

Exploring new arrows in the BCGW-groupoid-II

Higher structures PhD retreat

Book of Abstracts

Burbach, Germany
7th – 10th of March, 2025

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1 Scientific Program Schedule

Time	Friday 07.03.25	Saturday 08.03.25	Sunday 09.03.25	Monday 10.03.25
07:30-09:00		Breakfast	Breakfast	Breakfast
09:00-10:30		David Aretz	Linus Mußmächer	Departure
10:30 -11:00		Snacks	Snacks	
11:00-12:00		Sergio Romero	Individual Mentoring	
12:00-12:30			Break	
12:30-13:30		Lunch	Lunch	
13:30-15:00		Hike	Rodrigo Baptista	
15:00-15:30		Snacks	Snacks	
15:30-16:30		Free Discussions	Short Talks	
16:30-18:00	Arrival	Karandeep Singh	Jorn van Voorthuizen	
18:00-19:00	Dinner	Dinner	Dinner	
19:00-20:00	Group mentoring			

2 Abstracts: 1 hour talks

2.1 Categorical perspectives on Clifford algebras and geometric spin structures

Speaker: David Aretz

Abstract: Miraculously, Clifford algebras are very important in the study of topological K-theory and spin geometry. I will attempt to address the question: What do Clifford algebras have to do with vector bundles? I will review the connection between determinants and orientations and interpret this as the first stage of a categorical Whitehead tower. The next stage will give rise to Clifford algebras and spin structures. This will feature a more geometric definition of a spin structure. I will end by sketching how this provides a construction of the spin orientation of real K-theory.

2.2 Computation of Coarse Cohomology through Topological Bornological Spaces

Speaker: Sergio Romero

Abstract: Coarse cohomology of a metric space is an invariant that measures the asymptotic behaviour of the space at infinity and the way in which uniformly large subspaces fit together. In this talk we tackle the problem of computing coarse cohomology in terms of standard better-known tools from classical algebraic topology. The key point of the strategy we will follow is based on the observation that a metric space has three structures interacting in a compatible way: topology, bornology, and coarse structure. Here we shall present a cohomological approach to understand the relations between these three. Lastly, classical cohomology theories such as Alexander-Spanier can be enriched with a cup product, and this additional structure allows one to tell more spaces apart. This will lead us to the Roe product, and we shall discuss how to compute it from the classical cup product.

2.3 Stability of leaves and differential graded Lie algebras

Speaker: Karandeep Singh

Abstract: The stability of leaves of a geometric structure is a classical problem: Given a geometric structure that induces a (singular) foliation on a manifold and a leaf of this foliation, when is the leaf preserved under deformations of the geometric structure? This question has been addressed for Lie algebroids and Poisson manifolds by M. Crainic and R. Fernandes, who found a cohomological obstruction to stability. I will discuss how the question can be reformulated into an algebraic statement concerning a pair consisting of a differential graded Lie algebra and a differential graded Lie subalgebra, and give a cohomological obstruction to this abstract stability, which recovers the results by M. Crainic and R. Fernandes. Then, I will apply the result to obtain a stability criterion for leaves of Dirac structures in arbitrary Courant algebroids of split signature

2.4 The bar construction on double Lie groupoids

Speaker: Linus Mußmächer

Abstract: We will begin with a short reminder on double Lie groupoids and VB groupoids. Based on a paper by Mehta and Tang, we then discuss the nerve functor and the bar construction first in the more general case of double Lie groupoids before discussing the goal of my master's thesis: Using a description of VB groupoids as cochains to achieve more specific results in the VB groupoid case.

2.5 Local Structures in (complex) Dirac Geometry

Speaker: Rodrigo Baptista

Abstract: Dirac geometry, as is the case of many other important geometries, has its origin in Physics (particularly classical mechanics) and generalises the structures present in Symplectic and Poisson geometry. In particular, those Dirac structures can be shown to have an associated foliation leading to a normal form around points (à la Darboux or Weinstein). Moreover, by complexifying, we are able to describe a much larger class of structures, from the already mentioned symplectic and Poisson to (Generalised) Complex and CR structures, and, thus, we would also like to obtain some normal form results in this setting. Unfortunately, complex Dirac structures turn out to be much more complex and, even though a partial result for a normal form has been given by Agüero and Rubio (2022), there is still much to be understood. In this talk, we shall explore all of these facets of Dirac geometry as well as discuss on-going work on the (L_∞ -algebras encoding) deformations of certain complex Dirac structures and holomorphisation of (real-)analytic complex Dirac manifolds.

