pacheco and M. U. Rehman, Primitive immersions of constant curvature of the two-sphere into flag manifolds, arXiv:2502.15502 [math.DG]. R. Pacheco and M. U. Rehman, Classification of primitive immersions of constant curvature into flag manifolds, arXiv:2503.08490 [math.DG]

Rosalia Rodriguez-Gigirey Villar

Ricci solitons on four-dimensional Lorentzian Lie groups

THURSDAY • 9:30–10:00 • ROOM: G2

(Joint work with Eduardo Garcia-Rio and Ramon Vazquez-Lorenzo) Ricci solitons, being self-similar solutions of the Ricci flow are natural generalizations of Einstein metrics. Although a general classification is not available (even in low dimensions), Riemannian Ricci solitons are well-understood in the Riemannian homogeneous cathegory. Appart from rigid gradient Ricci solitons, they reduce to algebraic Ricci solitons, which are realized on some solvable Lie groups. In this talk, we describe four-dimensional Lorentzian algebraic Ricci solitons. In sharp contrast with the Riemannian situation, any connected and simply connected four-dimensional Lie group admits a left-invariant Lorentz metric which is a Ricci soliton [3]. Moreover, non-Einstein compact Lorentzian Ricci solitons are obtained from some left-invariant Ricci solitons on almost Abelian Lie groups [1, 2].

References

[1] M. Brozos-Vazquez, G. Calvaruso, E. Garcia-Rio, and S. Gavino-Fernandez, Three-dimensional Lorentzian homogeneous Ricci solitons, *Israel J. Math.* **188** (2012), 385–403. Corrigendum *Israel J. Math.* **255** (2023), 975–984.

[2] M. Ferreiro-Subrido, E. Garcia-Rio, and R. Vazquez-Lorenzo, Ricci solitons on four-dimensional Lorentzian Lie groups, *Anal. Math. Phys.* **12** (2022), Paper No. 61, 35 pp.

[3] E. Garcia-Rio, R. Rodriguez-Gigirey, and R. Vazquez-Lorenzo, Four-dimensional Lorentzian algebraic Ricci solitons, to appear.

Mario Julián Rodríguez Sánchez-Toca

Curvature-adapted hypersurfaces in symmetric spaces of non-compact type

TUESDAY • 11:15–11:45 • ROOM: G2

In Riemannian Geometry, two of the most important operators when studying submanifolds are the shape operator and the Jacobi operator. A hypersurface is said to be curvature-adapted precisely when these two operators have a nice behavior between them, that is, when they diagonalize simultaneously. In this talk we will investigate this property in the presence of symmetry. More precisely, we will provide the classification of curvature-adapted homogeneous hypersurfaces in symmetric spaces of non-compact type.

Hiroyasu Satoh

Conformal Vector Fields on Complex Hyperbolic Space

MONDAY • 15:50–16:30 • ROOM: G2

We prove a conformal rigidity theorem for complex hyperbolic space $\mathbb{C}H^n$ ($n \geq 2$): every conformal vector field is Killing, so the full conformal transformation group coincides with $\mathrm{PU}(n, 1)$. This settles a long-standing open question and contrasts sharply with the real hyperbolic case, where an $(n+1)$-dimensional family of non-Killing conformal fields exists. Our approach combines the Damek-Ricci solvable model with an analytic study of the conformal Killing equation. Writing the equation in a left-invariant frame yields an over-determined first-order PDE system for the potential ρ; weighted harmonic analysis, together with a Cauchy–Riemann-type decomposition forces all higher-order coefficients to vanish, giving $\rho \equiv 0$. The proof is dimension-free and applies uniformly to all $n \geq 2$. The theorem provides the first non-compact Kähler-Einstein analogue of the classical Lichnerowicz rigidity theorem, offering a new instance where negative curvature enforces complete conformal rigidity. Immediate consequences include the non-existence of non-trivial Yamabe or Ricci solitons self-similar to $\mathbb{C}H^n$. We also outline prospective extensions to quaternionic and Cayley hyperbolic spaces and propose a conjecture asserting conformal rigidity for all Damek-Ricci harmonic manifolds. This is joint work with Hemangi M. Shah (Harish-Chandra Research Institute, India), based on arXiv:2506.09710. The talk will survey the geometric background, present the key analytic steps, and place the result within the broader programme aiming to understand conformal symmetries on rank-one symmetric and harmonic spaces.

Kinga Słowik

Basic Albanese maps of regular Riemannian foliations

TUESDAY • 14:00–15:00 • POSTER

For a compact orientable manifold integrating suitable chosen 1-forms representing a basis of the first cohomology group of the manifold one defines a map into the torus of the dimension equal to the first Betti number of the manifold. This mapping is called the Albanese or Abel—Jacobi map. It has proved to be very useful in the study of geometry and topology of compact manifolds or varieties. We consider a generalization of this concept to manifolds with regular foliations. In this case in the classical definition we can use basic 1-forms as the first basic cohomology group injects into the first cohomology group of the foliated manifold. For Riemannian foliated manifolds, we study the interplay between the dimension of leaves and of their closures. and the first basic Betti number as well as the first Betti number of the manifold. Moreover, we investigate the influence of the defined Albanese mapping on the properties of the singular Riemannian foliation by leaf closures.

Kyoji Sugimoto

Antipodal sets of pseudo-Riemannian symmetric R-spaces

Tuesday • 16:45–17:15 • Room: G2

The notion of pseudo-Riemannian symmetric R-spaces was introduced by H. Naitoh as a generalization of the notion of symmetric R-spaces in 1984. I will show that a maximal antipodal set of the pseudo-Riemannian symmetric R-space associated with a semisimple symmetric graded Lie algebra can be obtained as an orbit of a Weyl group.

Homare Tadano

An improvement of the Myers theorem via m-Bakry–Émery Ricci curvature with ε-range

Tuesday • 9:00–9:30 • Room: G2

By using conjugate and disconjugate theorems for second-order linear differential equations, we establish an improvement of the Myers theorem for complete Riemannian manifolds via m-Bakry–Émery Ricci curvature with ε-range. In contrast to the classical theorem of S.B. Myers (Duke Math. J. **8** (1941), 401–404), our result does not always require nonnegativity of the m-Bakry–Émery Ricci curvature in the whole manifold and is new even when the m-Bakry–Émery Ricci curvature is reduced to the Ricci curvature.

Makiko Tanaka

Polars of compact Lie groups and antipodal sets

Monday • 14:00–14:40 • Room: G2

A polar of a compact Riemannian symmetric space with a base point o is a connected component of the fixed point set of the symmetry s_o at o. A compact Lie group G is a Riemannian symmetric space with respect to a bi-invariant Riemannian metric. The symmetry s_g at $g \in G$ is given by $s_g(h) = gh^{-1}g\,(h \in G)$. It allows us to define the symmetries naturally on non-connected compact Lie groups. A subset S of a compact Riemannian symmetric space M is called an antipodal set if $s_x(y) = y$ holds for any $x, y \in S$. The maximum of the cardinalities of antipodal sets of M, which is called the two-number of M, is deeply related to the topology of M. A compact connected irreducible Riemannian symmetric space M is realized as a polar of a certain compact Lie group, which is not necessarily connected. This fact is useful when we classify maximal antipodal sets of M. In this talk, a realization of compact connected irreducible Riemannian symmetric spaces as polars of compact Lie groups is explained. This talk is based on joint work with Hiroyuki Tasaki.

