Program Booklet

SYMMETRIES IN GEOMETRY ANALYSIS AND SPECTRAL THEORY

ON THE OCCASION OF JOACHIM HILGERT'S 60TH BIRTHDAY
JULY 23 – 27, 2018

ORGANIZERS
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Symmetries in Geometry, Analysis and Spectral Theory

Universität Paderborn
July 23-27, 2018

Organizing Committee

Jan Frahm (FAU Erlangen-Nürnberg)
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Conference Venue

Institut für Mathematik, Universität Paderborn, Warburger Straße 100, D-33098 Paderborn

Building O

This conference is financially supported by the German Science Foundation (DFG)

Contents

General information

Conference venue: Building O

Check-in for Conference: Room O1.224

All talks are held in lecture room O1.

All rooms are equipped with blackboards and a projector.
Technical assistance: Nico Rathai, Philipp Schütte.

Coffee breaks take place in Room O1.224.

Room O1.252 serves as a common room for discussions and reading; it is equipped with a number of sockets.

Internet Access

We provide two networks for the WIFI access: Eduroam and WEBAUTH. Please follow the instructions on the information sheet which is part of your conference material.

Transport

It is possible to reach the University Campus from the city center by foot in roughly 30 minutes or alternatively by bus in about 15 minutes. Tickets can be purchased on the bus (only cash) and at many bus stations (including Hauptbahnhof). We recommend to buy either **4er Tickets** (4 rides), or a **7 Tage Ticket** (7 days).

There are three lines going to the University campus from Paderborn train station (Hauptbahnhof) through the city center: line 4, line 9 and line 68. Busses 4 and 9 are running every 15 minutes.

Bus stops close to the campus:

1. Bus stop **Uni-Südring** can be reached from downtown (Hauptbahnhof, Westerntor, Rathausplatz, Kamp) by line 4 (direction Dahl) and line 9 (direction Kaukenberg).

2. Bus stop **Schöne Aussicht** can be reached from downtown (Hauptbahnhof, Neuhäuser Tor, Detmolder Tor, Am Bogen) by line 68, direction **Schöne Aussicht**. It operates every 30 minutes.

Notice: The line **UNI** does not operate during the semester break. The stop **Zentralstation** is presently closed.

Meals

The University Restaurant (Mensa, denoted by ME on the campus map) is located near the main University entrance in the C-building. It offers a varied selection of meals including vegetarian and vegan options and it is possible to pay cash (payment by credit card is not available). The opening hours are 11:15-14:00 Monday-Thursday and 11:15-13:30 on Friday.

Hot meals and snacks are also served in the bar "Grill Café" and in the Cafeteria, both located in the same building as the Mensa.

A big chinese restaurant "China Palast" (Warburger Str. 138) is available within 10-15 minute walk from the University campus. The shopping mall "Südring Center" (5-10 Minutes) offers various snack and fast food options.

Some recommended restaurants in Paderborn downtown:

- Restaurant Orangerie (Italian), Mühlenstraße 6
- Restaurant "La Petite Galerie" (in the Abdinghof Hotel), Bachstraße 1
- Goa Curry (Indian), Westernmauer 86
- Edoki Sushi Bar, An der alten Synagoge 1
- Steakhouse El Rancho, An der Warmen Pader 9
- Paderborner Brauhaus (German), Kisau 2
- Taste of Chennai (authentic south Indian food), Am Westerntor 4
- Kö13 (German/Mediterranean), Neuer Platz

ATM on the Campus

There is an ATM in the Mensa building (ground floor).

Schedule

Monday, July 23

8:30 – 9:30	**Registration** (room O1.224)
9:30 – 9:45	**Opening** (Lecture room O1)
9:45 – 10:45	Henrik Schlichtkrull *Harmonic analysis on spherical spaces*
10:45 – 11:15	Coffee/Tea
11:15 – 12:15	Benjamin Harris *The Asymptotics of the Support of Plancherel Measure*
12:15 – 13:45	Lunch
13:45 – 14:45	Martin Olbrich *Different notions of resonances:* *the case of locally symmetric spaces of infinite volume*
14:45 – 15:15	Benjamin Küster *Quantum-classical correspondence on vector bundles*
15:15 – 15:45	Coffee/Tea
15:45 – 16:45	Angela Pasquale *Resonances of the Laplacian on noncompact Riemannian symmetric spaces of low rank*
16:45 – 17:45	Genkai Zhang *Second variation of Selberg zeta function and asymptotics of* L^2 *-curvature on Teichmüller space*

Tuesday, July 24

9:00 – 10:00	Bent Ørsted *Fractional differential operators in conformal geometry*
10:00 – 10:30	Coffee/Tea
10:30 – 11:30	Andreas Juhl *Residue families and shift operators*
11:30 – 12:30	Wolfgang Bertram *On the Algeometry Problem*
12:30 – 14:00	Lunch
14.00 – 15:00	Aprameyan Parthasarathy *Boundary value problems on rank one symmetric spaces*
15:00 – 15:30	Coffee/Tea
15.30 – 16:30	Sönke Hansen *Boundary values of eigenfunctions of Riemannian symmetric spaces*
16.30 – 17:00	Julia Budde *Wave Front Sets of Unitary Representations for Nilpotent Lie Groups*

