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Harmonische Analysis und Darstellungstheorie topologischer Gruppen

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The Oberwolfach Tagung on Harmonische Analyse und Darstellungstheorie topologischer Gruppen took place from July 9 - 15, 2000, under the leadership of Roger Howe (New Haven), Eberhard Kaniuth (Paderborn), and Gerard Schiffmann (Strasbourg). There were 48 attendees, down slightly from over 50 acceptances, due to last-minute crises (including a broken foot). The participants came from 13 countries: from Asia, Australia, North and South America, as well as seven European countries. This Tagung continued a series begun in 1969 under the leadership of H. Leptin and E.Thoma. Harmonic analysis and representation theory is a broad area. Rather than focus on some subspecialty, this Tagungsreihe has attempted to survey developments in a variety of areas, and to provide attendees with some overview of current directions. The warm response to our invitations and the high quality of the talks, many by younger mathematicians, testify that these principles remain viable. It was difficult to select a program of only 23 talks from the strong field of participants. The organizers are grateful to the Leitung of the Mathematisches Institut, and to all the attendees, both speakers and non-speakers. We especially thank Dr. B. Krötz for preparing this summary of the meeting.

J. Adler: *Murnaghan-Kirillov theory for supercuspidal representations* (joint work with S. DeBacker)

We have little explicit information about the basic objects of harmonic analysis on reductive p-adic groups and Lie algebras: irreducible characters and orbital integrals. We outline a situation in which they are related to each other, thus giving both more information about each and an illustration of the Kirillov philosophy.

More specifically, we show that it is often the case that a supercuspidal character, after composition with a substitute for the exponential map, coincides on a certain large region with the product of the formal degree and the Fourier transform of a certain elliptic orbital integral. This extends earlier work of F. Murnaghan in two directions.

In my talk, I introduce all of the objects referred to above, state the theorem more precisely, and give an application.

R. Archbold: *Strength of convergence in duals of C^*-algebras and nilpotent Lie groups*

We discuss the recent concept of upper multiplicity for an irreducible representation of a C^*-algebra, and its link to Ludwig's earlier notion of strength of convergence in the dual of a nilpotent Lie group G. In joint work with Kaniuth, Ludwig, Schlichting and Somerset, trace formulae have been used to show that if $\pi \in \widehat{G}$ has finite upper multiplicity then this integer is the greatest strength with which a sequence in $\widehat{G}$ can converge to π. Upper multiplicities have been calculated for all irreducible representations of the groups in the threadlike generalization of the Heisenberg group. The values are computed by combining new C^*-theoretic results with detailed analysis of the convergence of coadjoint orbits, and they show that every positive integer occurs for this class of groups.

B. Bekka: *Fundamental domains, square integrable representations and von Neumann algebras*

Let G be a unimodular Lie group, and let Γ be a discrete subgroup of G. Let $(\pi, \mathcal{H})$ be a square integrable irreducible unitary representation of G. If G is non compact, then the restriction $\pi|_\Gamma$ of π to Γ is never irreducible. The following is a natural question:

Is $\pi|_\Gamma$ cyclic, that is, does there exist a vector ξ in $\mathcal{H}$ such that the linear span of the set $\{\pi(\gamma)\xi : \gamma \in \Gamma\}$ is dense in $\mathcal{H}$?

The representation $\pi|_\Gamma$ extends to a representation of the von Neumann algebra $VN(\Gamma)$, the closure for the strong operator topology of the linear span of $\{\lambda(\gamma) : \gamma \in \Gamma\}$ in the algebra $\mathcal{B}(\ell^2(\Gamma))$ of all bounded operators on $\ell^2(\Gamma)$, where λ denotes the left regular representation of Γ. In this way, $\mathcal{H}$ is a $VN(\Gamma)$-module. Such a module has a von Neumann dimension (or continuous dimension) $\dim_\Gamma \mathcal{H}$, a non-negative (possibly infinite) real number. A necessary condition for the existence of a Γ-cyclic vector in $\mathcal{H}$ is that $\dim_\Gamma \mathcal{H} \leq 1$. (This condition is also sufficient when $VN(\Gamma)$ is a factor, that is, when Γ is an ICC-group.) In the case where $\mathcal{H}$ comes from a square integrable representation π of G, one has the following nice formula due to Atiyah and Schmid:

$$\dim_\Gamma \mathcal{H} = d_\pi \mathrm{vol}(G/\Gamma),$$

where d_π is the formal dimension of π and $\mathrm{vol}(G/\Gamma)$ is the volume of a fundamental domain for the action of Γ by right translation on G (for a choice of a Haar measure on G).

