

Workshop

Representation Theory and Harmonic Analysis on Homogeneous Spaces
Théorie des représentations et analyse harmonique sur les espaces homogènes
CIRM, 28 September – 2 October 2026

Titles and Abstracts

Alexandre Afgoustidis (Nancy)

Title: Well-tempered symmetric spaces

Abstract: I will discuss a class of real symmetric spaces for which the support of the Plancherel measure admits a reasonably simple description in terms of characters of real tori. These spaces are all tempered in the sense of Benoist and Kobayashi. I shall also comment on the Fell topology of the Plancherel support, mostly in the special case where this topology is Hausdorff. This is joint work with Peter Hochs, Shintaro Nishikawa and Yanli Song.

Boujemaa Agrebaoui (Sfax)

Title: Conformal solenoidal Lie (super)algebras and their cuspidal modules and q -analogues

Abstract:

Solenoidal Lie (super)algebras of contact type, their cuspidal modules and their q -analogues

V. Kac and J. van de Leur [7], give a conjecture on the classification of superconformal algebras ($\mathbb{Z}$ -graded Lie superalgebras of growth one where the Witt algebra $\mathcal{W}(1) := \mathfrak{Der}(\mathbb{C}[t, t^{-1}])$ is a subalgebra of the even part). They study their central extensions (again the Virasoro algebra is a subalgebra of the even part). One important class is contact superalgebras. In a recent work (172 pages) C. Martínez, O. Mathieu and E. Zelmanov [8], describe an explicit classification of all cuspidal modules over the superconformal algebras given in [7].

The $\mathbb{Z}^n$ -graded algebras of Witt type and their central extensions were considered by R. Yu in [9]. Recently, Y. Billig and V. Futorny [6], considered the so called solenoidal Lie algebra $\mathcal{W}_\mu(n)$ ($\mathcal{W}_\mu(1) \cong \mathcal{W}(1)$ which is simple of Witt type and they study its cuspidal modules.

In [4], we compute the universal central extension of the solenoidal Lie algebra, we obtain a higher rank Virasoro algebra. For $n = 1$, it is the well known Virasoro algebra-the universal central extension of $W(1)$ -generated by the well known Gelfand-Fuks 2-cocycle. Then we study its Harish-Chandra modules. In an other work, [5], we introduce the solenoidal Heisenberg-Virasoro algebras and we study its Harish-Chandra modules.

We introduce the so called solenoidal contact Lie superalgebras and we compute their central extensions and we study their cuspidal modules. The case $N = 1$ is a work in progress in collaboration with V. Futorny.

We will consider also the q -analogues $q - W_\mu(n)$ and $q - HW_\mu(n)$ of $W_\mu(n)$ and $HW_\mu(n)$ respectively. We computed their universal central extensions $q - Vir_\mu(n)$ and $q - HVir_\mu(n)$ and we studied their cuspidal modules [1, 2] in progress.

Références

- [1] B. Agrebaoui, M. Haddar, A. Hajjaji, W. Mhiri, A. Makhlouf The q -solenoidal (-Virasoro) algebra and its cuspidal modules, in progress.
- [2] B. Agrebaoui, M. Haddar, A. Makhlouf The q -solenoidal (Heisenberg-Virasoro) algebras and its cuspidal modules
- [3] B. Agrebaoui, V. Futorny, The solenoidal contact Lie superalgebras, their central extensions and their cuspidal modules. Work in progress.
- [4] B. Agrebaoui, W. Mhiri, The solenoidal Virasoro algebra and its simple weight modules. Communications in algebra, 53(4), pp. 1568-1580.
- [5] B. Agrebaoui, W. Mhiri, The solenoidal Heisenberg-Virasoro algebra and its simple weight modules arXiv :2403.07381 [math.RT]. To appear in Communications in algebra.
- [6] Y. Billig, V. Futorny, Classification of simple cuspidal modules for solenoidal Lie algebras, Isr.J.Math. 222,(2017), 109-123.
- [7] V.G. Kac and J.W. van de Leur, On classification of superconformal algebras. Proceedings of Strings 88 Teaneck (1989) 77-106.
- [8] C. Martinez, O. Mathieu and E. Zelmanov, Cuspidal modules over superconformal algebras of rank ≥ 1 . arXiv :2505.20974 [math.RT]
- [9] R. W. T. Yu, Algèbre de Lie de type Witt. Communications in algebra, 25(5), 1471-1484(1997).