Wednesday, July 25

9:00 – 10:00	Dieter Mayer *The transfer operator for $\Gamma_0(n)$ and its decomposition into irreducible components*
10:00 – 10:30	Coffee/Tea
10:30 – 11:30	Anke Pohl *Dynamics in spectral geometry*
11:30 – 12:00	Ana Cristina Ferreira *Naturally reductive homogeneous spaces - classification and special geometries*
12:00 – 14:00	Lunch
14:00 – 19:00	Excursion to Open Air Museum Detmold

Thursday, July 26

9:00 – 10:00	Karl Heinrich Hofmann *Weakly complete real vector spaces*
10:00 – 10:30	Coffee/Tea
10:30 –11:30	Jimmie D. Lawson *Loos Symmetric Cones*
11:30 – 12:30	Jacques Faraut *Horn's problem, and Fourier analysis*
12:30 – 14:00	Lunch
14:00 – 15:00	Tilman Wurzbacher *Symmetries in multisymplectic geometry*
15:00 – 15:30	José Mourão *Imaginary time hamiltonian symplectomorphisms, Bohr-Sommerfeld fibers and a new look into quantization commutes with reduction*
15:30 – 16:00	Coffee/Tea
16:00 – 17:00	Hadi Salmasian *Jordan superalgebras and the Capelli eigenvalue problem*
17:00 – 17:30	Sigiswald Barbier *A minimal representation of the orthosymplectic Lie superalgebra*
19:00 –	Conference Dinner "Gasthaus Haxterpark"

Friday, July 27

9:00 – 10:00	Gestur Ólafsson *Toeplitz operators, representation theory and the Segal-Bargman transform*
10:00 – 10:30	Coffee/Tea
10:30 –11:30	Tomasz Przebinda *Howe's correspondence and characters for dual pairs over Archimedean and non-Archimedean fields*
11:30 – 12:30	Toshiyuki Kobayashi *Branching Problems and Symmetry Breaking*
12:30 – 14:00	Lunch

Abstracts

Monday, July 23

The Asymptotics of the Support of Plancherel Measure

Benjamin Harris
(Joint work with Yoshiki Oshima)

This is joint work with Yoshiki Oshima. Let $G_{\mathbb{R}}$ be a real, reductive group, and let $X_0 \simeq G_{\mathbb{R}}/H_0$ be a homogeneous space for $G_{\mathbb{R}}$ such that (i) X_0 admits a non-zero, $G_{\mathbb{R}}$-invariant density and (ii) H_0 has an algebraic Lie algebra. In this talk, we associate to X_0 a finite number of families of irreducible, unitary representations of $G_{\mathbb{R}}$, and we compute the (non-empty) asymptotics of the support of the Plancherel measure for $L^2(X)$ inside each family. In addition, we show that the contribution of irreducible, unitary representations not within these families to the Plancherel formula for X is "small".

Quantum-classical correspondence on vector bundles

Benjamin Küster
Philipps-Universität Marburg, Germany

In joint work with Tobias Weich, we apply results due to Martin Olbrich on a vector-valued Poisson transform to the study of classical (Pollicott-Ruelle) resonances on homogeneous vector bundles over a compact Riemannian locally symmetric space of rank one. We obtain a band structure, as well as a "quantum − classical" correspondence between so-called first band resonant states and generalized eigensections of the algebra of invariant differential operators.

References

[1] B. Küster, T. Weich, *Quantum-classical correspondence on associated vector bundles over locally symmetric spaces* arXiv:1710.04625 2017

Resonances of the Laplacian on noncompact Riemannian symmetric spaces of low rank

Angela Pasquale
Université de Lorraine, Institut Élie Cartan de Lorraine, France

Let Δ be the Laplacian on a Riemannian symmetric space $X = G/K$ of the noncompact type, and let $\sigma(\Delta) \subseteq \mathbb{C}$ denote its spectrum. The resolvent $(\Delta - z)^{-1}$ of Δ is a bounded operator on $L^2(X)$ which depends holomorphically on the complex variable $z \in \mathbb{C} \setminus \sigma(\Delta)$. Let $C^\infty(X)$ and $C_c^\infty(X)$ respectively denote the space of smooth and compactly-supported smooth functions on X. If we view the resolvent as a function on $C_c^\infty(X)$, then it has values in $C^\infty(X)$ and it often admits a meromorphic continuation across the spectrum $\sigma(\Delta)$ to a suitable Riemann surface above $\mathbb{C}$. The poles of the meromorphically extended resolvent are called resonances. The image of the residue operator at a resonance is a spherical G-module. The main problems are the existence and the localization of the resonances as well as the study of the corresponding G-modules.

The resonances of Δ are related to the singularities of the Plancherel measure. Their study reduces to the meromorphic continuation of a singular integral. In this talk we look at the some low rank cases for which the singularities are along hyperplanes perpendicular to the coordinate axes. This situation occurs for products of rank-one symmetric spaces and for several symmetric spaces of type BC.

The talk is based on ongoing works with Joachim Hilgert (Universität Paderborn) and Tomasz Przebinda (University of Oklahoma).