We apply the above to the infinite dimensional unitary representations of the Heisenberg group (which are square integrable modulo the centre) and show the following result, also obtained by L. Baggett (Coll. Math. 60/61 (1990), 195–203). For fixed g in $L^2(\mathbb{R})$, the associated windowed Fourier transform (or Wigner-Fourier transform) $T_g^{\mathrm{win}} : L^2(\mathbb{R}) \to L^2(\mathbb{R}^2)$ is defined by

$$T_g^{\mathrm{win}} f(t,\omega) = \langle f, g_{t,\omega} \rangle, \qquad f \in L^2(\mathbb{R}),$$

with $g_{t,\omega}(s) = e^{-i\omega s} g(s-t)$. Let Λ be a lattice in $\mathbb{R}^2$. Then there exists g in $L^2(\mathbb{R})$ such that, for every f in $L^2(\mathbb{R})$, the restriction of $T_g^{\mathrm{win}} f$ to Λ uniquely determines f if and only if $\mathrm{vol}(\mathbb{R}^2/\Lambda) \leq 2\pi$.

M. Cowling: *Slowly growing representations*

This talk is about a weak notion of equivalence of representations, namely, homotopy. The object is to be able to treat representations with a Jordan–Hölder series as if they were a direct sum.

We consider the following notion of "good continuity" for maps $s \mapsto \rho_s$ whose values are representations of a locally compact group G: all the representations ρ_s act on the same Hilbert space $\mathcal{H}$, and the integrated representations of $L^1(G)$ are such that $s \mapsto \rho_s(f)$ is continuous in operator norm. We will say that two unitary representations are homotopic if we can find a continuous curve of representations (in the above sense) joining one to the other. We will see that in order to make this notion work as we would like, we need to introduce more general representations than unitary ones; in particular, we will discuss uniformly bounded representations and "slowly growing representations".

We motivate this with some examples of semisimple Lie groups and related groups. In each case, there is a natural space X on which G acts (the boundary of the symmetric space or similar object on which G acts isometrically) with a quasi-invariant measure μ (or rather, a class of these of which we choose one).

The principal series of representations $\pi_{s,c}$ of G may be defined by

$$\pi_{s,c}(g)\,\xi(x) = \Big(\frac{d\mu(g^{-1}x)}{d\mu(x)}\Big)^{(s+1)/2} c(g,x)\,\xi(g^{-1}x) \qquad \forall x \in X \quad \forall x \in X,$$

for all ξ in an appropriate function space on G. The function c is a cocyle taking values in some (finite-dimensional) unitary group $\mathrm{U}(m)$, and the functions ξ take values in $\mathbb{C}^m$. The parameter s may be complex-valued, and when $\operatorname{Re} s \in [0,1]$, if we define p by requiring that $p(\operatorname{Re} s + 1) = 2$, then $\pi_{s,c}$ acts isometrically on $L^p(X)$.

If $G = \mathrm{SL}(2,\mathbb{R})$, then the principal series representations are obtained by considering the action of G on the projective space $\mathbb{P}^1$; it is usually appropriate to view this in either the "compact picture", in which X is the circle (usually equipped with the rotation invariant measure), or the "noncompact picture", in which X is the line $\mathbb{R}$ (usually equipped with the Lebesgue measure). For the even principal series of $\mathrm{SL}(2,\mathbb{R})$, the cocycle c is the trivial cocycle e. In this case, when $-1 < s < 1$, we can find a Hilbert space $\mathcal{H}_s$ on which $\pi_{s,e}$ acts unitarily (given by the intertwining operator); in the noncompact picture this is a Sobolev space, in which the norm of ξ is

$$\|\xi\|_{H^s} = \|\Delta^{-s/4}\xi\|_{L^2}. \tag{1}$$

We then realise all the representations $\pi_{s,e}$ on the same Hilbert space, namely $L^2(\mathbb{R})$, by mapping $\mathcal{H}^s$ to L^2 by $\Delta^{-s/4}$ (this is usually considered to be the square root of the intertwining operator). In any case, the extra unitary representations are known as the complementary series. For s such that $-1 < \operatorname{Re} s < 1$, let ρ_s denote $\Delta^{-s/4}\pi_{s,c}\Delta^{s/4}$ (where c is either the trivial cocycle or the "sign cocycle"). It was shown by R.A. Kunze and E.M. Stein that when $-1 < \operatorname{Re} s < 1$, the representations ρ_s are always uniformly bounded.