Tomasz Zawadzki

Variations of metric that preserve a Riemannian submersion and geometry of its fibers

THURSDAY • 11:15–11:45 • ROOM: G2

On the domain of a Riemannian submersion, we consider variations (i.e., smooth one-parameter families) of Riemannian metrics, for which the submersion is Riemannian and which all keep the metric induced on its fibers fixed. In particular, we vary the horizontal distribution of the submersion, while rescaling the metric on it to keep the submersion Riemannian. We obtain a formula for the variation of the second fundamental form of the fibers with respect to such changes of metric. We find a choice of parameters defining the variations, that allows to easily formulate the necessary and sufficient conditions for preserving particular geometry of the fibers, i.e., keeping them totally geodesic, totally umbilical, or minimal. These conditions are related to the existence of Killing, conformal Killing and divergence-free vector fields on the fibers. We find conditions for metric to be a critical point of integrated squared norms of the mean curvature and the second fundamental form of the fibers, with respect to the considered variations, and prove that at all critical points of these functionals the second variation is non-negative. We also examine variations of sectional curvatures of planes defined by the horizontal lifts of vectors from the image of the submersion. The talk is based on the preprint: http://arxiv.org/abs/2412.00969

Ilka Agricola

A new approach to the classification of almost contact metric manifolds via intrinsic endomorphisms

THURSDAY • 14:00–14:40 • ROOM: M1

In 1990, D. Chinea and C. Gonzalez gave a classification of almost contact metric manifolds into 212 classes, based on the behaviour of the covariant derivative of the fundamental 2-form. This large number makes it difficult to deal with this class of manifolds. We propose a new approach to almost contact metric manifolds by introducing two intrinsic endomorphisms S and h, which bear their name from the fact that they are, basically, the entities appearing in the intrinsic torsion. We present a new classification scheme for them by providing a simple flowchart based on algebraic conditions involving S and h, which then naturally leads to a regrouping of the Chinea-Gonzalez classes, and, in each step, to a further refinement, eventually ending in the single classes. This method allows a more natural exposition and derivation of both known and new results, like a new characterization of almost contact metric manifolds admitting a characteristic connection in terms of intrinsic endomorphisms. We also describe in detail the remarkable (and still very large) subclass of H-parallel almost contact manifolds. This is joint work with Dario Di Pinto, Giulia Dileo, and Marius Kuhrt.

Diego Artacho

Generalised Spin Structures

TUESDAY • 13:30–14:00 • ROOM: AULA

The structure group of an oriented Riemannian manifold is $SO(n)$. A spin structure is a further lift of this group to its double cover, $Spin(n)$, which is simply connected for $n > 2$. These structures come equipped with a natural complex vector bundle, whose sections—spinors—carry rich geometric information about the manifold. However, not all manifolds admit a spin structure. In this talk, we will explore $spin^r$ structures, where r is a natural number. The case $r = 1$ recovers classical spin structures, while $r = 2$ and $r = 3$ -— corresponding to the $spin^c$ and $spin^h$ structures—have played central roles in geometry and topology over the past thirty years. Like spin structures, these generalisations naturally induce associated spinor bundles whose sections encode significant geometric information. Crucially, every oriented Riemannian manifold admits a *spin*^{r} structure for some r, extending the reach of spin geometry far beyond the classical setting.

Efrain Basurto Arzate

Prescribing the curvature tensor of torsion-free connections

Thursday • 15:20–15:50 • Room: M1

We consider the problem of when an algebraic curvature map can geometrically be realized as the action of the parallel transport map on the curvature tensor of a torsion-free connection. In the analytic category, this boils down to solving a concrete singular initial value problem, which can be achieved by means of a suitable power series ansatz. Some integrability conditions about the space of solutions of this initial value problem are presented. Finally, as an illustrative class of examples, we explicitly describe these curvature maps for normal homogeneous spaces.

Aleksandra Borówka

Complex quaternionic manifolds

Tuesday • 9:30–10:00 • Room: Aula

Complex quaternionic manifolds are quaternionic manifolds with distinguished integrable complex structure, and in this case there exists a unique quaternionic connection preserving the complex structure. If this connection preserves additionally some volume form, then we call such a manifold a special complex quaternionic manifold. In this talk we will compare and study the properties of these structures.We will also show a particular class of examples admitting a compatible circle action coming from quaternionic Feix–Kaledin construction. We will finish the talk by discussing what can be said about the complex quaternionic manifolds with compatible circle action in general.

Andreas Čap

The Riemannian deformation sequence revisited

Monday • 16:45–17:25 • Room: Aula

For metrics of constant sectional curvature, the Riemannian deformation sequence is a complex, which is also known as the Calabi complex or as the fundamental complex of linear elasticity. The original construction due to Calabi extends to arbitrary Riemannian metrics and admits a projectively invariant version, that can be obtained as a BGG sequence. In my talk, I will discuss a construction of the Riemannian deformation sequence based on the equivalent description of Riemannian manifolds as Cartan geometries and resembling the BGG construction for parabolic geometries. For constant sectional curvature metrics, this reproduces the Calabi complex, but in general, there are subtle differences. An advantage of the construction is that the relation to deformations is very transparent in the Cartan picture.

Martin Doležal

Cartan connection of 3-link snake robot model

Tuesday • 14:00–15:00 • Poster

The model of a 3-link snake robot is a well-known example of a $(2, 3, 5)$-model. More concretely, the model consists of a 2-dim bracket-generating distribution that represents allowed movements in a 5-dim configuration space, and thus, this model is controllable. One can find two vector fields that generates the distribution of the snake in such a way that they form a finite-dimensional Lie subalgebra of the infinite algebra of vector fields. Thanks to the existence of such a finite-dimensional Lie algebra structure, one can compute the normalized Cartan connection of the model with polynomials in only two functions as its coefficients. Consequently, the form of the Cartan connection is more suitable for further computations.

Nicklas Day

Rank 2 Distributions of Maximal Class: Harmonic Curvatures and Syzygies

Tuesday • 16:45–17:15 • Room: Aula

The symplectification procedure of B. Doubrov and I. Zelenko gives a unified method for assigning a normal Cartan connection to a rank 2 distribution on a manifold of dimension $n > 5$ satisfying a generic condition called maximality of class. In the talk, I will describe the harmonic curvatures of these Cartan geometries, which form a fundamental system of invariants for the distribution. I will also give relations (syzygies) between the harmonic curvatures in the case of $n = 6$. This talk is based on joint work with Boris Doubrov, Alexandr Medvedev, and Igor Zelenko.

Dario Di Pinto

Anti-quasi-Sasakian manifolds: homogeneous structures and topological constraints

Friday • 17:00–17:30 • Room: M1

In the present talk I will explore geometric obstructions to the existence of anti-quasi-Sasakian (aqS) structures on smooth manifolds, focusing on homogeneity conditions and topological properties.
I will begin by presenting a complete classification of nilpotent Lie groups that admit left-invariant aqS structures. Then, I will examine compact manifolds endowed with aqS structures of maximal rank, showing that such manifolds cannot be homogeneous.
Focusing further on the compact case, I will turn to topological constraints by analyzing the Betti numbers of compact anti-quasi-Sasakian manifolds. In particular, for a distinguished class of transversely hyperkähler aqS manifolds, we derive specific estimates for all Betti numbers. Precisely, up to half the dimension of the manifold, the odd Betti numbers are divisible by 4, while the even ones satisfy the inequality $b_{2k} \geq k + 1$.
This talk is partially based on joint work with Ivan Yudin (University of Coimbra).

References

[1] D. Di Pinto, *On anti-quasi-Sasakian manifolds of maximal rank*, J. Geom. Phys. **200** (2024), Paper no. 105174, 10 pp.

[2] D. Di Pinto, I. Yudin, *Topology of double aqS-Sasakian manifolds*, in preparation.

[3] D. Di Pinto, G. Dileo, *Anti-quasi-Sasakian manifolds*, Ann. Global Anal. Geom. **64** (1), Article no. 5 (2023), 35 pp.

Giulia Dileo

Anti-quasi-Sasakian manifolds as transversely Kähler manifolds

TUESDAY • 15:00–15:30 • ROOM: AULA

Among the huge variety of classes of almost contact metric manifolds, those with Killing characteristic vector field ξ are of particular interest. In the present talk, I will discuss some special classes of almost contact metric manifolds $(M, \varphi, \xi, \eta, g)$ such that the structure (φ, g) is projectable along the 1-dimensional foliation generated by ξ, and the transverse geometry is given by a Kähler structure. I will focus on quasi-Sasakian manifolds, which were introduced by Blair in [1], and the new class of anti-quasi-Sasakian manifolds [3]. In this case, the transverse geometry is given by a Kähler structure endowed with a closed 2-form of type $(2,0)$, as for instance hyperkähler structures. I will show how these manifolds can be placed in the framework of the Chinea-Gonzalez classification of almost contact metric manifolds [2], and describe examples, including compact nilmanifolds and principal circle bundles. I will investigate Riemannian curvature properties, characterizing transversely hyperkähler aqS manifolds in terms of ξ-sectional curvatures, and showing that they always carry a null Sasaki η-Einstein structure. By using a metric connection with torsion, I will provide a sufficient condition for an aqS manifold to be locally decomposable as the Riemannian product of a Kähler manifold and an aqS manifold with structure of maximal rank. Under the same hypothesis, (M, g) cannot be locally symmetric. This is based on a joint work with D. Di Pinto (Bari).