Second variation of Selberg zeta function and asymptotics of L^2-curvature on Teichmuller space

Genkai Zhang
Mathematical Sciences, Chalmers University of Technology and Gothenburg University, Götebrog, Sweden

The Selberg zeta function $\zeta(s)$ for a compact Riemann surface Σ is defined as a product in terms of lenghts of primitive geodesics, and it appears naturally in the computation of the trace of powers of resolvent of the Laplace operator on Σ via the Selberg trace formula. For integer values of s it is also the analytic torsion of $\bar{\partial}$-Laplacians of line bundles $\mathcal{K}^m$ over Σ. We study the second variation of $\zeta(s)$ as a function on the Teichmüller space and find its aysmptotics for $s \to \infty$. We study also the variation of analytic torsion of

general line bundles over Σ. As application we find the asymptotics of L^2-curvatures. (Joint works with K. Fedosova, J. Rowlett and with X. Wan.)

References

[1] B. Berndtsson, *Positivity of direct image bundles and convexity on the space of Kähler metrics*, J. Differ. Geom. **81** (2009), no.3, 457-482.

[2] P. Sarnak, *Determinants of Laplacians*, Communications in Mathematical Physics **110** (1987), no. 1, 113–120.

[3] X. Wan and G. Zhang, The asymptotics of the L^2-curvature and the second variation of analytic torsion on Teichmüller space, preprint 2018.

[4] K. Fedosova, J. Rowlett and G. Zhang, Second variation of Selberg zeta functions and curvature asymptotics, preprint 2017.

Tuesday, July 24

Fractional differential operators in conformal geometry

Bent Ørsted

Department of Mathematics, Aarhus University, Denmark

Conformal geometry deals on one side with Riemannian differential geometry, differential operators, and curvature invariants, and on the other side with representation theory of the conformal group G of the standard sphere. Both aspects have seen many recent developments, and there seems to be several interplays between these two aspects. In this talk we shall review some of the representation theory, in particular the Knapp-Stein intertwining operators for induced representations of G corresponding to differential forms; thus we shall find some natural Riesz distributions on differential forms, in analogy with fractional powers of the Laplacian on functions. This is joint work with M. Fischmann [1]. See also [2] and [3] for corresponding Poisson transforms and boundary-value problems.

References

[1] Fischmann, Matthias; Ørsted, Bent, A family of Riesz distributions for differential forms on Euclidian space, arxiv (2017)

[2] Frahm, Jan; Ørsted, Bent; Zhang, Genkai, On boundary value problems for some conformally invariant differential operators. Comm. Partial Differential Equations 41 (2016), no. 4, 609–643.

[3] Fischmann, Matthias; Somberg, Petr; Ørsted, Bent, Bernstein-Sato identities and conformal symmetry breaking operators, arxiv (2017)

Residue families and shift operators

Andreas Juhl

Humboldt University, Berlin

Symmetry breaking operators $C^\infty(\mathbb{R}^{n+1}) \to C^\infty(\mathbb{R}^n)$ are equivariant for the conformal group of $\mathbb{R}^n$ with respect to principal series representations acting on $C^\infty(\mathbb{R}^{n+1})$ and $C^\infty(\mathbb{R}^n)$. These can be written as compositions of certain second-order equivariant differential operators on $\mathbb{R}^{n+1}$ (shift operators) and the restriction to $\mathbb{R}^n$. We describe curved generalizations of shift operators in terms of Poincaré metrics (in the sense of [1]). Certain compositions of these operators can be identified with residue families (introduced in [3]). Among other things, this identification naturally implies holographic formulas for Branson's Q-curvature. In the talk, we describe the main ideas of that theory.

References

[1] C. Fefferman and C. R. Graham, *The Ambient Metric*. Annals of Math. Studies **178**, Princeton University Press, 2012. `arXiv:0710.0919`

[2] M. Fischmann, A. Juhl and B. Ørsted, *Shift operators, residue families and degenerate Laplacians.* (work in progress)

[3] A. Juhl, *Holographic formula for Q-curvature. II*, Adv. Math. **226** (2011), 3409–3425. `arXiv:1003.3989`

[4] A. Juhl, *Families of conformally covariant differential operators, Q-curvature and Holography*, Birkhäuser, Progress in Mathematics **275**, 2009.

On the Algeometry Problem

Wolfgang Bertram
Institut Élie Cartan de Lorraine
Université de Lorraine at Nancy, France

By "Algeometry Problem" I mean the question if there is a general relation between algebras and geometries, following the pattern of the Lie functor relating Lie groups and Lie algebras. At present, this problem is still wide open, but I think it would be a challenge, especially for the "Lie community", to attack this problem more systemetically. I will report on my work on special cases of this problem (Jordan and associative algebras, and their ternary analogs), and I will try to highlight general methods and results which also shed new light on the Lie functor.

Boundary value problems on rank one symmetric spaces

Aprameyan Parthasarathy
Department of Mathematics, IIT Madras, Chennai, India

In this talk, we'll outline some recent work on boundary value problems on Riemannian symmetric spaces of rank one, and more generally on Damek-Ricci spaces, having some applications in mind. Following the ideas of Oshima in [2] giving a simplified definition of boundary values, we give an elementary proof of the rank one Helgason conjecture for distributions. This (see [1]) is joint work with S. Hansen and J. Hilgert. Time permitting, we'll give an application to scattering theory on symmetric spaces as well as mention some work in progress (with L. Roncal and S. Thangavelu) in relation to the extension problem for the sub-Laplacian on H-type groups.