Malika Ait Ben Haddou (Meknes)

Title: Lorentzian Algebraic Ricci Solitons on Four-Dimensional Nilpotent Lie Groups

Abstract: There exist seven non-equivalent Lorentzian metrics on the nilpotent four-dimensional Lie group G_4 . We show that three of these metrics do not yield algebraic Ricci solitons, while two are confirmed to be algebraic Ricci solitons. Among the latter, one metric is Ricci-flat under a certain condition but not flat. The remaining two metrics admit an algebraic Ricci soliton structure only in specific cases, depending on particular parameter relations. In contrast, for the nilpotent Lie group $H_3 \times \mathbb{R}$, five Lorentzian metrics are algebraic Ricci solitons and one is flat.

Références

- [1] W. Batat and K. Onda, *Algebraic Ricci solitons of three-dimensional Lorentzian Lie groups*, J. Geom. Phys., **114**, 138–152 (2017).
- [2] N. Bokan, T. Šukilović, and S. Vukmirović, *Lorentz geometry of 4-dimensional nilpotent Lie groups*, Geom. Dedicata, **177**, 83–102 (2015).
- [3] T. H. Wears, *On Lorentzian Ricci solitons on nilpotent Lie groups*, Math. Nachr., **290**, no. 8-9, 1381–1405 (2017).

Joint work with : Youssef Ayad

Salma Azaouzi (Sfax)

Title: Hardy's theorem on compact extensions of Nilpotent Lie Groups

Abstract: This paper investigates a sharp analogue of Hardy's uncertainty principle for compact extensions of connected, simply connected nilpotent Lie groups, structured as semi-direct products $G = K \ltimes N$, where K is a compact subgroup of automorphisms of N .

By leveraging Mackey's little group method, representation theory, and orbital norm structures on the dual space $\mathfrak{g}^*$, we establish exact characterizations for the joint decay of a function $f \in L^1(G) \cap L^2(G)$ and its operator-valued Fourier transform $\Theta_\ell(f)$.

Specifically, under Gaussian-type decay conditions governed by parameter constants $\alpha, \beta > 0$ and polynomial order $m \in \mathbb{Z}_{\geq 0}$:

- If $\alpha\beta > \frac{1}{4}$, then $f = 0$ almost everywhere on G .
- If $\alpha\beta = \frac{1}{4}$, then

$$f(k, n) = f(k, t, x) = (f(k, 0, x) + H(k, t, x)) e^{-\alpha\|t\|^2},$$

where $H(k, t, x)$ is a polynomial in t of degree at most $2m$ with $H(k, 0, x) = 0$, and is square-integrable in x .

- If $\alpha\beta < \frac{1}{4}$, there exist infinitely many linearly independent functions on G satisfying the given decay conditions.

““latex

Raphaël Beuzart-Plessis (Marseille)

Title: Towards a local trace formula for local symmetric varieties

Abstract: For G a reductive group over a local field of characteristic zero, the local trace formula of Arthur expresses a truncation of the trace of a convolution operator acting on L^2 in two different ways : one in terms of “geometric” distributions, featuring orbital integrals and certain weighted generalizations thereof, and one in terms of “spectral” contributions, involving (weighted) characters of irreducible representations.

In this talk, I will explain a generalization of Arthur's truncation procedure for general symmetric varieties, as well as a geometric expansion for certain types of symmetric varieties that we call “coregular”. This includes, in particular, all symmetric varieties of the form $G(F) \backslash G(E)$, when E/F is a quadratic extension of local fields.

This is based on joint work with Chen Wan. ““

Abdelhamid Boussejra (Kenitra)

Title: On the L^2 -range of generalized spectral projectors on vector bundles over rank one symmetric spaces

Abstract: Let G/K be a rank one Riemannian symmetric space. Let (τ, V_τ) be an irreducible representation of K , and $G \times_K V_\tau$ the associated homogeneous vector bundle.

By the Harish-Chandra Plancherel theorem, the space $L^2(G \times_K V_\tau)$ of square integrable sections decomposes into direct sum of continuous part $L^2_{\text{cont}}(G \times_K V_\tau)$ and possibly of discrete part.

Let $E_{\sigma, \lambda}$ be the space of all generalized joint eigensections of the algebra of G -invariant differential operators on $G \times_K V_\tau$ with respect to a finite dimensional representation $\chi_{\sigma, \lambda}$.