References

[1] D. E. Blair, *The theory of quasi-Sasakian structures*, J. Differential Geom. **1** (1967), 331-345.

[2] D. Chinea, C. Gonzalez, *A classification of almost contact metric manifolds*, Ann. Mat. Pura Appl. (IV) **CLVI** (1990), 15-36.

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Boris Doubrov

Cartan connections for scalar ODEs under point and fiber-preserving transformations

Friday • 14:00–14:40 • Room: M1

It is known that the equivalence problem for scalar ODEs of order 3 and higher can be solved via the construction of a canonical Cartan connection. The invariants then appear as part of the curvature of this connection. This allows to describe explicitly all scalar ODEs of order 3 and higher that can be brought to the trivial equation by contact transformations. The goal of this talk is to show how most of this approach can be extended to the equivalence of scalar ODEs under point and fiber-preserving transformations.

Michael Eastwood

Calculus on complex projective space

Monday • 16:00–16:40 • Room: Aula

Following joint work with Jan Slovák, and using the BGG machinery from parabolic geometry, it is useful to set up some curious vector bundles with connection on complex projective space that emphasise the Fubini-Study symplectic form rather than the metric. This construction allows one to find the Killing tensors of arbitrary valence and, therefore, their dimension.

Jarah Fluxman

The Unitary Irreducible Representations of the canonical Lifshitz Groups and their central extensions

THURSDAY • 9:30–10:00 • ROOM: M1

In recent years there has been an interest in systems displaying Lifshitz symmetry, both in holography and condensed matter. These systems scale anisotropically in space and time. In other words, when a scaling λ is applied, position scales as $x \to \lambda x$ while time scales as $t \to \lambda^z t$. The parameter z is called the Lifshitz parameter and encodes the degree of anisotropic scaling. Unless $z = 1$, Lifshitz systems break Lorentz symmetry. The Lie groups underlying Lifshitz symmetries are called the Lifshitz Lie groups and there are 7 of them up to isomorphism. The quantum systems exhibiting Lifshitz symmetry can be thought of as fields on a Lifshitz spacetime, which is simply a homogenous space of one of the Lifshitz groups. These fields are obtained by means of a sort of group-theoretic Fourier transform of a unitary representation of the Lifshitz group in question, or one of its central extensions. Understanding Lifshitz quantum systems is therefore simply a matter of classifying the unitary irreducible representations of the Lifshitz groups and their central extensions.

Jan Gregorovič

Models of 2-nondegerate CR hypersurfaces

FRIDAY • 16:25–16:55 • ROOM: M1

I will review recent progress in solving equivalence problem for 2-nondegerate CR hypersurfaces. I will talk about CR invariants called models associated with these hypersurfaces and their classification.

Zhangwen Guo

Fefferman-type constructions from path geometries to almost Grassmann structures

TUESDAY • 11:50–12:20 • ROOM: AULA

We introduce a Fefferman-type construction that associates to each $(n+1)$-dimensional path geometry an almost Grassmann structure of type $(2, n+1)$ on the total space of a natural principal $\mathbb{R}_+$-bundle. We also characterize all almost Grassmann structures of type $(2, n+1)$ which locally arise in this way. This characterization can be formulated in terms of the holonomy of the canonical Cartan connection or, equivalently, in terms of certain parallel tractors. We give a complete description of parallel standard tractors and standard cotractors on almost Grassmann structures in terms of simpler geometric objects, which should be of independent interest. This way, we arrive at a characterization that does not involve Cartan geometry.

Stefan Haller

The eta invariant of $(2,3,5)$*-distributions*

TUESDAY • 17:20–17:50 • ROOM: AULA

A $(2,3,5)$- distribution, aka as generic rank two distribution in dimension five, is a maximally non-integrable tangent 2-plane field on a 5-manifold. These can equivalently be characterized as regular normal parabolic geometries of type (G_2, P) where G_2 denotes the split real form of the exceptional Lie group and P is a particular parabolic subgroup. The Rumin complex associated with a $(2,3,5)$-distribution is a Rockland complex, the analogue of an elliptic complex in the Heisenberg calculus. In this talk we focus on the eta invariant of the Rumin differential in middle degrees, twisted by unitary flat vector bundles. Conjecturally, this spectral invariant coincides with the eta invariant of the (Riemannian) odd signature operator. We present recent computations using harmonic analysis which show that this conjecture holds true for $(2,3,5)$-nilmanifolds.

Boris Kruglikov

Global relative differential invariants are finitely generated (or perhaps not?)

THURSDAY • 10:30–11:10 • ROOM: M1

Invariants of Lie pseudogroup actions are important in solving the equivalence problem for geometric structures. Differential invariants arise as those for the lifted action to the space of jets, and relative invariants describe singular orbits (which may be, for instance, symmetric models for geometric structures). In this work we restrict to scalar relative invariants and explain the global approach to them via equivariant line bundles. Then we discuss the basic question of finite generation of the algebra of relative differential invariants. The work is joint with Eivind Schneider and is based on:

1 Boris Kruglikov, Eivind Schneider, Invariant divisors and equivariant line bundles, Forum of Mathematics Sigma 13, doi:10.1017/fms.2025.20 (2025).
2 Boris Kruglikov, Eivind Schneider, Relative differential invariants, to appear (2025).

Andrey Krutov

Clifford algebra analogue of Cartan's theorem for symmetric pairs

FRIDAY • 14:50–15:20 • ROOM: M1

We extend Kostant's results about ?-invariants in the Clifford algebra Cl(?) of a complex semisimple Lie algebra ? to the relative case of ?-invariants in the Clifford algebra Cl(?), where (?,?) is a classical symmetric pair and ? is the (−1)-eigenspace of the corresponding involution. In this setup we prove the Cartan theorem for Clifford algebras, a relative transgression theorem, the Harish–Chandra isomorphism for Cl(?), and a relative version of Kostant's Clifford algebra conjecture. The talk is based on the joint work with Kieran Calvert, Karmen Grizelj, and Pavle Pandžić (arXiv:2504.20917).

Svatopluk Krýsl

Lefschetz map on symplectic spinor-valued forms

FRIDAY • 17:35–18:05 • ROOM: M1

Let (M,ω) be a symplectic manifold admitting a symplectic spin structure. It is known that covariant derivatives restricted to specific subspaces of symplectic spinor-valued wedge forms form complexes if the covariant derivatives are induced by a symplectic torsion-free connection on M with symplectic Weyl curvature zero. They serve as examples of complexes on symplectic manifolds beside the well known complexes introduced by Koszul and Brylinski. We focus on when the Lefschetz map, i.e., the exterior product with $\omega^{\wedge k}$, induces an isomorphism on appropriate cohomology groups of the complexes.

Omid Makhmali

The Beltrami theorem in three-dimensional sub-Riemannian geometry

THURSDAY • 11:15–11:45 • ROOM: M1

Every three-dimensional sub-Riemannian metric defines an underlying contact projective structure whose curvature depends on the first jet of the sub-Riemannian fundamental invariants. The vanishing of this curvature defines the class of contact projectively flat sub-Riemannian metrics, which we show to have a finite local moduli. Using the three-dimensional twistor correspondence, we characterize such sub-Riemannian metrics as a class of non-Einstein conformally flat Lorentzian metrics defined on their space of autoparallel curves. This is a joint work with Marek Grochowski.

Peter W. Michor

Unbalanced Riemannian Metric Transport and the Wasserstein-Ebin Metric

MONDAY • 14:00–14:40 • ROOM: AULA

Starting with the framework of unbalanced optimal transport, this work aims to establish a class of optimization problems, that correspond to determining an "optimal" way to transport Riemannian metrics onto each other; in the following we will refer to these problems as Unbalanced Optimal Riemannian Metric Transport (UORMT). Joint work with Martin Bauer and F.X. Viallard

Katharina Neusser

Cone structures and conic connections

TUESDAY • 11:15–11:45 • ROOM: AULA

A cone structure on a manifold M is given by a closed submanifold $\mathcal{C} \subset \mathbb{P}TM$ of the projectived tangent bundle of M, which is submersive over M. Such geometric structures arise naturally in differential and algebraic geometry and they come often equipped with a conic connection, which specifies a distinguished family of curves on M in directions of $\mathcal{C}$. In this talk we will discuss some important local invariants of conic connections and describe their geometric interpretation. This talks is based on a joint work with Jun-Muk Hwang and a joint work in progress with Andreas Čap.