References

[1] (with S. Hansen and J. Hilgert) Resonances and scattering poles for Riemannian symmetric spaces of rank one, To appear in Int. Math. Res. Not. (IMRN).

[2] T. Oshima, A definition of boundary values of solutions of partial differential equations with regular singularities, Publ. Res. Inst. Math. Sci., 19(3):1203–1230, 1983.

Boundary values of eigenfunctions of Riemannian symmetric spaces

Sönke Hansen
Universität Paderborn, Germany

Joint eigenspaces E_λ of the algebra $\mathbb{D}(X)$ of invariant differential operators of a Riemannian symmetric space $X = G/K$ are, by left translation, representation spaces of G. The spherical principal series representation induced from the spectral parameter $\lambda \in \mathfrak{a}_c^*$ is, provided λ is not a zero of the **e**-function, G-isomorphic to E_λ via the Poisson transform. This was conjectured by Helgason, and the conjecture was positively resolved by Kashiwara et al. in the late seventies. They developed a microlocal theory of boundary problems for systems of regular singular PDE and applied it to $\mathbb{D}(X)$ at infinity, that is at the Furstenberg boundary $B = K/M$ of X. Generically, the inverse of the Poisson transform is a boundary value map from E_λ onto the space of hyperfunctions on B. I report about joint work with Hilgert and Parthasarathy on simplifications of the boundary value theory for $u \in E_\lambda$ and of the proof of the former Helgason conjecture.

Wave Front Sets of Unitary Representations for Nilpotent Lie Groups

Julia Budde
Universität Paderborn, Germany

The notion of a wave front set for a unitary Lie group representation was introduced in the 1980s by Kashiwara-Vergne [3] and Howe [2]. For unitary representations of compact Lie groups they showed that the wave front set is equal to the asymptotic orbital support. This was recently generalized for real reductive Lie groups by Harris, He and Olafsson [1].

In this talk I present a version of this theorem for nilpotent Lie groups. I will explain the necessary objects and the main ingredients to the proof and would like to discuss applications of this result.

This is joint work with Tobias Weich.

References

[1] Benjamin Harris, Hongyu He, and Gestur Olafsson, *Wave Front Sets of Reductive Lie Group Representations*, Duke Mathematical Journal 165 (2016),

no. 5, 793-846.

[2] Roger Howe, *Wave Front Sets of Representations of Lie Groups*, in Automorphic Forms, Representation Theory, and Arithmetic, in Tata Institute of Fundamental Research Studies in Mathematics 10, Bombay, 1981, Springer Berlin Heidelberg, 117-140.

[3] Masaki Kashiwara and Michele Vergne, *K-types and singular spectrum*, in Noncommutative Harmonic Analysis (Proc. Third Colloq.), Marseilles-Luminy, 1978, in Lecture Notes in Math. 728, Springer Berlin, 1979, 177-200.

Wednesday, July 25

The transfer operator for $\Gamma_0(n)$ and its decomposition into irreducible components

Dieter Mayer
Institute for Theoretical Physics, Clausthal University, Germany

The transfer operator for the Hecke congruence subgroups $\Gamma_0(n)$ is given by

$$\begin{pmatrix} 0 & \mathcal{L}_s^{\Gamma_0(n),+} \\ \mathcal{L}_s^{\Gamma_0(n),-} & 0 \end{pmatrix},$$

where $\mathcal{L}_s^{\Gamma_0(n),\pm} : B(D,\mathbb{C}^\mu) \to B(D,\mathbb{C}^\mu)$ has the form

$$\mathcal{L}_s^{\Gamma_0(n),\pm}\underline{f} = \sum_{n=1}^{\infty} \frac{1}{(z+n)^{2s}} \chi_{\Gamma_0(n)}(ST^{\pm n})\underline{f}\left(\frac{1}{z+n}\right),$$

where $T = \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}$ respectively $S = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$ denote generators of $PSL(2,\mathbb{Z})$, and $\chi_{\Gamma_0(n)}$ denotes the representation of $PSL(2,\mathbb{Z})$ induced from the trivial representation of $\Gamma_0(n)$ and $\mu = [PSL(2,\mathbb{Z}) : \Gamma_0(n)]$. It is well known, that the values of s, for which this operator $\mathcal{L}_s^{\Gamma_0(n)}$ has the eigenvalue $\lambda = 1$, respectively the corresponding eigenvectors determine the spectrum of the automorphic Laplacian $\Delta = -y^{-2}(\partial_x^2 + \partial y^2)$ for $\Gamma_0(n)$, which on the other hand is unitarily equivalent to the spectrum of the automorphic Laplacian $A(\Delta, PSL(2,\mathbb{Z}), \chi_{\Gamma_0(n)})$, where Δ is acting on the Hilbert space of functions $\underline{f}$ transforming under the representation $\chi_{\Gamma_0(n)}$ of the group $PSL(2,\mathbb{Z})$ as