When c is the sign cocycle o, i.e.,

$$o\left(\begin{pmatrix} a & b \\ c & d \end{pmatrix}, x\right) = \operatorname{sgn}(-cx + d), \tag{2}$$

we obtain the odd principal series of representations. The representation $\pi_{0,o}$ splits as the sum of two unitary representations, known as limits of discrete series. With our notion of continuity, we can say that all the representations $\pi_{it,o}$ ($t \in \mathbb{R}^+$) are homotopic, and that these are also homotopic to the sum of the two limits of discrete series representations.

If we consider the square root of the sign cocyle o (as in (2)), we obtain a new cocycle r which does not give rise to a representation of $\mathrm{SL}(2,\mathbb{R})$, but does give rise to a representation of its double cover. If we now consider this new group G, we find that the principal series $\pi_{s,r}$ admits a complementary series when $-1/2 < s < 1/2$. At the end of this series of representations, $\pi_{s,r}$ becomes reducible, and the composition series is made of the so-called "oscillator representation" and a discrete series representation. It is possible to find $\pi_{s,r}$-invariant positive semidefinite sesquilinear forms on the spaces for $\pi_{s,r}$ when $-1/2 \leq s \leq 1/2$, but when $s = \pm 1/2$, these are not positive definite, and the unitary representations do not act on the whole Hilbert space (it suffices to observe that some of the K-types from $\pi_{0,r}$ are missing). In order to find a Hilbert space on which the whole representation acts, it is necessary to use a different Hilbert space on which $\pi_{s,r}$ acts uniformly boundedly.

Theorem. (P.A. Sally) Let r be the square root cocycle on $\mathrm{SL}(2,\mathbb{R}) \times \mathbb{R}$. *If $-1 < s < 1$, then the representation $\pi_{s,r}$ acts uniformly boundedly on the Hilbert space $H^s(\mathbb{R})$ described in (1) above.*

The following theorem is a generalisation of the above theorem.

Theorem. Let $\pi_{s,c}$ be a principal series representation a simple Lie group G of real rank one, let X be the boundary of the associated symmetric space, realised as the Bruhat group $\bar{N}$, and let Δ be the natural sublaplacian on X. Suppose that $-1 < s < 1$, and let $H^s(X)$ be the (possibly vector-valued) Sobolev space with norm

(3) $$\|\xi\|_{H^s} = \|\Delta^{-sQ/4}\xi\|_{L^2},$$

where Q is the homogeneous dimension of $\bar{N}$ (i.e., $Q = \dim \mathfrak{g}_\alpha + 2\dim \mathfrak{g}_{2\alpha}$). Then $\pi_{s,c}$ acts uniformly boundedly on $H^s(X)$.

Finally, to deal with the behaviour of the representations when $s = \pm 1$, we have a problem, namely, the Sobolev spaces introduced above behave badly when $s \to \pm 1$. It seems that we have to consider "slowly growing representations". We say that a representation π of a group G on C^∞_π (the space of smooth vectors) is slowly growing if the following holds: for any ε in $\mathbb{R}^+$, we can find a Hilbert space completion H_ε of C^∞_π and a constant C such that

$$\|\pi(x)\xi\|_{H_\varepsilon} \leq C\,\|x\|^\varepsilon\,\|\xi\|_{H_\varepsilon} \qquad \forall \xi \in C^\infty(X) \quad \forall x \in G,$$

where $\|x\|$ is the standard matrix norm of x. This notion was introduced by N. Higson and V. Lafforgue (unpublished) to tackle the Baum–Connes conjecture.