There exists a family of linear maps

$$(Q_\lambda)_{\lambda \in \mathfrak{a}_+^*} := (Q_{\sigma, \lambda})_{\sigma \in \widehat{M}},$$

with

$$Q_\lambda : L^2_{\text{cont}}(G \times_K V_\tau) \longrightarrow \bigoplus_{\sigma \in \widehat{M}} E_{\sigma, \lambda},$$

such that any $f \in C_c^\infty(G \times_K V_\tau)$ can be expanded into generalized joint eigensections as

$$f = \sum_{\sigma \in \widehat{M}} \int_{\mathfrak{a}_+^*} Q_{\sigma, \lambda} f \, d\lambda.$$

In this talk, we shall give an image characterization of the L^2 -range of the generalized spectral projectors Q_λ , thereby extending the Strichartz conjecture to vector bundles associated to arbitrary irreducible representations of K .

If time permits, we discuss the example of spectral projectors related to the Hodge–de Rham Laplacian on real hyperbolic spaces.

Bécher Dali (Bizerte)

Title: An Outline on the Cortex of Nilpotent Lie Algebras

Abstract: In this talk, we consider the open question : is the cortex of the dual of a nilpotent Lie algebra an algebraic set? We give a partial answer by considering the class of two-step nilpotent Lie algebra $\mathfrak{g}$. For this class of Lie algebras we give an explicit algorithm for finding its corresponding cortex.

Next we give an example of 7-dimensional (real) nilpotent Lie algebra for which the cortex is a proper semi-algebraic set in the set of the common zeros of the G -invariant polynomials on $\mathfrak{g}^*$ namely the I -cortex, where G is the corresponding connected and simply connected Lie group and $\mathfrak{g}^*$ is its dual.

Finally we study the cortex of a class of nilpotent Lie groups given by a semi-direct product of abelian groups $G := \mathbb{R}^m \rtimes_\pi V$ where π is the continuous representation of $\mathbb{R}^n$ on the m -dimensional (real) vector space V defined by

$$\pi(t_1, \dots, t_n) = \exp \left(\sum_{i=1}^n t_i A_i \right)$$

with $\{A_1, \dots, A_n\}$ is a set of pairwise commuting nilpotent matrices in $\mathbb{R}^{m \times m}$.

References

1. D. Arnal, M. Ben Ammar, B. Currey, and B. Dali, Canonical coordinates for coadjoint orbits of completely solvable Lie groups, Jour. Lie Theory No. 2 (2005), 521–560.
2. D. Arnal, M. Cahen, and J. Ludwig, Lie groups whose coadjoint orbits are of dimension smaller or equal to two, Lett. Math. Phys. 33 (1995), 183–186, MR13116347.
3. A. Baklouti, le cortex en dimension 6, Publication du centre Universitaire de Luxembourg. Fascicule V (1993), 7–45.
4. M.E.B. Bekka, and E. Kaniuth, Irreducible representation of locally compact group that cannot be Hausdorff separated from the identity representation, J. Reine Angew. Math., 385 (1988), 203–220.
5. J. Boidol, J. Ludwig, and D. Müller, On infinitely small orbits, Studia Math. T. LXXXVIII (1988), 1–11.
6. B. Dali, On the cortex of a class of exponential Lie algebras, Jour. Lie Theory No. 22 (2012), 845–867.

7. B. Dali, Infinitely small orbits of two-step nilpotent Lie algebras, Jour. Alg. No. 461 (2016), 351–374.
8. B. Dali, C. Sayari, The Cortex of a class of matrix groups and exponential Lie groups. REVISTA DE LA UNION MATEMATICA ARGENTINA Vol. 65, No. 2, 2023, Pages 313–329.
9. B. Dali, C. Sayari, The Cortex of Nilpotent Lie Algebras of Dimensions Less or Equal to 7 and Semi-Direct Product of Vector Groups :Nilpotent Case. Journal of Lie Theory Volume 32 (2022) 643–670.
10. J.M.G. Fell, Weak containment and induced representations of groups, Canad. J. Math. 14 (1962), 237–268.
11. L. Magnin, Sur les algèbres de Lie nilpotentes de dimension ≤ 7 , Jour. Geom. Phys. Volume 3, Issue 1, (1986), 119–144.
12. Gong, Ming-Peng, Classification of nilpotent Lie algebras of dimension 7 (over algebraically closed fields and $\mathbb{R}$). Thesis (Ph.D.) University of Waterloo (Canada). (1998), 165 pp. ISBN : 978-0612-30613-4, Proquest LLC.
13. V.V. Morozov, Classification of nilpotent Lie algebras of dimension 6, Izv. Vyssh. Uchebn. Zar. 4 (1958) 161–171.
14. O. A. Nielsen, Unitary representations and coadjoint orbits of low-dimensional nilpotent Lie groups. Vol. 63 of Queen’s Papers in Pure and Applied Mathematics. Queen’s University, Kingston, ON, 1983.
15. M. Romdhani, Classification of real and complex nilpotent Lie algebras of dimension 7, Linear and Multilinear Algebra, vol. 24, no. 3, 167–189, (1989).
16. Craig Seeley, 7-dimensional nilpotent Lie algebras. Trans. Amer. Math. Soc. Vol. 335, Number 2, 479–496.
17. A.M. Vershik and S.I. Karpushev, Cohomology of groups in unitary representations, the neighbourhood of the identity and conditionally positive definite functions, Math. USSR Sbornik 47 (1984), 513–526.