$\underline{f}(gz) = \chi_{\Gamma_0(n)}(g)\underline{f}(z)$. The representation $\chi_{\Gamma_0(n)}$ is the permutation representation determined by the action of $PSL(2,\mathbb{Z})$ on the finite set $PSL(2,\mathbb{Z})/\Gamma_0(n)$. Since the kernel of $\chi_{\Gamma_0(n)}$ is the maximal subgoup of $\Gamma_0(n)$ normal in $PSL(2,\mathbb{Z})$, which indeed is the group $H_n = \{g \in PSL(2,\mathbb{Z}) : g = \alpha\, id_2 \mod n, \alpha^2 = 1 \mod n\}$, the representation $\chi_{\Gamma_0(n)}$ can be considered also as a representation of the finite group $Q_n = PSL(2,\mathbb{Z})/H_n$. It is known that $Q_{nm} \cong Q_n \times Q_m$ for $(n,m) = 1$ and therefore if n has the prime power decomposition $n = \prod_{l=1}^{r} p_l^{k_l}$ one has $Q_n \cong Q_{p^{k_1}} \times \cdots \times Q_{p^{k_r}}$. But $H_{p^k} = \Gamma(p^k)$ and hence $Q_{p^k} \cong PSL(2,\mathbb{Z}/p^k\mathbb{Z})$ and therefore $Q_n \cong PSL(2,\mathbb{Z}/p^{k_1}\mathbb{Z}) \times \cdots \times PSL(2,\mathbb{Z}/p^{k_r}\mathbb{Z})$. The irreducible representations of these groups are known from the work of Nobs and Wolfahrt. The simplest case is when n is square free which I will discuss in my talk. Important for the spectral theory of the automorphic Laplacian $A(\Delta, PSL(2,(Z),\chi)$ are the eigenvalues of the matrix $\chi(T)$ where $T = \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}$ generates the parabolic cyclic subgroup Γ_∞ fixing the cusp $z = \infty$ of the modular group $PSL(2,\mathbb{Z})$. Denote by V the eigenspace of $\chi(T)$ to the eigenvalue $\lambda = 1$. If its dimension $\dim V > 0$ one calls χ singular of degree $\dim V > 0$. Then one knows that the automorphic Laplacian $A(\Delta, PSL(2,(Z),\chi)$ has a continuous spectrum of multiplicity $\dim V$. I will show that all the irreducible components of the induced representation $\chi_{\Gamma_0(n)}$ for n squarefree are singular of degree 1. This holds true especially for the groups $\Gamma_0(d)$ for d the discriminant of the unit group $\mathcal{O}_d$ of an indefinite quaternion division algebra and hence their new Maass cusp forms cannot be characterized by an irreducible component of the representation $\chi_{\Gamma_0(d)}$.

Dynamics in spectral geometry

Anke Pohl
University of Bremen, Germany

The intimate relation between the geometric and spectral properties of Riemannian locally symmetric spaces is of utmost interest in various areas, including dynamical systems, spectral theory, harmonic analysis, representation theory, number theory and quantum chaos, and contributes to their cross-fertilization. Up to date, the full extent of this relation, its consequences and the properties of several entities on the geometric and the spectral side remain an active area of research. I will report on recent results in an ongoing research program to understand this relation by means of transfer operator techniques.

Naturally reductive homogeneous spaces - classification and special geometries

Ana Cristina Ferreira
University of Minho, Portugal

In this talk, we will present geometric tools to classify and study naturally reductive homogeneous spaces. Let M be a manifold, g a Riemannian metric on M and T a 3-form in $\Omega^3(M)$. We will say that a triple (M, g, T) is *naturally reductive* if the metric connection $\nabla := \nabla^g - T$ is such that $\nabla T = 0 = \nabla R$, where R is the curvature tensor of ∇. If M is connected and simply connected, this is equivalent to the standard notion of naturally reductive homogenous space. After discussing our tools and methods, which are based on the interplay between geometric structures and characteristic connections, we will recover the well-known classifications in dimensions 3, 4 and 5 and present our classification in dimension 6. Time permitting, we will also present large families of examples of such spaces in higher dimensions.

References

[1] Agricola, Ilka; Ferreira, Ana Cristina; Friedrich, Thomas. *The classification of naturally reductive homogeneous spaces in dimensions $n \leq 6$*. Differential Geom. Appl. 39 (2015), 59–92.

[2] Agricola, Ilka; Ferreira, Ana Cristina; Storm, Reinier. *Quaternionic Heisenberg groups as naturally reductive homogeneous spaces*. Int. J. Geom. Methods Mod. Phys. 12 (2015), no. 8, 1560007, 10 pp.

[3] Agricola, Ilka; Ferreira, Ana Cristina; *Tangent Lie groups as naturally reductive spaces*; Adv. Appl. Clifford Algebras, Volume 27, Issue 2, pp. 895–911 (2017)

Weakly complete real vector spaces

Karl Heinrich Hofmann
Fachbereich Mathematik, Technische Universität Darmstadt, Germany

In the Lie theory of pro-Lie groups, in particular that of compact and locally compact groups, the so-called *weakly complete real topological vector spaces* play a significant role as was amply discussed in [2] and [3]. It should be noted that weakly complete real unital topological algebras and topological Hopf algebras deserve attention in their own right. Every compact group is a closed multiplicative subgroup of a weakly complete unital algebra [2]. RAFAEL DAHMEN proved that the multiplicative group of *any* weakly complete unital algebra is a pro-Lie group ([1], [4]). The topic of the presentation is projected as a new chapter of the 4th edition of [2], including a geodesic approach to Tannaka duality of compact groups. The lecture also is a drum roll for a joint article by RAFAEL DAHMEN, SIDNEY MORRIS, and the presenter.