Theorem. Let G be a simple Lie group of real rank one. For any ε in $\mathbb{R}^+$, there exist constants C and C' such that, for all s in $[-1,1]$,

$$\|\pi_{s,c}(x)\xi\|_{H^{s(1-\varepsilon)}} \leq C\,\|x\|^{C'\varepsilon}\,\|\xi\|_{H^{s(1-\varepsilon)}} \qquad \forall x \in G. \tag{4}$$

This theorem allows us to say that the sum of the trivial representation τ and a couple of additional representations is homotopic to the principal series representation $\pi_{0,e}$. More generally, we may show that τ is homotopic to a formal weighted sum of tempered representations. It is hoped that this will lead to a proof of the full Baum–Connes conjecture for $\mathrm{Sp}(n,1)$ (and the exceptional group $F_{4,-20}$).

M. Flensted-Jensen: *On the Plancherel Formula for semisimple symmetric spaces* (joint work in progress with Francois Rouviere (Nice))

I. An observation about the structure of the Plancherel formula

Recently Delorme, and van den Ban and Schlichtkrull have generalized Harish-Chandras Plancherel formula for a semisimple Lie group G to the case of a semisimple symmetric space G/H. In particular this decomposition splits $L^2(G/H)$ into pieces parametrized by certain parabolic subgroups P.

Let K be a maximal compact subgroup of G, such that the involutions σ and θ, corresponding to H and K, commute.

The first piece of the Plancherel formula is the discrete series, which is non-empty if and only if $rank(G/H) = rank(K/K\cap H)$. This part is described through the work of the author, and Oshima and Matsuki. In the group case it is due to Harish-Chandra.

The other pieces correspond to choices of $\sigma\theta$-invariant parabolic subgroups $P = MAN$, where $M/(M\cap H)$ has discrete series. Ignoring the question of multiplicity and working with the normalized Fourier transform, the corresponding piece can be described as a subspace $L^2_P(G/(M\cap HA\cap HN))$ of $L^2(G/(M\cap HA\cap HN))$ defined by the condition on a function f, that $m \to f(gm)$ belongs to the discrete series of $M/(M\cap H)$ for each $g\in G$.

In the lecture we discussed the possibility of doing analysis on G/H by studying each P-related piece separately.

II. A Radon type tranform related to a parabolic subgroup

It is natural in this context to try to generalize the Radon transform from the Riemannian case G/K, by defining the map:

$$f \to \int_N f(gn)dn$$

followed be the projection onto the discrete series for $M/(M \cap H)$ from the right. Notice that this extra projection is not relevant for P minimal as a $\sigma\theta$-invariant parabolic subgroup, since in this case $M/M \cap H$ is compact.

If well defined it should map suitable functions on G/H directly into the relevant P-part of the Plancherel formula, $L^2_P(G/(M \cap HA \cap HN))$.

In the lecture we discussed the problems of defining this transform and of relating it, whenever well defined, to the Fourier transform.

III. Can Harish-Chandra's description of the discrete series as cusp forms be generalized?

Notice that in the above discussions the discrete series for G/H corresponds to G considered as a parabolic subgroup of itself. It is then quit natural to expect that this part (i.e. nice functions f in the discrete series) is characterized by the property that the integrals

$$f \to \int_N f(gn)dn$$

vanish for all the other parabolic subgroups.

In the lecture we discussed in what sense this could lead to a generalization of Harish-Chandra's result for the group case.

Summary

Questions were raised and few results given. One of the main obstacles being that the integral $\int_N f(gn)dn$ does not converge in general for L^2-Schwartz functions on G/H, not even in the group case, where it corresponds to integrating a function f on G over $N \times \bar{N}$. However sometimes there is convergence, as for example for $G = SL(2,\mathbb{R})$ or for $G/H = SL(2,\mathbb{C})/SL(2,\mathbb{R})$.