Justin Feuto (Abidjan)

Title: Amalgam space on space of homogeneous type and the Hardy–Littlewood maximal operator

Abstract: We study the boundedness of the maximal Hardy–Littlewood operator on an amalgam of Lebesgue spaces defined on homogeneous spaces.

Hidenori Fujiwara (Fukuoka)

Title: Monomial representations of type I solvable Lie groups

Abstract: We would like to extend our previous results from exponential to type I solvable Lie groups (Joint work with Ali Baklouti).

Volker Heiermann (Marseille)

Title: On the determination of unramified spherical special automorphic representations

Abstract: The talk will be on the determination of special representations (i.e. square integrable, but not cuspidal) in the subspace of square integrable automorphic forms generated by spherical functions. This takes part of a joint project with M. DeMartino et E. Opdam.

Junko Inoue (Tottori)

Title: Holomorphically induced representations of some nilpotent Lie groups

Abstract: Let $G = \exp \mathfrak{g}$ be a simply connected nilpotent Lie group with Lie algebra $\mathfrak{g}$, and $f \in \mathfrak{g}^*$ be a real linear form.

Taking a complex subalgebra $\mathfrak{h}$ of the complexification of $\mathfrak{g}$ such that $f([\mathfrak{h}, \mathfrak{h}]) = \{0\}$, we define a holomorphically induced representation ρ of G as a subrepresentation of a monomial representation associated with the subgroup $\exp(\mathfrak{h} \cap \mathfrak{g})$ and the unitary character χ of $\exp(\mathfrak{h} \cap \mathfrak{g})$ satisfying $d\chi = if$.

In this talk, we are concerned with some cases such that the space $\mathfrak{h} + \bar{\mathfrak{h}}$ is not necessarily a subalgebra. We shall treat examples where the subspace $(\mathfrak{h} + \bar{\mathfrak{h}}) \cap \mathfrak{g}$ generates the Lie algebra $\mathfrak{g}$ and discuss conditions of non-vanishing of ρ and Frobenius reciprocity in the sense of distributions.

Jean Bosco Kayoya (Burundi)

Title: The Zeta Functional Equation for Jordan Algebras of Type III

Abstract:

Let W be a simple Euclidean Jordan algebra and let α be an involution of W . Writing

$$W = W^+ \oplus W^-,$$

the modification of W associated with α is the real Jordan algebra

$$W^\alpha = W^+ \oplus iW^-.$$

In the classification of simple real Jordan algebras obtained through involutions, Type III is characterized by the fact that W^+ is simple while its rank r_0 is strictly smaller than the rank r of W . In fact,

$$r = 2r_0.$$

This rank-doubling phenomenon is the essential structural feature distinguishing Type III from Type II.

The purpose of this work is to study the functional equation of the zeta integrals associated with the Type III modification W^α . The problem goes back to a conjecture formulated at the end of my doctoral thesis, defended in 1993. That conjecture, concerning the zeta distributions and their Fourier transform, has remained open despite several attempts to resolve it.

The present approach combines the structure of the involution α , the decomposition $W = W^+ \oplus W^-$, and the specific Peirce decomposition arising from the simple algebra W^+ . The Type III condition ($r = 2r_0$) leads to a structure of the generalized power functions and of the associated zeta integrals that is different from the Type II case. We investigate how this structure is reflected in the analytic continuation, the Bernstein-type identities, and the gamma factors occurring in the functional equation.