2.6 Generic Poisson structures

Speaker: Jorn van Voorthuizen

Abstract: Poisson structures generalise symplectic geometry, and appear in diverse mathematical and physical contexts. In this talk, we focus on generic Poisson structures, exploring their definition, fundamental examples, and basic properties. A key distinction arises between even- and odd-dimensional manifolds: in even dimensions, generic Poisson structures correspond to log-symplectic structures, while in odd dimensions, their behaviour is more intricate and remains less understood. My PhD research is dedicated to studying generic Poisson structures in odd dimensions, and I will illustrate my current research directions through examples.

3 Short talks

3.1 Linearisation of Poisson Structures

Speaker: Christoph Balcerzak

Abstract: Due to Weinstein's Splitting Theorem, the local study of Poisson structures reduces to the study of Poisson structures around zeros. The cotangent space at those points has a natural Lie algebra structure and therefore a natural linear Poisson structure on the tangent space. In coordinates, that is precisely the first order approximation of the Poisson structure around the zero. The problem of linearisation is now, if there is (locally) a Poisson diffeomorphism between these Poisson structures.

3.2 Geodesic rays in space of Kähler metrics with T-symmetry

Speaker: Dan Wang

Abstract: Geometric quantization on symplectic manifolds plays an important role in representation theory and mathematical physics, and is deeply related to symplectic and differential geometry. A crucial problem is to understand the relationships among geometric quantizations associated with different polarizations. In this talk, we will discuss the existence of geodesic rays in the space of Kähler metrics with T-symmetry, driven by imaginary time flow. This is joint work with Conan Leung.

3.3 Transversely and isotropically multiplicative connections

Speaker: Sven Holtrop

Abstract: A connection on the source map of a groupoid G for which the associated distribution H is a subgroupoid of TG is called a Cartan connection. In this talk, I will introduce two alternative notions of multiplicativity for a connection on the source map of a groupoid. These connections are dual to each other in precise sense. Finally, I will explain how transversely multiplicative connections are a key part of the structure of Riemannian groupoids.

3.4 From vector bundles to principal bundles: Groupoids version

Speaker: Alfonso Garmendia

Abstract: For any vector space, we have many choices for an ordered basis. An extra structure (as orientation or inner product) on the space usually means a nice choice of an ordered basis. Given a vector bundle, the space of ordered bases at each point is its principal bundle of frames. This talk, about a joint work with Francesco Cattafi, shows a choice for ordered basis on a vector bundle groupoid, leading to a principal bundle groupoid with a lie 2 groupoid as structure space.

4 Mentoring sessions

We have scheduled a group mentoring session and individual mentoring sessions. Participation in each session is entirely voluntary.

We do not specify a singular purpose or topic for these sessions. Instead, for your inspiration, we give below some possible discussion points, some general and some [specific].

Jobs

- How, where, and when to apply?
- How to determine if a job is suitable for me?
- What are the strengths or weaknesses of my CV?
- What are the different paths in academia?

Networking

- How to find or what my precise area or community is?
- Feedback on your presentation and communication skills
- What talks to give, and where to give them?
- Imposter syndrome and insecurities

Academia

- Minorities, hierarchies, and discrimination in academia
- How do I choose a project?
- How do I move beyond my PhD project?
- When and how should I seek collaborations?
- Where to find help if bullied at work or in the community?

- Building mental resilience against psychological violence within academia
- Navigating the publishing process

Life

- Balancing work, life, and family
- Managing geographic uncertainty in the early stages of a career

This list is non-binding and non-exhaustive! What you discuss is between you and your mentor. We encourage discussions ranging from the concrete to the philosophical, and from the short-term to long. Details will also be given at the retreat.

For more information, visit the website: [BGW Official Website](#).
You can reach us at: bgw-retreat@mpim-bonn.mpg.de.