H. Fujiwara: *Central elements of Corwin-Greenleaf* (joint work with G. Lion, B. Magneron and S. Mehdi)

Let $G = \exp(\mathfrak{g})$ be a connected, simply connected nilpotent Lie group with Lie algebra $\mathfrak{g}$, $H = \exp(\mathfrak{h})$ be a connected subgroup and χ be a unitary character of H. We study the monomial representation $\tau := \mathrm{Ind}_H^G \chi$. Its canonical central decomposition is denoted by

$$\tau \cong \int_{\widehat{G}}^{\oplus} m(\pi)\pi \; d\mu(\pi)$$

with a measure μ on the unitary dual $\widehat{G}$ of G and the multiplicity function $m(\pi)$. Let $D_\tau(G/H)$ be the algebra of G-invariant differential operators on the line bundle with basis G/H associated to χ. We prove the following conjecture of Duflo, Corwin-Greenleaf: $D_\tau(G/H)$ is commutative if and only if τ is of finite multiplicities.

S. Helgason: *Geometry of the Multitemporal Wave Equation on Symmetric Spaces*

On a symmetric space $X = G/K$ of the noncompact type, Semenov-Tian-Shansky has introduced a canonical hyperbolic system of differential equations which generalizes the classical wave equation in Euclidean space. Here the time variable is however in the Cartan subspace of X and is therefore multidimensional. Reference is made to work of Shahshahani and Phillips-Shahshahani. The theory of this multitemporal system shows remarkable analogies with the Euclidean wave equation, yet many new phenomena turn up. For example, Huygens' principle relates to the number of conjugacy classes of Cartan subgroups of G rather than to the dimension. If G is complex Huygen's principle holds in a considerably stronger form. Various solution formula are shown, by Fourier transform, by Radon transform and by the mean value operator, each method having certain merits. The spectral representation is also considered including a range theorem established jointly with Schlichtkrull.

K. Kikuchi: *Gelfand pairs associated to Heisenberg groups*

Let F be a non-Archimedean local field of characteristic 0, that is, a finite extension of $\mathbb{Q}_p$ for some prime number p, $\mathcal{O}_F$ the ring of integers and $\mathcal{P}_F$ the maximal ideal of $\mathcal{O}_F$. We assume that the characteristic of the residue field $\mathcal{O}_F/\mathcal{P}_F$ is odd. Let n be a positive integer, $G^n = F^n \times F^n \times F$ the $(2n+1)$-dimensional Heisenberg group over F with the product $(x,y,t)(u,v,s) := (x+u, y+v, t+s+(x\cdot v - y\cdot u)/2)$, where $(x,y) \mapsto x\cdot y$ is the standard symmetric form on F^n to F. The symplectic group $Sp(n,F)$ acts on G^n as automorphisms which fix each element in the center of G^n. For a compact subgroup $K \subset Sp(n,F)$ a pair $(K;G^n)$ is a Gelfand pair if the algebra $L^1_K(G^n)$ of all K-invariant integrable functions on G^n is a commutative Banach $*$-algebra. By Carcano's Theorem we have that a pair $(K;G^n)$ is a Gelfand pair if and only if for any non-trivial character $\sigma \in \widehat{F}$ the restriction to K of the metaplectic representation W_σ attached to σ has a multiplicity-free decomposition as a K-module.

In this talk we show that for a maximal compact subgroup $Sp(n, \mathcal{O}_F) \subset Sp(n, F)$ the restriction of the metaplectic representation of $Sp(n, F)$ has a multiplicity-free decomposition as $Sp(n, \mathcal{O}_F)$-module for both cases where the representation is attached to $\tau \in \widehat{F}$ of conductor 0 and to $\sigma \in \widehat{F}$ of conductor 1. This implies that the pair $(Sp(n, \mathcal{O}_F); G^n)$ is a Gelfand pair.

The restriction $W_\tau|_{Sp(n,\mathcal{O}_F)}$ is realized on the lattice model, that is, the space H_τ of all measurable functions on $F^n \times F^n$ to $\mathbb{C}$ which satisfy

$$\begin{aligned} f(u+k, v+l) &= \tau((l \cdot u - k \cdot v)/2) f(u,v) \text{ for any } k, l \in \mathcal{O}_F^n, \\ ||f||^2 &= \int_{(F/\mathcal{O}_F)^n \times (F/\mathcal{O}_F)^n} |f(u,v)|^2 d\dot{u} d\dot{v} < \infty. \end{aligned}$$