More precisely, for a Schwartz function f , we consider zeta distributions of the form

$$Z(f, s) = \int_{\mathcal{O}} \Delta_s(x) f(x) dx,$$

where $\mathcal{O}$ denotes the relevant open orbit and Δ_s is the generalized power function associated with the Jordan structure. The main question is to determine the precise relation between $Z(f, s)$ and the zeta distribution associated with the Fourier transform $\hat{f}$, and to identify the transformation of the parameter s and the corresponding gamma factor in the Type III setting.

The results are intended to provide a resolution, or a decisive reformulation, of the conjecture formulated in 1993 and to clarify the role played by the Type III involution in the functional equation of zeta distributions on non-Euclidean Jordan algebras.

Kangni Kinvi (Abidjan)

Title: On delta-Bochner theorem

Abstract: Let G be a locally compact group, K a large compact subgroup of G and d an arbitrary class of irreducible unitary representations of K . In this talk, before giving an extension of Bochner theorem, we'll construct the spherical Fourier transform according to the unitary dual of K , construct the $p - \delta$ -spherical grassmannian using a generalized Abel transform and study a relationship with disintegration of representations.

Toshiyuki Kobayashi (Tokyo)

Title: Hidden Symmetry and Spectral Analysis on Locally Symmetric Spaces beyond the Riemannian Setting

Abstract: Branching problems in representation theory ask how irreducible representations behave upon restriction to subgroups. The problem becomes particularly challenging when the representations are infinite-dimensional and the subgroup is non-compact. In this talk, I will discuss applications of branching laws to spectral analysis on standard locally symmetric spaces, extending beyond the classical Riemannian setting. Recent advances have addressed several challenges in global analysis with indefinite metrics, largely due to progress in the branching theory of infinite-dimensional representations of reductive groups. These developments are closely related to geometric structures with hidden symmetries on certain spherical varieties. I will highlight several key ideas and perspectives while avoiding technical details as much as possible. The talk is a continuation of a three lectures given the previous week, but no prior attendance is assumed.

Khalid Koufany (Nancy)

Title: Group and multiplication invariant subspaces

Abstract: This talk addresses a question posed by Adam Korányi and is based on ongoing joint work with Genkai Zhang.

Let $G = SU(1, 1)$, or more generally its universal covering group, acting on the unit disc $\mathbb{D}$. Let $K \subset G$ denote the stabilizer of the origin.

Consider the representation U induced, in the sense of Mackey, by a unitary character of K , realized as a multiplier representation on an L^2 -space of functions on $\mathbb{D}$. Let M_z denote the operator of multiplication by the coordinate function z .

The subspace of holomorphic functions is invariant under both U and M_z . Korányi's question is whether it is the only nontrivial proper closed subspace with this joint invariance property.

In this talk, I will discuss this problem and present an answer to Korányi's question.

Ajay Kumar (Delhi)

Title: L^p -Gabor transform norm on locally compact groups

Abstract: We study the L^p -Gabor transform $G_\psi f$ for $f \in L^p(G)$, window function $\psi \in L^q(G)$, $1 < p \leq 2$ and $q = \frac{p}{p-1}$, where G is a locally compact group of type I which is separable and unimodular.

Next, we discuss the L^p -Gabor transform norm given by

$$\|G^p(G)\| = \sup_{f, \psi \neq 0} \left\{ \frac{\|G_\psi f\|_q}{\|f\|_p \|\psi\|_q} \right\} \leq 1$$

and establish that $\|G^p(G)\| = 1$ if and only if G has a compact open subgroup. This provides us several classes of non-abelian groups G having $\|G^p(G)\| = 1$.

We show that

$$\|G^p(\mathbb{R}^n \rtimes K)\| = (A_p)^n,$$

where K is a compact subgroup of $\text{Aut}(\mathbb{R}^n)$ and

$$A_p = p^{\frac{1}{2p}} q^{-\frac{1}{2q}}.$$

If N is a closed normal subgroup of G such that G/N is compact, then we have

$$\|G^p(G)\| \leq \|G^p(N)\|.$$

Also, for any compact normal subgroup K of G , we have

$$\|G^p(G/K)\| \leq \|G^p(G)\|.$$

These results allow us to explicitly compute $\|G^p(G)\|$ for several classes of groups including groups in $[FC]^- \cap [SIN]^-$, the Heisenberg group over p -adic numbers Ω_p , $\mathfrak{h}_n \times \mathbb{R}^m \times \Omega_p$,

$$\mathfrak{h}_3/N, \quad N = \left\{ \begin{bmatrix} 1 & 0 & n \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} : n \in \mathbb{Z} \right\},$$

$\mathfrak{h}_n \times D$, $\mathfrak{h}_n \times \mathbb{R}^m \times D$, $(\mathfrak{h}_n \times D) \rtimes K$, $(\mathfrak{h}_n \times \mathbb{R}^m) \rtimes K$, where $\mathfrak{h}_n$ is the Heisenberg group, D is a discrete group of type I and K is a compact group. Bounds for connected and simply connected nilpotent Lie groups can also be obtained.