References

[1] Bogfiellmo, G., R. Dahmen, and A. Schmeding, *Character groups of Hopf algebras as infinite dimensional Lie groups*, Ann. Inst. Fourier **66** (2016), 2101–2155.

[2] Hofmann, K. H., and S. A.Morris, *The Structure of Compact Groups*, De Gruyter, Berlin, 2013 (3rd ed).

[3] —, *The Lie Theory of Connected Pro-Lie Groups*, Europ. Math. Soc., Zürich, 2007.

[4] —, *Pro-Lie Groups: A Survey with Open Problems*, in: S. A. Morris. Ed., Topological Groups: Yesterday, Today, Tomorrow, MDPI AG Basel etc., 2016, 11-31.

Loos Symmetric Cones

Jimmie Lawson
Department of Mathematics, Louisiana State University, USA

We consider a variant, actually a special case, of a Loos symmetric space called a *Loos symmetric cone*. These are open cones in Banach spaces with closure a normal cone satisfying a mildly strengthened version of the Loos axioms for a symmetric space. The Loos structure is connected to the order structure via a weak version of the inequality for the geometric and arithmetic means and to the linear structure via a linearity condition for the displacements. From the Loos structure one obtains a uniquely defined spray with a corresponding exponential map. The geodesics turn out to be metric geodesics for a natural (and standard) Finsler structure on the open cone and one can show that the Finsler distance metric is the well-known Thompson metric on the cone. The metric space can be shown to have nonnegative curvature in the sense of Busemann. These and further structural results will be discussed in the presentation.

Horn's problem, and Fourier analysis

Jacques Faraut
Institut de Mathématiques de Jussieu, Sorbonne Université, Paris, France

Let A and B be two $n \times n$ Hermitian matrices. Assume that the eigenvalues $\alpha_1, \ldots, \alpha_n$ are known, as well as the eigenvalues $\beta_1, \ldots, \beta_n$ of B. What can be said about the eigenvalues of the sum $C = A + B$? This is Horn's problem. In 1962 Horn proposed a conjecture, the so-called Horn's conjecture, which says: The set of possible eigenvalues $\gamma_1, \ldots, \gamma_n$ for C is determined by a system of linear inequalities of the form

$$\sum_{k \in K} \gamma_k \leq \sum_{i \in I} \alpha_k + \sum_{j \in J} \beta_j,$$

where $\{I, J, K\}$ is a triple of subsets of $\{1, 2, \ldots, n\}$ which is admissible (in a sense to be given). Horn's conjecture has been proven by Klyachko in 1998. We revisit this problem from a probabilistic point of view. The set of Hermitian matrices X with spectrum $\{\alpha_1, \ldots, \alpha_n\}$ is an orbit $\mathcal{O}_\alpha$ for the natural action of the unitary group $U(n)$: $X \mapsto UXU^*$ ($U \in U(n)$). Assume that the random Hermitian matrix X is uniformly distributed on the orbit $\mathcal{O}_\alpha$, and, independently, the random matrix Y is uniformly distributed on $\mathcal{O}_\beta$. In this talk we will present a formula for the joint distribution of the eigenvalues of the

sum $Z = X + Y$. The proof involves orbital measures with their Fourier transforms, and Heckman's measures. This distribution is related to the product formula of the spherical functions for a Cartan motion group.

Symmetries in multisymplectic geometry

Tilmann Wurzbacher
Université de Lorraine, France

After briefly recalling how multisymplectic structures (i.e., closed non-degenerate differential forms of degree two and higher) arise in nature, we will give examples galore. We will then discuss linear and nonlinear symmetries of these structures, and finally introduce the so-called homotopy co-moment for Hamiltonian symmetries on a multisymplectic manifold. If time permits we will give applications to conservation theorems.

References

[1] Leonid Ryvkin and Tilmann Wurzbacher, *An invitation to multisymplectic geometry*, `arXiv:1804.02553`

[2] Leonid Ryvkin, Tilmann Wurzbacher and Marco Zambon, *Conserved quantities on multisymplectic manifolds*, `arXiv:1610.05592`

Imaginary time hamiltonian symplectomorphisms, Bohr-Sommerfeld fibers and a new look into quantization commutes with reduction

José Mourão
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Let the compact connected Lie group G act in an Hamiltonian and Kähler way on a Kähler manifold M and assume that its action extends to $G_{\mathbb{C}}$. Then, by taking geodesics of Kähler structures generated by convex functions of the G-momentum map to infinite geodesic time, one gets (conjecturally always,

proved on several important examples) a concentration of holomorphic sections of holomorphic line bundles on inverse images of coadjoint orbits under the G-momentum map.