Pawel Nurowski

deSitter space and G_2

TUESDAY • 10:30–11:10 • ROOM: AULA

Malte Schulz

Representation theory of curvature tensors and applications to GR

THURSDAY • 14:45–15:15 • ROOM: M1

The well-known Petrov classification (1960) classifies solutions of the vacuum Einstein equation of general relativity through the algebraic properties of the Weyl tensor. In dimensions larger than 4, this approach does not work anymore. We present a representation-theoretic framework for classifying vacuum Einstein geometries in arbitrary dimensions. Specifically, we consider the (complexified) space of Weyl curvature tensors as a highest-weight representation of $\mathrm{SO}(n, \mathbb{C})$. We then demonstrate that physically significant families of solutions, such as static vacuum spacetimes, correspond bijectively to the $\mathrm{SO}(n-k, \mathbb{C})$-irreducible components for a suitably chosen branching. This is joint work with Ilka Agricola (Marburg).

Vladimír Souček

Strongly invariant differential operators on $Gr(3,3)$

MONDAY • 17:30–18:10 • ROOM: AULA

Curved Cartan geometries modelled on the homoegeous space $Gr(n, n)$ form a natural sequence of generalizations of the classical geometries based on $Gr(2, 2)$, which were essntially used in modern theoretical physics. Classification of strongly invariant differential operators for conformal geometries was studied by M. Eastwood and J. Slovák using the notion of semiholonomic Verma modules. In the lecture, similar methods are applied to the geometries modelled on $Gr(3, 3)$. The lecture is based on the joint work with J. Slovák.

Josef Šilhan

On a compatibility complex in conformal geometry

MONDAY • 15:10–15:35 • ROOM: AULA

In the locally flat case, the compatibility complex fot the conformal-to-Einstein operator is the BGG-complex. We consider the 'opposite' case when the Weyl tensor is (in a suitable sense) generic and construct a compatibility complex in this setting. We also briefly mention analogues for certain operators beyond the conformal geometry. This is a joint wrk with I. Khavkine.

Arman Taghavi-Chabert

Almost complex structures in projective and conformal geometries

Friday • 15:50–16:20 • Room: M1

We develop projective and conformal approaches to almost complex structures. In both cases, we replace the almost complex structure by a weighted analogue. In the conformal setting, using a certain canonical connection, we provide criteria characterising certain classes of the Gray-Hervella classification of almost Hermitian manifolds, notably the class of semi-Kaehler manifolds, which includes nearly and almost Kaehler manifolds as special cases. Similar results can be obtained in projective geometry. Time permitting, I will also cover applications to conformal Patterson-Walker geometries. This is joint work with Josef Šilhan.

Dennis The

Geometry of $(3,6)$-distributions: structure and models

Tuesday • 9:00–9:30 • Room: Aula

I'll report on some recent joint work with Omid Makhmali and Travis Willse in which we use Cartan geometry to explore the geometry of $(3,6)$-distributions. I'll discuss some interesting examples, give a partial analogue of the Cartan-Petrov classification, and discuss holonomy and some BGG equations for such structures.

Zhixiang Wu

On pseudotensor categories

Thursday • 11:50–12:20 • Room: M1

A pseudotensor category is a generalization of a tensor category. In this talk, I will introduce the pseudotensor category and some algebras in this category.

Petr Vlachopulos

The Cheeger constant of curved tubes in space forms

Tuesday • 14:00–15:00 • Poster

Motivated by the geometric properties of curved tubes $T(P,a)$ defined by closed curves P, we compute the Cheeger constant $h(T(P,a))$ in arbitrarily dimensional space forms with constant sectional curvature. The structure and properties of the system of Fermi coordinates allowed us to parametrize the curved tube and straightforwardly compute the upper bound of $h(T(P,a))$ using the exact formulas for the area and volume of $T(P,a)$. Hereafter, we work with the divergence of some suitable vector field, in order to obtain the ideal lower bound for $h(T(P,a))$. Considering the geometric structure of $T(P,a)$, the vector field then corresponds to the gradient of the distance function modified by certain scaling factor. This allows us to compute the lower bound via the divergence theorem and obtain the desired result. We also extend the obtained result for the class of unbounded curved tubes in space forms, bounding the Cheeger constant from above.

Lenka Zalabová

Nilpotent algebras, control, and nonholonomic mechanisms

TUESDAY • 14:00–15:00 • POSTER

We give an overview of our study of control problems on Carnot groups. We focus on control problems coming as nilpotent approximations for problems of motion of planar mechanisms. We apply the Hamiltonian viewpoint and use symmetries of the corresponding geometric structures to discuss the control. Joint with Jaroslav Hrdina.

Igor Zelenko

Generalized Pseudo-Product structures and Finiteness of Type

TUESDAY • 16:00–16:40 • ROOM: AULA

A *pseudo-product* structure on a smooth manifold M is a pair (E, F) of completely integrable distributions such that $E \cap F = 0$ and $D = E + F$ is a bracket generating distribution. These structures naturally arise in the geometry of ordinary and partial differential equations, CR structures, and in the study of rank 2 distributions via symplectification. In 1970, Tanaka proved that, under certain natural nondegeneracy conditions, such structures are of finite type—that is, they admit a finite-dimensional symmetry group. His proof involved reducing the problem of determining the finite-dimensionality of the Tanaka prolongation of a fundamental symbol to the finite-dimensionality of the Kobayashi–Nomizu–Spencer–Sternberg prolongation of the symbols of certain G-structures, and then applying Spencer's criterion for the finite-dimensionality of the latter. However, in many important geometric settings—such as systems of ODEs and PDEs of mixed order, the geometry of distributions of rank greater than 2 via symplectification, and CR or para-CR structures with higher nondegeneracy—more general pseudo-product structures arise, which satisfy more refined degeneracy assumptions. We prove that such generalized structures are also of finite type by extending Tanaka's criterion to structures with non-fundamental symbols. In this talk, we present this result and discuss various applications to the finite-dimensionality of the symmetry algebras for the geometric structures mentioned above. The talk is based on two papers currently in preparation: one jointly with Boris Doubrov, and another jointly with Boris Doubrov, Tohru Morimoto, and David Sykes.

Vojtěch Žádník

How to move along a trajectory

Monday • 14:45–15:10 • Room: Aula

We review the distinguished parametrizations of curves, both special and general, in parabolic geometries, both general and concrete.

Alexander Zuevsky

Recent developments in cohomology methods associated with vertex algebras

Thursday • 9:00–9:30 • Room: M1

In this talk we review recent applications of cohomology methods associated with vertex operator algebras to problems in CFT, differential geometry, number theory, and algebraic topology.

C. Geometry and Physics

Chen-Hsu Chien

Dressing Field Method and Cartan Geometry

Tuesday • 14:00–15:00 • Poster

The dressing field method is a powerful geometric framework in gauge theory, designed to systematically reduce gauge symmetries by introducing auxiliary fields—called dressing fields—that transform in a specific way under a subgroup of the original gauge group. This approach allows for the construction of gauge-invariant combinations of fields, thereby simplifying the description of physical systems and clarifying their geometric structure. When applied in the context of Cartan geometry—which generalizes Klein geometry to model curved analogs of homogeneous spaces via Cartan connections—the dressing field method offers a natural tool for eliminating redundant gauge degrees of freedom and revealing the underlying geometric content of the theory. In particular, the method is especially relevant in conformal and projective geometries, where it helps to construct tractors and reduce principal bundles, thus establishing a deep connection between gauge-theoretic and geometric perspectives on physical systems.

Ioannis Chrysikos

Decomposable solutions in eleven-dimensional supergravity

Tuesday • 17:20–17:50 • Room: F1

In this talk we will present decomposable (5,6)-solutions $\widetilde{M}^{1,4} \times M^6$ in eleven-dimensional supergravity by solving the bosonic supergravity equations for a variety of non-trivial flux forms. Many of the bosonic backgrounds that will be presented are induced by various types of null flux forms on products of certain totally Ricci-isotropic Lorentzian Walker manifolds and Ricci-flat Riemannian manifolds. We also present bosonic backgrounds that are products of Lorentzian Einstein manifolds with negative Einstein constant and Riemannian Kähler-Einstein manifolds with positive Einstein constant, generalizing an older result by C. N. Pope and P. van Nieuwenhuizen. This talk is based on a joint work with Hanci Chi and Eivind Schneider.