For a non-negative integer m we put $M_m = \{(r,s) \in F^n; \min(\mathrm{ord}(r), \mathrm{ord}(s)) = -m\}$. We denote by $H_\tau^{(m)} = \{f \in H_\tau; \mathrm{supp}\, f \subset M_m\}$ and by $H_\tau^{(m),+} = \{f \in H_\tau^{(m)}; \text{even}\}$, $H_\tau^{(m),-} = \{f \in H_\tau^{(m)}; \text{odd}\}$ for a positive integer m. Then we have an irreducible decomposition

$$H_\tau = H^{(0)} \oplus \oplus_{m=1}^\infty H_\tau^{(m),+} \oplus \oplus_{m=1}^\infty H_\tau^{(m),-}$$

as $Sp(n, \mathcal{O}_F)$-module. This decomposition is multiplicity-free. Next we realize $W_\sigma|_{Sp(n,\mathcal{O}_F)}$ on the space of all measurable functions on $F^n \times F^n \times \mathcal{O}_F^n$ which satisfy

$$\begin{aligned} f(u+k, v+l, \xi) &= \sigma((l \cdot u - k \cdot v)/2)\sigma(k \cdot l/2 + l \cdot \xi) f(u, v, \xi + k) \text{ f. } k, l \in \mathcal{O}_F^n, \\ f(u, v, \xi + \xi') &= f(u, v, \xi) \text{ for any } \xi' \in \mathcal{P}_F^n, \\ ||f||^2 &= \int_{(F/\mathcal{O}_F)^n \times (F/\mathcal{O}_F)^n \times (\mathcal{O}_F/\mathcal{P}_F)^n} |f(u,v,\xi)|^2 d\dot{u} d\dot{v} d\dot{\xi} < \infty. \end{aligned}$$

For a non-negative integer m we denote by $H_\sigma^{(m)} = \{f \in H_\sigma; \mathrm{supp}\, f \subset M_m \times \mathcal{O}_F^n\}$, $H_\sigma^{(m),+} = \{f \in H_\sigma^{(m)}; \text{even}\}$, $H_\sigma^{(m),-} = \{f \in H_\sigma^{(m)}; \text{odd}\}$. Using these notations we have a multiplicity-free decomposition

$$H_\sigma = H_\sigma^{(0),+} \oplus H_\sigma^{(0),-} \oplus \oplus_{m=1}^\infty H_\sigma^{(m),+} \oplus \oplus_{m=1}^\infty H_\sigma^{(m),-}$$

as $Sp(n, \mathcal{O}_F)$-module. These arguments above say that for a given compact subgroup K of $Sp(n, \mathcal{O}_F)$ to know whether $(K; G^n)$ is a Gelfand pair or not we may compute an irreducible decomposition of each $H_\tau^{(0)}$, $H_\tau^{(m),\pm}$, $H_\sigma^{(0),\pm}$, $H_\sigma^{(m),\pm}$ as K-module.

J.L. Kim: *An Explicit Plancherel formula of Sp_4 over p-adic fields* Harish-Chandra derived the Plancherel formula on p-adic groups. However, to have an explicit formula, one will have to compute the measures appearing in the formula. Here, we compute Plancherel measures on Sp_4 over p-adic fields explicitly.

The basic method for computation lies in the scheme of theory of Types: Let G be a connected reductive group. Then the theory of types illustrates a method of understanding the category $\mathcal{R}(G)$ of smooth representations of G via pairs (J, ρ), which consist of an open compact subgroup and its irreducible representation ρ, and their associated (generalized) Hecke algebras $H(G//J, \rho)$. Let $\mathcal{R}_\rho$ be the category of smooth representations $\tau \in \mathcal{R}(G)$ such that all the subquotients of τ contain ρ. In a good case, we will have a categorical equivalence between the category $\mathcal{R}_\rho$ and the category of representations of $H(G//J, \rho)$. When this is achieved, Plancherel measures on $\mathcal{R}_\rho$ can be found via Plancherel measures on $H(G//J, \rho)$.