Abdenacer Makhlouf (Mulhouse)

Title: On restricted Lie triple systems

Abstract: Lie triple systems are relevant in the study of symmetric spaces. The aim of this talk is to introduce the theory of Lie triple systems in positive characteristic. We discuss some constructions, representations, restricted Rota–Baxter operators, cohomology and deformations. This talk is based on joint works with Jon Beristain.

Dominique Manchon (Clermont)

Title: Post-Lie algebras, post-groups and post-groupoids

Abstract: Post-groups were introduced in 2023 by C. Bai, L. Guo, Y. Sheng and R. Tang. They are closely related to skew-braces (L. Guarnieri and L. Vendramin, 2017) and braided groups (J.-H. Lu, M. Yan, and Y. Zhu, 2000). Post-Lie algebras, introduced by B. Vallette in 2007, are to post-groups what Lie algebras are to groups. Post-groupoids have been recently introduced by Y. Li and Y. Sheng. I shall give a detailed account of these notions, and outline an application to geometric numerical integration via the Butcher post-groupoid. Based on a joint work in progress with Eugen Bronasco, Ludwig Rahm and Gilles Vilmart.

Norbert Mahoungou Moukala (Brazzaville)

Title: Représentations d'algèbres de Lie-Rinehart généralisées

Abstract: The notion of a Lie–Rinehart algebra, introduced by Herz [1], provides an algebraic framework that generalizes the concept of a Lie algebroid [3]. Subsequently, Huebschmann [2] developed the theory of Lie–Rinehart algebras systematically and highlighted their significant role in algebraic and differential geometry, particularly in Poisson geometry.

In this talk, we introduce and study generalized Lie–Rinehart algebras [4] as a natural extension of Lie–Rinehart algebras, and we present several examples illustrating their structure and geometric significance. We then introduce the notion of a representation of a generalized Lie–Rinehart algebra and develop several constructions. We establish a natural one-to-one correspondence between representations of generalized Lie–Rinehart algebras and modules over generalized Lie–Rinehart algebras.

Keywords : First-order differential operators, Generalized Lie–Rinehart algebras, Representations, Modules.

Références

- [1] J.-C. Herz, *Pseudo-algèbres de Lie*, C. R. Acad. Sci. Paris, 1953, **236**, 1935–1937.
- [2] J. Huebschmann, *Poisson cohomology and quantization*, J. Reine Angew. Math., 1990, **408**, 57–113.
- [3] D. Iglesias and J. C. Marrero, *Generalized Lie bialgebroids and Jacobi structures*, J. Geom. Phys., 2001, **40**, 176–199.
- [4] E. Okassa, *Algèbres de Jacobi et Algèbres de Lie–Rinehart–Jacobi*, J. Pure Appl. Algebra, 2007, **208**(3), 1071–1089.

Salah Mehdi (Metz)

Title: Representation theoretic symplectic Dirac operators

Abstract: After introducing the standard Dirac operators and reviewing some of their key properties in representation theory, we will define symplectic Dirac operators. We will explain how they differ from their standard counterparts, describe an analogue of Parthasarathy’s inequalities, and derive a criterion for unitarity. These results are part of ongoing joint work with D. Ciubotaru, G. Liu and N. Prudhon.

Aboubacar Nibirantiza (Burundi)

Title: Geometric quantization of coadjoint superorbits and Schrödinger–Fock representations of the Heisenberg supergroup $\mathcal{H}^{m|n}$

Abstract: In the framework of Kirillov’s orbit method for nilpotent supergroups, coadjoint superorbits of the Heisenberg supergroup naturally carry supersymplectic structures arising from the Kirillov–Kostant–Souriau form. Their geometric quantization provides a geometric realization of the irreducible unitary representations of the Heisenberg supergroup. In particular, after choosing an appropriate polarization, the resulting quantum state space is identified with

$$L^2(\mathbb{R}^m) \otimes \Lambda^\bullet(\mathbb{C}^n),$$

combining the bosonic Schrödinger representation with the fermionic Fock representation. Thus $\mathfrak{h}^{m|n}$ provides the simplest geometric model combining bosonic and fermionic quantization. The bosonic sector reproduces the canonical commutation relations, while the fermionic sector generates a Clifford algebra through anticommutation relations. This construction shows that Schrödinger–Fock representations arise naturally as the geometric quantization of coadjoint superorbits, thereby providing a deep connection between supergeometry, supersymplectic structures, and the representation theory of nilpotent supergroups. We begin by explicit calculations for the case $m = n = 1$ and generalize to arbitrary values of m and n .