Owen Dearricott

Edge-cone singularities on anti-self-dual Einstein spaces in dimension four and 3-Sasakian spaces in dimension seven

Friday • 15:50–16:20 • Room: F1

Atiyah and Le Brun introduced the notion of edge-cone spaces as mildly singular spaces that are smooth Riemannian manifolds everywhere but a codimension two submanifold where the metric has a transnormal polar coordinate system that allows for a cone angle about the codimension two submanifold other than 360 degrees. In this talk we display some explicit edge-cone anti-self-dual Einstein metrics in dimension four. We explain the restrictive behaviour this forces upon the edge-cone metrics that occur on the seven-dimensional 3-Sasakian spaces canonically associated with them.

Evgeny Ferapontov

Involutive scroll structures on solutions of 4D dispersionless integrable hierarchies

Friday • 14:40–15:20 • Room: F1

A rational normal scroll structure on an $(n+1)$-dimensional manifold M is defined as a field of rational normal scrolls of degree $n-1$ in the projectivised cotangent bundle of M. We show that geometry of this kind naturally arises on solutions of various $4D$ dispersionless integrable hierarchies of heavenly type equations. In this context, rational normal scrolls coincide with the characteristic varieties (principal symbols) of the hierarchy. Furthermore, such structures automatically satisfy an additional property of involutivity. Our main result states that involutive scroll structures are themselves governed by a dispersionless integrable hierarchy, namely, the hierarchy of conformal self-duality equations. Based on joint work with Boris Kruglikov, arXiv:2503.10897.

Can Görmez

Seven Sphere Quantization

Friday • 17:00–17:30 • Room: F1

The dynamics of a classical mechanical system can be described by a contact form on an odd-dimensional manifold. This description can be quantized by generalizing Fedosov's geometric approach to formal deformation quantization. The central object is a formally flat connection on a bundle of Hilbert spaces, typically the symplectic spinor bundle. We explicitly construct such a connection for the seven-sphere equipped with its quaternionic homogeneous model. We then show how this model filters the spinor bundle and how the formal connection yields an exact flat connection on each corresponding subbundle. As a result, we obtain quantum dynamical systems parametrized by certain unitary representations of the model's principal group. This is joint work with Subhobrata Chatterjee and Andrew Waldron.

Ozgur Kelekci

Effect of T-duality with Torsion on Killing-Yano Forms

Friday • 14:00–14:30 • Room: F1

We investigate the transformation of Killing-Yano (KY) p-forms under Abelian T-duality in the presence of a non-trivial three-form torsion. Using a torsionful, metric-compatible connection and the Buscher rules of T-duality, we derive compact, coordinate-free transformation laws applicable to KY forms of arbitrary degree. In particular, we prove that a

Killing 1-form is preserved by the duality map whenever its transverse components are independent of the isometry (T-dual) direction. The framework is then applied to some general relativity spacetimes, including Schwarzschild and de Sitter, where we construct the dual KY forms explicitly and analyze the resulting symmetries. It is expected to extend these results to the generalized geometry programme, where T-duality and torsion are naturally unified in an $O(d, d)$-covariant language.

Giorgi Khimshiashvili

Maxwell"s conjecture for collinear point charges

TUESDAY • 11:50–12:20 • ROOM: F1

We are concerned with the Maxwell"s conjecture (MC) on the maximal number of isolated equilibrium points of point charges in three-dimensional Euclidean space. Specifically, for several classes of collinear configurations of point charges, we present upper estimates for the number of isolated equilibrium points, which in some cases imply that MC holds true. The main attention is given to the so-called balanced collinear configurations and polarized collinear configurations. Recall that a configuration of point charges lying in line L is called balanced if it is in equilibrium within L. A configuration of point charges lying in line L is called polarized if it consists of two clusters of like charges lying in two disjoint intervals of line L. It will be shown that MC holds true for balanced collinear configurations consisting of not more than five point charges. For a polarized configuration of point charges lying in line L, we give an upper estimate for the number of isolated equilibrium points in any plane containing the line L. A few illustrative examples and several feasible generalizations of the above results will also be presented.

Elias Knack

Invariant Spinors on S^{15} as a Homogeneous Sphere

TUESDAY • 14:00–15:00 • POSTER

If a homogeneous sphere admits an invariant spin structure, one can deduce the existence of a certain geometric structure in most cases except for the 15-dimensional sphere, which can be written as $S^{15} = \mathrm{Spin}(9)/\mathrm{Spin}(7)$ (cf. I. Agricola et al., 'Invariant spinors on homogeneous spheres', Differential Geometry and its Applications, Volume 89 (2023)). We discuss, whether one can identify a corresponding geometric structure in this case.

Jaroslaw Kopinski

Conformal geometry of spacetimes with prescribed asymptotic behavior

TUESDAY • 13:30–14:00 • ROOM: F1

Our universe can be modeled as a solution to the Einstein field equations that begins with an initial Big Bang singularity and evolves toward a late-time phase of exponential expansion driven by a positive cosmological constant. I will show how tractor calculus can be applied to describe the asymptotic behavior of this model at both early and late times. This approach establishes a connection between the stress-energy tensor and the geometric quantities associated with the hypersurfaces representing the regularized initial and final states.

Michal Marvan

Voss surfaces in sine-Gordon hierarchies

FRIDAY • 17:35–18:05 • ROOM: F1

Starting from a given pseudospherical surface, we show how to obtain infinite sequences of associated Voss surfaces by quadratures or even algebraically. The driving engine is the division algebra of recursion operators of the sine-Gordon equation.

Timothy Moy

Isomonodromic deformations and twistor geometry

TUESDAY • 15:00–15:30 • ROOM: F1

Given a tuple of integers indexing pole orders, one can define a moduli space M of meromorphic quadratic differentials on the Riemann sphere. There is a natural torus bundle T over this moduli space and we will show how to equip this torus bundle with a complex hyper-Kähler metric. The key idea is that points in the torus bundle correspond to a 1-parameter family hyper-elliptic curves, and there is the notion of distinguished directions in T that correspond to infinitesimal deformations orthogonal to the set of all deformations with respect to the intersection form of each curve. The hyper-Kähler metric defines what is known as a Joyce structure on M, a definition due to Tom Bridgeland as part of a programme of geometrising Donaldson-Thomas invariants. This is partly based on joint work with Maciej Dunajski.

Henrik Naujoks

Higher-power Harmonic Maps, Instantons and Yang-Mills Theory

Friday • 16:25–16:55 • Room: F1

In my talk I will present the geometric and physical properties of so-called higher-power harmonic maps, a generalization of harmonic maps described by C. Wood and A. Ramachandran in 2023. Due to the algebraic structure of their equations, they have strong similarities with Yang-Mills theory and are therefore particularly suitable for use in physical field theory. After a short introduction, I will explain the coupling of these maps to a gravitational field and the resulting coupled partial differential equations. I will show how explicit solutions of the system can be constructed on Lie groups under symmetry assumptions. If there is enough time, I will present an instanton theory for higher-power harmonic maps: This yields an easier first-order differential equation whose solutions coincide with those of the original equation. In addition to the simpler construction of solutions, this theory also allows an estimation of the energy of these maps via a topological invariant.

Marcella Palese

Symmetry transformations of extremals and higher conserved quantities

Tuesday • 9:00–9:30 • Room: F1

We relate symmetry transformations of extremals to Jacobi fields and study symmetries of higher variations. We tackle a systematic formulation of higher variations, interpretable as variations of suitable "deformed" Lagrangians; combined with symmetry considerations, this approach extends to field theory the concept of the so-called higher order Noether symmetries in Mechanics. As an output, we characterize symmetry transformations of Lagrangian extremals generating 'on shell' conservation laws and, in particular, the conserved current associated with two symmetry transformations is obtained. (based on a joint work with L. Accornero)

Yuichiro Sato

Construction of vacuum solutions in general dimensions using almost abelian Lie groups

Tuesday • 10:30–11:10 • Room: F1

We assume that the spacetime is spatially homogeneous or simply homogeneous, and solve the vacuum Einstein equations without a cosmological constant in more than three dimensions. An almost abelian Lie group is a Lie group whose Lie algebra has a codimension-one abelian ideal. We consider the spatial part of globally hyperbolic spacetime or spacetime itself to be an almost abelian Lie group, and derive Ricci-flat conditions of such spacetimes. In particular, we generalize the classical four-dimensional Taub and Petrov solutions to arbitrarily higher dimensions. For the solutions we obtained, we show that each of the spatial dimensions cannot expand or contract simultaneously in the late-time limit.