In the case of Sp_4, we know all the necessary types to understand $\mathcal{R}(G)$ and their associated Hecke algebras. In particular, those Hecke algebras are in the form of (generalized) affine Hecke algebras of rank at most 2. If $\mathcal{R}_\rho$ is of rank 0 or 1, since Plancherel measures on those Hecke algebras are known, we compute Plancherel measures on $\mathcal{R}_\rho$ from those on $H(G//J, \rho)$. If $\mathcal{R}_\rho$ is of rank 2, we find them by Shahidi's method of intertwining operators. As a corollary, we get a Plancherel formula on the Iwahori Hecke algebra of Sp_4 (note that its rank is 2). This is a joint work with Anne-Marie Aubert.

B. Krötz: *Analytic continuation of representations with applications to Maaß automorphic forms* (joint with R. Stanton)

Let G be a semisimple Lie group with Iwasawa decomposition $G = KAN$. Assume that $G \subseteq G_\mathbb{C}$. If $\Sigma = \Sigma(\mathfrak{g}, \mathfrak{a})$ denotes the restricted root system, then we define the domain $A_\mathbb{C}^1 := \{a \in A_\mathbb{C} : (\forall \alpha \in \Sigma)\, \mathrm{Re}(a^\alpha) > 0\}$. Then our first result is as follows:

Theorem 1. Let $(\pi, \mathcal{H})$ be an irreducible Hilbert representation of G and $\mathcal{H}_K$ the underlying $(\mathfrak{g}, K)$-module of K-finite vectors. Then for all $v \in \mathcal{H}_K$ the orbit map $G \to \mathcal{H}$, $g \mapsto \pi(g).v$ extends to a G-equivariant holomorphic map on the open domain $GA_\mathbb{C}^1 K_\mathbb{C} \subseteq G_\mathbb{C}$. If $X \in \log(\partial A_\mathbb{C}^1) \subseteq \mathfrak{a}_\mathbb{C}$, then we are interested in the behaviour of $\|\pi(\exp((1-\varepsilon)X).v\|^2$ for $v \in \mathcal{H}_K$ and $\varepsilon \to 0$. In general this is a very hard problem but we made important partial progress for low rank groups.

Theorem 2. Suppose that G has real rank one. Write $p := \dim \mathfrak{g}^\alpha$ and $q := \dim \mathfrak{g}^{2\alpha}$. Let v_0 be a K-spherical vector for an unitary irreducible representation $(\pi, \mathcal{H})$ of G. Then

$$\|\pi(\exp((1-\varepsilon)X).v_0\|^2 \sim \begin{cases} |\log \varepsilon| & \textit{for } p=1, q=0 \\ \varepsilon^{-p+1} & \textit{for } p>1, q=0 \\ |\log \varepsilon| & \textit{for } q=1 \\ \varepsilon^{-q+1} & \textit{for } q>1. \end{cases}$$

In addition we have explicit results for $G = \mathrm{Sl}(3,\mathbb{R})$.

Following Bernstein and Reznikov the estimates in Theorem 2 can be used to obtain estimates for the coefficients of Maaß automorphic forms on $\Gamma\backslash G/K$ for $\Gamma < G$ a discrete cocompact subgroup. In particular for $G = \mathrm{SO}(3,1)$ we improve on results of Sarnak.

J. Lauret: *Gelfand pairs associated with nilpotent Lie groups*

The main object of this work is to present several families of new examples of Gelfand pairs associated with nilpotent Lie groups. If N is a simply connected Lie group and K is a compact group of automorphisms of N, then we say that (K,N) is a *Gelfand pair* when the convolution algebra $L^1_K(N)$ of K-invariant integrable functions on N is commutative. (K,N) is a Gelfand pair precisely when (H,K) is a Gelfand pair in the usual sense, where $H = K \ltimes N$.

Starting from a faithful real representation (π, V) of a compact Lie algebra $\mathfrak{g}$, we construct a two-step nilpotent Lie algebra $\mathfrak{n} = \mathfrak{g} \oplus V$ with center $\mathfrak{g}$ and Lie bracket defined on V by $\langle [v,w], x\rangle := \langle \pi(x).v, w\rangle$ for all $v, w \in V$, $x \in \mathfrak{g}$, where $\langle , \rangle$ is any $\mathfrak{g}$-invariant inner product on $\mathfrak{n}$. We denote by $N(\mathfrak{g}, V)$ the simply connected Lie group with Lie algebra $\mathfrak{n} = \mathfrak{g} \oplus V$.