On work with T Baier, J Hilgert, O Kaya, JP Nunes and M Pereira

Jordan superalgebras and the Capelli eigenvalue problem

Hadi Salmasian

Department of Mathematics and Statistics, University of Ottawa, USA

For a finite dimensional unital complex simple Jordan superalgebra J, the Tits-Kantor-Koecher construction yields a 3-graded Lie superalgebra $\mathfrak{g}^\flat \cong \mathfrak{g}^\flat(-1) \oplus \mathfrak{g}^\flat(0) \oplus \mathfrak{g}^\flat(1)$, such that $\mathfrak{g}^\flat(-1) \cong J$. The algebra of superpolynomials $P(V)$, where $V \cong J^*$, is isomorphic to the supersymmetric algebra $S(J)$, and therefore it has a natural $\mathfrak{g}$-module structure, where $\mathfrak{g} := \mathfrak{g}^\flat(0)$. In most cases, $P(V)$ is completely reducible and multiplicity-free, and there exists a direct sum decomposition $P(V) := \bigoplus_{\lambda\in\Omega} V_\lambda$, where $(V_\lambda)_{\lambda\in\Omega}$ is a family of irreducible $\mathfrak{g}$-modules parametrized by a set of partitions Ω. In these cases, one can define a natural basis $(D_\lambda)_{\lambda\in\Omega}$ of "Capelli operators" for the algebra $PD(V)^{\mathfrak{g}}$ of $\mathfrak{g}$-invariant superpolynomial differential operators. The Capelli eigenvalue problem asks for the determination of the scalar $c_\mu(\lambda)$ by which D_μ acts on V_λ.

In this talk we give a complete solution to the Capelli eigenvalue problem. To this end, we associate a restricted root system Σ to the symmetric pair $(\mathfrak{g}, \mathfrak{k})$ that corresponds to J, which is either a deformed root system of type $\mathtt{A}(m,n)$ or a root system of type $\mathtt{Q}(n)$. We prove a necessary and sufficient condition on the structure of Σ for $P(V)$ to be completely reducible and multiplicity-free. When Σ satisfies the latter condition we obtain an explicit formula for the eigenvalue $c_\mu(\lambda)$, in terms of Sergeev-Veselov's shifted super Jack polynomials when Σ is of type $\mathtt{A}(m,n)$, and Okounkov-Ivanov's factorial Schur Q-polynomials when Σ is of type $\mathtt{Q}(n)$. Along the way, we prove that the natural map from the centre of the enveloping algebra of $\mathfrak{g}$ into $PD(V)^{\mathfrak{g}}$ is surjective in all cases except when $J \cong F$, where F is the 10-dimensional exceptional Jordan superalgebra. This talk is based on joint works with Alexander Alldridge, Siddhartha Sahi, and Vera Serganova.

A minimal representation of the orthosymplectic Lie superalgebra

Sigiswald Barbier
Ghent University, Belgium

Minimal representations are an important class of "small" infinite dimensional unitary representations of Lie groups. They are characterised by the fact that their annihilator ideal is equal to the Joseph ideal. Two prominent examples are the metaplectic representations of $Mp(2n)$ (a double cover of $Sp(2n)$) and the minimal representation of the indefinite orthogonal group $O(p,q)$.

In this talk I will construct a generalisation of the minimal representation of $\mathfrak{so}(p,q)$ to the orthosymplectic Lie superalgebra $\mathfrak{osp}(p,q|2n)$ using the framework of Jordan superalgebras. This representation also has an annihilator ideal equal to a Joseph-like ideal.

Friday, July 27

Toeplitz operators, representation theory and the Segal-Bargman transform

Gestur Ólafsson
Louisiana State University, USA

Classification of commutative C^*-algebras of Toeplitz operators on bounded symmetric domains has been an active fields in operators algebras for some time. We relate the question to multiplicity one restriction of holomorphic discrete series representations through the C^* algebra of invariant symbols. By that we are able to construct several unexpected examples. We then specialize to the unit ball in $\mathbb{C}^n$ and relate this to the restriction principle and the Segal-Bargmann transform to determine the symbol of the Toeplitz operators that invariant under maximal abelian subgroups.

This is a joint work with M. Dawson, CIMAT, Merida and R. Quiroga-Barranco, CIMAT, Guanajuato

Howe's correspondence and characters for dual pairs over Archimedean and non-Archimedean fields

Tomasz Przebinda
Department of Mathematics, University of Oklahoma, USA

A number of ideas going back to Cauchy's Determinantal Identity,

$$\det\left(1-\frac{1}{h_jh'_k}\right)=\frac{\prod_{j<k}(h_j-h_k)\prod_{j<k}(h'_j-h'_k)}{\prod(1-h_jh'_k)}$$

evolved over time to the contemporary notion of Howe's correspondence or local θ correspondence. This is a bijective correspondence $\Pi' \leftrightarrow \Pi$ of irreducible representations for cartain pairs (G, G') of reductive groups defined over finite, real or p-adic fields. Since an irreducible representation Π is determined by its character Θ_Π, it seems natural to look for an integral kernel operator, analogous to

$$\Theta_\Pi(g)=\frac{1}{|G'|}\sum_{g'\in G'}\Theta(gg')\Theta_{\Pi'}(g'^{-1}) \qquad (g\in G)$$

in the finite case, which has the potential of describing the character correspondence

$$\Theta_{\Pi'} \leftrightarrow \Theta_\Pi\,.$$

We shall explain such a construction for real and p-adic groups and the cases where it serves its purpose.

In part, this talk is based on a work in progress with Hung Yean Loke, National University of Singapore.

Branching Problems and Symmetry Breaking

Toshiyuki Kobayashi
University of Tokyo, Japan

I plan to discuss some general results for induction and restriction problems for reductive groups, and then explain the complete classification of symmetry breaking operators for differential forms on a pair of spheres as an application. If time permits, I would like to discuss some relations to a conjecture of Gross and Prasad.