Wijnand Steneker

Variationality of conformal geodesics in dimension 3

Tuesday • 11:15–11:45 • Room: F1

Conformal geodesics form an invariantly defined family of unparametrized curves in a conformal manifold generalizing unparametrized geodesics/paths of projective connections. The equation describing them is of third order, and it was an open problem whether they are given by an Euler–Lagrange equation. In dimension 3 (the simplest, but most important from the viewpoint of physical applications) we demonstrate that the equation for unparametrized conformal geodesics is variational.

Andrew Waldron

Quantum Mechanics and Quantization

Tuesday • 16:00–16:40 • Room: F1

Following a lightning review of modern formulations of quantum mechanics, we explain how to obtain quantum systems from flat connections on bundles of symplectic spinors associated to underlying classical geometries.

Ekkehart Winterroth

Variational cohomology and topological solitons in Yang–Mills–Chern–Simons theories

Tuesday • 9:30–10:00 • Room: F1

In cohomological formulations of the calculus of variations obstructions to the existence of (global) solutions of the Euler–Lagrange equations can arise in principle. It seems, however, quite common to assume that such obstructions always vanish, at least in the cases of interest in theoretical physics. This is not so: for Yang–Mills–Chern–Simons theories on compact manifolds in odd dimensions ≥ 5 we find a non trivial obstruction which leads to a quite strong non existence theorem for topological solitons/instantons. The consequences of this result for the Yang–Mills–Chern–Simons theories of holographic QCD (on $\mathbb{R}^5$) are discussed.

Hartwig Winterroth

A constructive approach to generalized principal connections

Tuesday • 16:45–17:15 • Room: F1

In the framework of classical field theory, in its fiber bundle approach, we investigate the notions of generalized principal bundle and generalized principal connection as introduced by Castrillón López and Rodríguez Abella (2023), aiming at the development of an instance of generalized mathematical gauge theories. We provide a characterization of Lie group fiber bundle connections and generalized principal connections in order to obtain the local coordinate representation of all such structures. In particular, studying the curvature of generalized principal connections, we specialize the Bianchi identities obtaining a generalized version of the classical homogeneous field equations. As an application, we prove also that vector bundles are an example of generalized principal bundles, that a generalized principal connection on a vector bundle is an affine connection and that the generalized homogeneous field equations can be rephrased, in this case, in terms of basic soldering forms and torsion tensors. This is a joint work with Lorenzo Fatibene.

Qiaoling Xia

On almost square Ricci solitons

Tuesday • 13:30–14:00 • Room: G2

In this talk, I will introduce the almost Ricci solitons in Finsler geometry. In particular, we focus on almost square Ricci solitons (M, F, V) defined by a square metric F and a vector field V on an n-dimensional manifold M. We prove that (M, F, V) is an almost square Ricci soliton if and only if F is Ricci flat and V is a conformal vector field of F when $n \geq 2$, and it is an almost locally projectively flat square Ricci soliton if and only if F is of zero flag curvature and V is a Killing vector field of F when $n \geq 3$. As applications, we determine the local structures of almost (resp. locally projectively flat) square Ricci solitons.

E. Poisson Geometry

Dan Aguero

On the geometry of complex Poisson bivectors

Monday • 16:00–16:40 • Room: F1

We study the geometry of complex Poisson bivectors over smooth manifolds, that is, bivectors $\pi \in \Gamma(\wedge^2 T_{\mathbb{C}} M)$ satisfying the condition $[\pi, \pi]_{Sch} = 0$. We show that under mild regularity conditions any complex Poisson bivector has associated a complex presymplectic foliation (here the two-forms are defined on the complexified tangent bundle). We use techniques of Dirac geometry to provide a more concise description of this complex presymplectic foliation. Moreover, we introduce two new classes of structures: quasi-real Poisson and quasi-real Dirac structures. Finally, we provide a normal form theorem for complex Poisson structures along certain kind of special submanifolds.

Martha Valentina Guarin Escudero

Homotopy algebras associated with dg-manifolds

Thursday • 11:15–11:45 • Room: F1

The topic of this talk is the construction of L-infinity algebras on the space of vector fields in a dg-manifold. On one hand, by using the Fedosov connection. On the other, by using a similar idea to Kapranov homotopy Lie algebra, exposed by Stienon, Xu and Seoul. Further, it is intended to expose a generalization of the previous constructions to Hamiltonian dg manifolds.

Chiara Esposito

Equivariant formality and reduction

Thursday • 11:50–12:30 • Room: F1

In this talk, we discuss the reduction-quantization diagram in terms of formality. First, we propose a reduction scheme for multivector fields and multidifferential operators, phrased in terms of L-infinity morphisms. This requires the introduction of equivariant multivector fields and equivariant multidifferential operator complexes, which encode the information of the Hamiltonian action, i.e., a G-invariant Poisson structure allowing for a momentum map. As a second step, we discuss an equivariant version of the formality theorem, conjectured by Tsygan and recently solved in a joint work with Nest, Schnitzer, and Tsygan. This result has immediate consequences in deformation quantization, since it allows for obtaining a quantum moment map from a classical momentum map with respect to a G-invariant Poisson structure.

Naoki Kimura

Correspondence between Koszul-Vinberg structures and Poisson structures

THURSDAY • 9:00–9:30 • ROOM: F1

Koszul-Vinberg manifolds were introduced by Benayadi and Boucetta as a generalization of Hessian manifolds. A non-degenerate Koszul-Vinberg manifold is equivalent to a Hessian manifold. It is known that a Riemannian manifold M with a flat connection yields a Hermitian structure on the total space of its tangent bundle TM. It is called Dombrowski's construction. In Dombrowski's construction, the Riemannian metric on M satisfies the Codazzi equation if and only if the fundamental 2-form of the Hermitian structure on TM is closed. Therefore, this gives a correspondence between Hessian structures on M and Kähler structures on TM. In this talk, we present a generalization of the correspondence. We show that there is a correspondence between Koszul-Vinberg structures on a left-symmetric algebroid A over M and Poisson structures on the prolongation of the algebroid A. We also explain variations of such correspondence; a correspondence between compatible pairs of Koszul-Vinberg structures and compatible pairs of Poisson structures; a correspondence between Koszul-Vinberg-Nijenhuis structures and Poisson-Nijenhuis structures. This is a joint work with Tomoya Nakamura (Kogakuin University).

Hubert Kołcz

Lie Algebraic Structures in Quantum Error Correction for Measurement-Based Quantum Computing: A Poisson Geometric Approach to Prototype Validation

TUESDAY • 14:00–15:00 • POSTER

Quantum computing's promise is fundamentally challenged by noise and decoherence, particularly in measurement-based quantum computing (MBQC), where adaptive measurements drive computation. We present a novel framework that unifies Lie algebraic structures and Poisson geometry to enhance quantum error correction (QEC) in MBQC. Our approach interprets stabiliser measurements as elements of a Lie algebra, mapping error syndromes to deformations on a Poisson manifold via a momentum map. This geometric-algebraic model enables

the construction of corrective flows that restore the quantum state's structure, integrating error correction seamlessly into the MBQC process. Prototype validation is conducted through dynamic circuit implementations and benchmarking on both simulated and real quantum hardware. We demonstrate, via randomised benchmarking and quantum controlled error correction protocols, significant reductions in error rates and improvements in fidelity, up to 30% error rate reduction and fidelity above 0.95 in teleportation and gate teleportation tasks, even under noise. Our benchmarking suite evaluates standard codes (surface, toric) and integrates with state-of-the-art software tools (Qiskit-QEC, MQT QECC, TQEC), providing a decision-support system for selecting optimal QECCs tailored to specific MBQC applications. We further discuss the implications for mid-circuit measurement performance, the role of error mitigation tools (e.g., Mitiq), and the integration of machine learning for adaptive code selection. This work establishes a rigorous, modular, and experimentally validated methodology for quantum error correction in MBQC, bridging advanced mathematics and practical quantum computing, and paving the way for scalable, robust quantum information processing.
References: https://github.com/hubertkolcz/dynamic-quantumvengers/

Filip Moučka

Beyond Poisson geometry: when a bivector field is symmetric

THURSDAY • 9:30–10:00 • ROOM: F1

Poisson geometry is a well-established field of mathematics concerned with skew-symmetric bivector fields obeying a specific integrability condition, however, much less is known about their symmetric counterparts. In this talk, I will introduce symmetric Poisson structures: symmetric bivector fields satisfying a new integrability condition inspired by the Poisson framework. I will demonstrate their close relation to totally geodesic foliations and Jacobi-Jordan algebras and provide several illustrative examples.