Nicolas Prudhon (Metz)

Title: Connes Kasparov isomorphism and lowest K-types

Abstract: Given a connected linear real reductive group G , Connes and Kasparov defined in the early eighties a map that associates to a (virtual) representation V of its maximal compact subgroup K the G -index of the Dirac operator on G/K twisted by V — an element of the K-theory group of the reduced C^* -algebra of G and they conjectured it was an isomorphism. In 1987, Wassermann announced in outline a proof of this conjecture, using representation theory. Clare, Higson, Song, and Tang finally explained this proof in full detail in 2023. Their proof is divided into two parts. First, the structure of the reduced C^* -algebra is detailed using Harish-Chandra’s completeness theorem and the theory of Knapp-Stein operators. This structural result then yields the identification of generators of its K-theory. Second, the theory of Vogan’s lowest K-types is used to compute the G -index map in terms of these generators. In this talk, we will explain how one can switch the order of these two parts, leading to a reduction of the proof of the conjecture to lower-dimensional subgroups of G (which may not be compact) and to the understanding of some representations of those subgroups. This amounts to establishing abstract isomorphisms between certain ideals of the reduced C^* -algebra of these subgroups and that of G . Finally, we geometrically construct a homomorphism between the K-theory of the ideals in question that concretely realizes these abstract isomorphisms, providing a construction parallel to cohomological induction. This is a work in progress with A. Afgoustidis.

Aymen Rahali (Monastir)

Title: On Visible Actions in Cartan Motion Groups

Abstract: Visible actions, introduced by Toshiyuki Kobayashi, provide a geometric framework with important applications to representation theory and complex geometry.

In this talk, we study strongly visible actions in the setting of Cartan motion groups. Our main result is a characterization of the closed subgroups whose actions on the complexified Cartan space are strongly visible.

The proof relies on the geometry of group orbits and the existence of suitable slices. This characterization sheds new light on the interplay between the geometry of Cartan motion groups and the theory of visible actions, and opens the way to further applications in representation theory.

Hedi Regeiba (Gabes)

Title: THE C^* -ALGEBRAS OF SOME LIE GROUPS FORMED BY A SEMI-DIRECT PRODUCT

Abstract: This work is devoted to the study and description of the C^* -algebras associated with certain Lie groups constructed as semi-direct products. The presentation focuses on two main problems : the description of the C^* -algebra of the Heisenberg motion groups

$$G_n = \mathbb{T}^n \ltimes H_n,$$

and, more generally, the description of the C^* -algebra associated with a semi-direct product

$$K \ltimes A,$$

where K is a compact group acting on an abelian locally compact group A .

Atsumu Sasaki (Tokai)

Title: Weyl group of reductive real spherical homogeneous spaces of one-dimensional fiber bundle type

Abstract: It is well known that Cartan decompositions and Weyl groups play fundamental roles in harmonic analysis on semisimple symmetric spaces.

For reductive real spherical homogeneous spaces, which form a broad class containing semi-simple symmetric spaces, the existence of Cartan decompositions has recently been established.

In this talk, we study reductive real spherical homogeneous spaces of one-dimensional fiber bundle type. We give an explicit description of Cartan decompositions for such spaces. Moreover, we introduce the corresponding Weyl groups and determine their group structures.

Birgit Speh (Cornell)

Title: Branching problems, translation functors and applications

Abstract: I am presenting joint work with Professor Kobayashi. We worked out a new approach to symmetry breaking for pairs of real forms of $(GL(n, \mathbb{C}), GL(n-1, \mathbb{C}))$.

Translation functors are powerful tools for studying families of representations of a single reductive group G . However, when applied to a pair of groups $G \supset G'$, they can significantly alter the nature of symmetry breaking between the representations of G and G' , even within the same Weyl chamber of the direct product group $G \times G'$.