Social program

Wednesday 2pm Excursion to LWL-Open Air Museum

Joachim and Ingrid Hilgert invite all participants of the conference to a joint excursion to the **LWL-Open-Air Museum Detmold** on Wednesday 25 July. The excursion will include a visit to the museum on rural Westphalian lifestyle and a joint coffee and cake in the museum's cafe **Im Weißen Ross**.

There will be a bus shuttle to the museum departing at the university at 2pm and returning approximately 7pm. More precise information on the departure of the bus will be announced during the conference and on the conference webpage.

Museum's homepage:
`http://www.lwl.org/LWL/Kultur/LWL-Freilichtmuseum-Detmold`

Thursday 7pm Conference Dinner

The Conference Dinner will be held in the **Gasthaus Haxterpark**, Haxterhöhe 2, 33100 Paderborn.

How to get there:

- On foot: The Gasthaus Haxterpark is located about 1km from the University
- By bus: The closest stop **Uni-Südring** can be reached from downtown (Hauptbahnhof, Westerntor, Rathausplatz, Kamp) by line 4 (direction Dahl) and line 9 (direction Kaukenberg).

There will be a bus back from Gasthof Haxterpark to the hotels in the city center at about 22:30.

Some tips for sightseeing in Paderborn

- The Pader springs: The Pader is Germany's shortest river with more than 200 springs directly in the city center (Paderquellgebiet).
- There are numerous interesting churches in the city center. The most important one is the Cathedral, named after Saint Mary, Saint Kilian and Saint Liborius. It has a beautiful inner courtyard, where you should search for the famous Window of the Three Hares (Dreihasenfenster). The relics of Saint Liborius, the patron saint of the archdiocese of Paderborn, are kept in the crypt.
- Schloss Neuhaus castle with its garden in baroque style.
- The Heinz Nixdorf MuseumsForum is the world's biggest computer museum, located 20 minutes on foot from the city center.

List of Participants

Afentoulidis Almpanis	Spyridon	IECL
Alfes-Neumann	Claudia	Universität Paderborn
Arends	Christian	Universität Paderborn
Barbier	Sigiswald	Ghent University
Barnum	Howard	University of New Mexico
Bertram	Wolfgang	Université de Lorraine
Blaga	Adara-Monica	West University of Timisoara
Blobel	Burkhard	Georg-August-Universität Göttingen
Budde	Julia	Universität Paderborn
Burban	Igor	Universität Paderborn
Cupit-Foutou	Stéphanie	Ruhr-Universität Bochum
Dahl	Tue	Aarhus University
Dawson	Matthew	CONACYT–CIMAT Unidad Mérida
Deitmar	Anton	University of Tuebingen
Farahmandparsa	Amir	Inst. Research in Fund. Sciences, Tehran
Faraut	Jacques	Sorbonne Université
Ferreira	Ana Cristina	University of Minho
Fischer	Mathias	Universität Greifswald
Frahm	Jan	FAU Erlangen-Nürnberg
Glöckner	Helge	Universität Paderborn
Hansen	Sönke	Universität Paderborn
Harris	Benjamin	
Hilgert	Joachim	Universität Paderborn
Hofmann	Karl Heinrich	Technische Universität Darmstadt
Juhl	Andreas	
Kath	Ines	Universtät Greifswald
Kiyek	Karl-Heinz	Universität Paderborn
Kobayashi	Toshiyuki	The University of Tokyo
Kolb	Martin	Universität Paderborn
Kuit	Job	Universität Paderborn
Küster	Benjamin	Philipps-Universität Marburg
Laubinger	Martin	Hannover Rück SE
Lawson	Jimmie	Louisiana State University
Marques	Fabio	UFSC
Mayer	Dieter	TU Clausthal

Mourao	José	Técnico Lisboa
Neeb	Karl-Hermann	FAU Erlangen-Nürnberg
Oeh	Daniel	FAU Erlangen-Nürnberg
Ólafsson	Gestur	Louisiana State University
Olbrich	Martin	Universite du Luxembourg
Ørsted	Bent	Aarhus University
Owis	Ashraf	Cairo University
Palmirotta	Guenda	University of Luxembourg
Parthasarathy	Aprameyan	IIT Madras, Chennai
Pasquale	Angela	Université de Lorraine, Metz
Patterson	Samuel	Universität Göttingen
Poguntke	Detlev	Universität Bielefeld
Pohl	Anke	Universität Bremen
van Pruijssen	Maarten	Universität Paderborn
Przebinda	Tomasz	University of Oklahoma
Ramacher	Pablo	Philipps University Marburg
Rathai	Nico	Universität Paderborn
Rösler	Margit	Universität Paderborn
Salmasian	Hadi	University of Ottawa
Schlichtkrull	Henrik	University of Copenhagen
Schnürer	Olaf	Universität Paderborn
Schuette	Philipp	Universität Paderborn
Shaikh	Zain	Universität Paderborn
Skill	Thomas	University of Applied Sciences Bochum
Spilioti	Polyxeni	University of Tübingen
Strasburger	Aleksander	Military University of Tech - WAT
Upmeier	Harald	University of Marburg
Weich	Tobias	Universität Paderborn
Weiske	Clemens	FAU Erlangen-Nürnberg
Wolf	Lasse	Universität Paderborn
Wurzbacher	Tilmann	Université de Lorraine, Metz
Zhang	Genkai	Chalmers Univ. Tech. and Gothenburg Univ.