Tomoya Nakamura

A generalization of Koszul-Vinberg manifolds

THURSDAY • 10:30–11:10 • ROOM: F1

A Koszul-Vinberg manifold is a generalization of a Hessian manifold and induces a left-symmetric algebroid structure on its cotangent bundle.

It is also known that there exists a correspondence between Koszul-Vinberg structures on an affine manifold (M, ∇) and Poisson structures on the total space of the tangent bundle TM. As Poisson structures are generalized to Jacobi structures, can Koszul-Vinberg structures be generalized to natural structures? In this talk, by generalizing the notion of left-symmetric algebroid, we define a natural generalization of Koszul-Vinberg manifolds, called Jacobi-Koszul-Vinberg manifolds, and introduce various properties of the structures. In particular, we introduce that there exists a correspondence between Jacobi-Koszul-Vinberg structures on an affine manifold (M, ∇) and Jacobi structures on the total space of $TM \oplus (M \times \mathbb{R})$. This is a joint work with Naoki Kimura (Tokyo University of Science).

Pedro Henrique Carvalho Silva

Homological reduction of Courant algebroids

MONDAY • 14:00–14:40 • ROOM: F1

Following Roytenberg-Severa, we know that Courant algebroids are in one-to-one correspondence with symplectic NQ-manifolds of degree two. On the other hand, it was observed by Bursztyn-Cattaneo-Mehta-Zambon that coisotropic reduction of a symplectic NQ-manifold of degree two relates to reduction of the corresponding Courant algebroid. In particular, from this perspective, the result by Bursztyn-Cavalcanti-Gualtieri on reduction of exact Courant algebroids can be derived from a degree two version of the Marsden-Weinstein reduction theorem. Based on these ideas, we explain how to obtain a homological model for Bursztyn-Cavalcanti-Gualtieri Courant reduction from a BFV model for graded hamiltonian reduction. Our result can be seen as the Courant counterpart to the classical homological formulation of hamiltonian reduction of symplectic and Poisson manifolds due to Kostant-Sternberg and Stasheff.

Alfonso Tortorella

A rigidity result for coisotropic submanifolds in contact geometry

MONDAY • 17:30–18:10 • ROOM: F1

In this talk, based on joint work with Stephane Geudens, we study coisotropic deformations of a compact regular coisotropic submanifold C in a contact manifold (M, H). Our main result states that C is rigid among nearby coisotropic submanifolds whose characteristic foliation is diffeomorphic to that of C. When combined with a classical rigidity result for foliations, this yields conditions under which C is rigid among all nearby coisotropic submanifolds.

Cornelia Vizman

Weighted loops, coadjoint orbits, and characters

Monday • 14:50–15:30 • Room: F1

For the group of area preserving diffeomorphisms we study a class of coadjoint orbits consisting of weighted loops in the plane. They model singular vorticities in ideal 2D fluids supported on closed curves, called vortex loops. We give an Onsager-Feynman condition for the existence of a character associated with a vortex loop and a geometric formula of the character, thus performing the algebraic part of the geometric quantization program for these coadjoint orbits.

Shizhuo Yu

Configuration Poisson groupoids of flags

Monday • 16:45–17:25 • Room: F1

In this talk, we will introduce a class of Poisson groupoids over multi-flag varieties, called configuration Poisson groupoids of flags. They contain a family of Poisson subgroupoids over generalized Schubert cells, whose total spaces are generalized double Bruhat cells. Moreover, certain symplectic leaves of these Poisson sub-groupoids are symplectic groupoids over generalized Schubert cells. This is a joint work Jiang-Hua Lu and Victor Mouquin.

F. Quantum Geometry

Julius Benner

Codifferential calculi and quantum homogeneous spaces

Friday • 17:00–17:30 • Room: F1

In this talk, we introduce the concept of codifferential calculus - a structure dual to differential calculus - that encapsulates the features of both classical and quantum differential geometry, and is motivated to serve as an abstract framework for both classical and quantum BGG sequences. We demonstrate that many foundational results from differential calculi extend naturally to this dual setting. For instance, in the case of equivariant codifferential calculi over quantum homogeneous spaces, Hermisson's classification of calculi admits a direct dual formulation. As a motivating example, we consider the Podleś sphere equipped with its standard noncommutative differential structure.

Arnab Kumar Bhattacharjee

q-deformation of Kostant differential for A-series irreducible quantum flag manifolds

Friday • 15:50–16:20 • Room: F1

In this talk, firstly we shall show systematic framework for quantum levi-subalgebra $U_q(\mathfrak{l}_S)$ module action on the quantum exterior powers of nil-radicals (in the sense of Berenstein and Zwicknagl) for A-series irreducible quantum flag manifolds, and then we show the $U_q(\mathfrak{l}_S)$ equivariant q-deformation of classical Kostant differential in the same setup, and we shall produce levi equivariant differential complex on the corresponding co-homology classes of $U_q(\mathfrak{l}_S)$ modules. Then we shall obtain a q-deformed de-Rham differential on the verma modules (as a $U_q(\mathfrak{g})$ module) induced from $U_q(\mathfrak{p}_+)$ modules (where $\mathfrak{p}_+$ denotes parabolic subalgebra of $\mathfrak{g}$), and we show this produce a differential calculus (graded co-Leibniz rule holds) on the verma modules using wedge co-product structure. Finally, we shall address the question of lifting q-deformed Kostant differential complex on the co-homology classes upto $U_q(\mathfrak{g})$ equivariance using q-deformed de-Rham differential. This is a joint work with Petr Somberg.

Fredy Díaz García

The Dolbeault-Dirac operator for the irreducible quantum flag manifolds

Friday • 14:40–15:10 • Room: F1

In this talk I will present the construction of the Dolbeault-Dirac operator associated to some type of quantum homogenous spaces, namely the irreducible quantum flag manifolds. For this, the starting point is to follow the framework of the quantum version of the Bernstein-Gelfand-Gelfand resolution appearing in the works of I. Heckenberger and S. Kolb. By dualizing this resolution and taking its locally finite part we get the so called Dolbeault complex satisfying similar properties as its classical counterpart, i.e., de Rham complex in classical differential geometry. This Dolbeault complex allows us to define the Dolbeault-Dirac operator $d+d^*$ acting on the space of differential forms where its spectral properties can be investigated. We illustrate this construction with the example of the irreducible quantum flag manifold of type B_2 for which it leads to a spectral triple in the sense of Connes, also we report some partial results in this direction for the quantum Grassmannian Gr(r,n) following this framework and the framework of the Parthasarathy formula. The case of the quantum Grassmannians is an ongoing project with K. Rodriguez and E. Wagner.

Alessandro Carotenuto

Convex orders and quantum tangent spaces

Thursday • 15:20–15:50 • Room: F1

Luzstig's notion of quantum root vectors associates a PBW basis of a quantized enveloping algebra $U_q(\mathfrak{g})$ to each choice of a reduced decomposition for the longest element w_0 of its Weyl group. These are defined via the iterated application of a certain action of the braid group on $U_q(\mathfrak{g})$ by algebra homomoprhisms. However, it is not obvious at first glance how this interacts with the coalgebra structure of $U_q(\mathfrak{g})$, most notably with its coproduct. In a recent article, Ó Buachalla and Somberg gave a suitable choice of a reduced decomposition of w_0 for which the corresponding quantum root vectors span a so-called quantum tangent space for the full quantum flag manifold of $U_q(\mathfrak{g})$ in type A. In order to extend this result we need to study the coproduct of quantum root vectors. In this project in collaboration with P. Papi and C. Hohlweg, we show that the coproduct of quantum root vectors can be understood through the notion of a convex order for the set of positive roots of $\mathfrak{g}$, and we give the combinatorial conditions of the reduced decomposition of w_0 in order to have a quantum tangent space.