We introduce the concept of fences for the interleaving pattern, which provides a refinement of the usual notion of “walls of Weyl chambers. We then establish a theorem stating that the multiplicity remains constant unless these fences are crossed, together with a new general vanishing theorem for symmetry breaking.

Sundaram Thangavelu (Bengaluru)

Title: A Fourier transform for operators

Abstract: Using an irreducible unitary representation of the twisted Heisenberg group acting on twisted Fock spaces we define a Fourier transform on the space of all Hilbert–Schmidt operators acting on $L^2(\mathbb{R}^n)$. We describe some of the main features of this transform including an analogue of Hardy’s theorem.

Jorge Vargas (Cordoba)

Title: Symmetry breaking operators for Discrete Series

Abstract: We fix a connected simple Lie group G and $H \subseteq G$ a closed reductive, connected subgroup. For a unitary irreducible representation (π, V) of G , a *symmetry breaking operator* S is an intertwining map from $\text{res}_H(V)$ into an irreducible H -factor (ρ, U) . When V, U are realized as spaces of smooth sections of homogeneous vector bundles, T. Kobayashi has defined and studied the concept of representing S as a *differential operator*. In the realm of square integrable representations in joint work with B. Ørsted we have shown : a) Whenever (π, V) admits a nonzero symmetry breaking operator represented by a differential operator, then, $\text{res}_H(V)$ is discretely decomposable. Besides, if every symmetry breaking operator is represented via a differential operator, then, $\text{res}_H(V)$ is H -admissible. b) Whenever (G, H) is a holomorphic symmetric pair, the associate pair (G, H_0) , allow us to define the concept of *normal derivative* symmetry breaking operator. We have that if every symmetry breaking operator is represented via normal derivative, then, except for $\mathfrak{g} \not\cong \mathfrak{su}(m, n), m > 1, n > 1, [[\mathfrak{p}_h^+, \mathfrak{p}_{h_0}^-], \mathfrak{p}_{h_0}^-] = \{0\}$, and the lowest K -type of π is one dimensional. The talk will be centered on the existence or non existence of normal derivative operators, we will present the basic concepts. Our results complement the work of Kobayashi-Pevzner and Nakahama.

Robert Yuncken (Nancy)

Title: Harish-Chandra’s principle via the Satake groupoid

Abstract: In his programme classifying the tempered dual of a real reductive group, one of Harish-Chandra’s most important observations was the principle that every tempered irreducible representation is either a discrete series representation (mod centre) or else is a subrepresentation of a parabolically induced representation from a Levi subgroup. The point of this talk is to show that this spectral decomposition can be deduced rather easily from a geometric decomposition of a Lie groupoid. The groupoid is called the Satake groupoid because it is built from the Satake compactification of G/K . (Joint work with J. Bradd and N. Higson.)

Oshima Yoshiki (Tokyo)

Title: Existence and non-existence of discrete series for homogeneous spaces

Abstract: When a real reductive Lie group G acts transitively on a manifold X , an irreducible subrepresentation of the unitary representation $L^2(X)$ is called a discrete series representation of X .

While the discrete series plays a central role in harmonic analysis on symmetric spaces, its behavior on general homogeneous spaces is less understood. In this talk, we discuss conditions for the existence and non-existence of discrete series for general homogeneous spaces.

We provide a sufficient condition for existence in terms of coadjoint orbits and a sufficient condition for non-existence derived from Benoist and Kobayashi's work on tempered homogeneous spaces. We also illustrate these conditions in the case where $G = SL(n, \mathbb{R})$.

This talk is based on joint works with Benjamin Harris and with Kazushi Maeda.

Tanaka Yuichiro (Tokyo)

Title: Visibility, Coisotropy, and Sphericity on Flag Manifolds and Applications to Multiplicity-Free Representations

Abstract: A unitary representation of a locally compact group is multiplicity-free if each irreducible representation occurs with multiplicity at most one in its irreducible decomposition.

In order to understand multiplicity-free phenomena from a geometric viewpoint, T. Kobayashi introduced the theory of visible actions for holomorphic actions of Lie groups on complex manifolds. This theory provides a unified framework for many known examples and produces new ones through Kobayashi's propagation theorem of the multiplicity-freeness property for visible actions.

In this talk, I will discuss some relationships among visibility, coisotropy, and sphericity for reductive group actions on flag manifolds. I will also explain how these geometric properties can be applied to representation theory via a cohomological version of Kobayashi's propagation theorem.