Antonio Del Donno

Principal bundles and differential structures in noncommutative geometry

Friday • 16:25–16:55 • Room: F1

We revisit and extend the Durdevic theory of complete calculi on quantum principal bundles. In this setting one naturally obtains a graded Hopf-Galois extension of the higher order calculus and an intrinsic decomposition of degree 1-forms into horizontal and vertical forms. This proposal is appealing, since it is consistently equipped with a canonical braiding and exactness of the Atiyah sequence is guaranteed. Moreover, we provide examples of complete calculi, including the noncommutative 2-torus, the quantum Hopf fibration and differential calculi on crossed product algebras.

Rita Fioresi

Reductions of Quantum Principal Bundles

Thursday • 14:00–14:40 • Room: F1

We study the problem of reduction of quantum principal bundles over non affine bases, providing with an existence theorem and relevant examples.

Keegan Flood

Constructing Canonical Calculi

Friday • 14:00–14:30 • Room: F1

One method to encode a notion of "geometry" on an associative algebra is to equip it with a first order differential calculus, i.e. a notion of 1-form. But, for a fixed associative algebra, there are many such choices and it is a difficult question, in general, to determine which first order differential calculi are of geometric interest. There are several examples of categories of algebras for which there is an existing notion of canonical first order differential calculus. On the category of unital associative algebras there is a universal functorial construction which assigns to objects their corresponding universal first order differential calculus. Similarly, on the category of unital commutative algebras there is a universal functorial construction assigning to objects their corresponding Kähler first order differential calculus. Further, on the category of smooth algebras (i.e. C^∞-rings) there is a universal functorial construction assigning to objects their corresponding de Rham first order differential calculus. We realize the three proceeding constructions as special cases of a more general procedure where a canonical first order differential calculus arises from a certain left adjoint. Finally, we give sufficient conditions on a category of algebras (satisfying properties and or being equipped with extra structure) such that it admits such a procedure for constructing a canonical first order differential calculus. This is based on joint work with Gabriele Lobbia and Giacomo Tendas.

Mauro Mantegazza

Jets in Noncommutative Geometry

Tuesday • 14:00–15:00 • Poster

In this poster I present some of the results of a collaboration with K. Flood and H. Winther concerning the generalization to the context of noncommutative differential geometry of the notion of jet functors and other concepts related to them (e.g. differential operators, symbols, differential equations).

Henrik Winther

Higher order connections in noncommutative geometry

THURSDAY • 14:45–15:15 • ROOM: F1

We introduce the notion of higher order connections in the setting noncommutative differential geometry, by which we mean unital associative algebras equipped with exterior algebras. This work involves introducing the notion of natural linear differential operator, as well as an important family of examples, namely the Spencer operators, generalizing their corresponding classical analogues. These Spencer operators form the building blocks of this theory by providing conversions between the different representations of higher order connections as left/right splittings of the jet exact sequences and as explicit pieces of the necessary jet connections which are constructed using the data of a left connection on the first-order differential calculus. Further we show that higher order connections are equivalent to (ordinary) connections on jet modules. We then prove that a system of such higher order connections gives a quantization, in the sense of a splitting of the projection from differential operator to their symbols. This yields total symbols and star products, i.e. phase space quantizations, but where we allow the position coordinates to form a possibly noncommutative algebra. Joint work with K. Flood and M. Mantegazza.

G. Geometry of Information

Dmitry Alekseevskiy

Functional Architecture of Early Vision

FRIDAY • 15:10–15:50 • ROOM: G2

The talk is based on joint papers with Andrea Spiro. The human visual system is a highly complicated, hierarchically organised system, consisting of several parts, the eyes, the LGN, the primary visual cortex V1, the cortices V2, V3, V4 etc., linked by a strong feedback. The first part of this talk gives a short survey of basic results of functional architecture of early vision in static (when the eye and the stimulus are still). In this case, all visual information contains in the light, incident to the retina. Most results about functional architecture of primary visual cortex arc based on classical experimental results and fundamental ideas by David Hubel and Torsten Wiesel (Nobel Prize , 1981). They include the classification of visual neurons in simple and complex, the discovery of the columnar structure of the V1 cortex and, division of the columns into regular and singular *pinwheels*). Hubel and Wiesel also introduced the fundamental notions of *internal parameters*, which was mathematically formalized by Jean Petitot as the statement that the V1 cortex geometrically may be represented by a fiber bundle over the retina. This was a source of developing a neutogeometry, initiated by Jean Petitot and his coworkers. The neurogeometry is an area of applied mathematics which is meant to produce *continuous* models for visual subsystem – using method and results from Differential Geometry, Lie Groups, Differential Equations and Statistics.

Other important idea is the concept of the hypercolumn. Huber and Wiesel define a hypercolumn as a minimal collection of collumns, which may detect any possible values of the internal parameters. The hupercolumn is responsible for detection of local structure of retinal image. We state a new Principle of Homogeneity, with reduces the construction of neurogeometric model of V1 cortex to choosing a Lie group (or, better, Lie subgroup) G of transformations of the retina R (considered as a plain or sphere) which has an open orbit $R_0 \subset R$. The corresponding model is defined as a homogeneous bundle $\pi : G \to R_0 = G/H$ where H is the stability subgrouo of a point $z_0 \in R_0$. We apply this principle to a unified description of the Petitot contact models of V1 cortex and its simplectic extension proposed by A. Sarti, G. Citti and J. Petitot and to extension of the spherical model of hypercolumn, developed by P. Bressloff and J. Cowan . The new conformal model of hypercolumns, has 6 internal parameters. We defined also a reduced model of hypercolumn which is formally identical to the simplectic model.

In a natural setting, the eye is always moving. The compensation of eye movements leads to lost of vision in 2-3 sec. In the second part of the talk , we consider the functional architecture of early vision in dynamics. In dynamics, the vision of a result of interaction of the retinal information with the oculomotor information about eye position. We discuss the new arising phenomenons : The presaccadic remapping and the "shift of receptive fields".

We consider the problem of identification of retina images after remapping and state the fundamental Gombrich's Etcetera Principle. Using the properties of the Minkowski space $\mathbb{R}^{1,3}$ we propose a solution of the problem, which consistent with the Gombrich's principle. We stated the classical Donders' and Listing's laws in terms of the Hopf bundle. These laws describe the configuration space of the eye, considered as a ball , which may rotate around its center. We use this result to study geometry of the saccades and saccadic cycles.

Subrahamanian Moosath Karickamadom Sreekumara

Geodesic-Based Interpolation using Gaussian Mixture Models

Friday • 14:35–15:05 • Room: G2

Shape interpolation is a fundamental challenge in computer vision and computer graphics with applications in animation, medical imaging, pattern recognition, etc. While simple linear approaches are computationally efficient, they often produce trajectories that ignore the underlying geometry of shape spaces, leading to unnatural deformations. In this paper, we present a geodesic-based framework for smooth interpolation between two-dimensional shapes. Each shape is represented as a K-component Gaussian Mixture Model with uniform weights and a fixed covariance, where the mixture means correspond to landmark points sampled from the shape. The space of K-component Gaussian Mixture Models is embedded into the manifold of Symmetric Positive Definite matrices. The affine-invariant metric on the manifold of Symmetric Positive Definite matrices is employed to compute geodesic paths between source and target Symmetric Positive Definite matrix representations yielding intermediate Symmetric Positive Definite matrices for all $t \in [0, 1]$. A re-projection step recovers the intermediate Gaussian Mixture Model means, which serve as control points in a Thin-Plate Spline warp to deform the entire shape. We validate the approach on both synthetic datasets (e.g., circle-to-square, kite-to-circle) and real dataset like fish shapes, demonstrating smooth, natural interpolations that preserve local features and avoid the distortions of shapes.

Daisuke Tarama

Geodesic flows of Lie groups associated to statistical transformation models

Friday • 14:00–14:30 • Room: G2

The talk deals with the information geometry of the statistical transformation models, which consist of a smooth sample manifold with a Lie group action and a family of invariant probability measures parameterized by the Lie group. The Fisher-Rao metric and the Amari-Chentsov tensor are defined as left-invariant tensors on the Lie group. The talk gives some descriptions for the geodesic flows of the induced α-connections induced by the Fisher-Rao metric and the Amari-Chentsov tensor in terms of geometric mechanics. Concrete examples, such as multivariate normal distributions and models over compact Lie groups, are mentioned and their connection to sub-Riemannian geometry is also discussed. The talk is partially based on collaborations with Jean-Pierre Françoise.