If G is the simply connected Lie group with Lie algebra $[\mathfrak{g},\mathfrak{g}]$ and U is the group of orthogonal intertwining operators of V, then $K = G \times U$ can be viewed as a compact subgroup of automorphisms of $N(\mathfrak{g}, V)$. The group U acts trivially on the center $\mathfrak{g}$ and each $g \in G$ acts on $\mathfrak{n} = \mathfrak{g} \oplus V$ by $(\mathrm{Ad}(g), \pi(g))$, where we also denote by π the corresponding representation of G on V.

Let T be any maximal torus of G and let $\widetilde{V}$ denote a T-invariant complement in V of the zero weight space V_0, regarded naturally as a complex vector space. Using the following characterization: $(G \times U, N(\mathfrak{g}, V))$ *is a Gelfand pair if and only if the action of $T \times U$ on $\widetilde{V}$ is multiplicity-free*; we obtain a complete classification of the Gelfand pairs of the form $(G \times U, N(\mathfrak{g}, V))$, determing explicitly the multiplicity free actions given above. This produces ten families of

Gelfand pairs associated with nilpotent Lie groups, containing almost all known examples. Up to now, relatively few examples were known and in such examples, N is one of the following: a product of Heisenberg groups, a free two-step nilpotent Lie group, or an Heisenberg -type group of a special kind.

S.T. Lee: *Degenerate principal series of $U(p,q)$*

Let $P = LN$ be the maximal parabolic subgroup of $U(p,q)$ $(p > q)$ with Levi subgroup $L \cong \mathrm{Gl}(q,\mathbb{C}) \times U(p-q)$. Let $s \in \mathbb{C}$ and $\sigma \in \mathbb{Z}$, define $\chi_{s,\sigma}\colon \mathrm{Gl}(q,\mathbb{C}) \to \mathbb{C}^*$ by

$$\chi_{s,\sigma}(a) := |\det a|^s \left(\frac{\det a}{|\det a|}\right)^\sigma.$$

Let τ^μ be the irreducible representation of $U(p-q)$ of highest weight μ. Let $\pi_{s,\sigma,\mu}$ be the representation of P which is trivial on N and

$$\pi_{s,\sigma,\mu}|_L = \chi_{s,\sigma} \otimes \tau^\mu.$$

Form the induced representation $\mathrm{Ind}_P^{U(p,q)} \pi_{s,\sigma,\mu}$. In this talk we shall describe the method used to determine the module structure and unitarity of $\mathrm{Ind}_P^{U(p,q)} \pi_{s,\sigma,\mu}$.

D. Müller: *Sub-Laplacians of holomorphic L^p-type on exponential Lie groups* (joint work with W. Hebisch and J. Ludwig)

Let L denote a right-invariant sub-Laplacian on an exponential (hence solvable)Lie group G, endowed with a left-invariant Haar measure. Depending on the structure of G, and possibly also that of L, L may admit differentiable L^p-functional calculi, or may be of holomorphic L^p-type for a given $p \neq 2$. By "holomorphic L^p-type"we mean that every L^p-spectral multiplier for L is necessarily holomorphic in a complex neighborhood of some non-isolated point of the L^2-spectrum of L. This can in fact only arise if the group algebra $L^1(G)$ is non-symmetric.

We conjecture that G admits a sub-Laplacian of holomorphic L^p-type $(p \neq 2)$ if and only if there exists a point l in the dual $\mathfrak{g}^*$ of the Lie algebra $\mathfrak{g}$ of G satisfying "Boidol's condition" (which is equivalent to the non-symmetry of $L^1(G)$), whose coadjoint orbit $\Omega(l) = Ad^*(G).l$ is closed.

What we can prove is the "if "part of this conjecture, under the stronger assumption that the restriction of $\Omega(l)$ to the nilradical of $\mathfrak{g}$ is closed. This work builds on previous joint works with M. Christ and J. Ludwig.

H. Oh: *Uniform pointwise bounds for matrix coefficients and equidistribution of Hecke points*

The aim of this talk is to explain the construction of new uniform pointwise bounds for the matrix coefficients of infinite dimensional irreducible unitary representations of a reductive algebraic group over a local field k with semisimple k-rank at least 2. Construction of such uniform pointwise bounds which are both sharp and explicit has several applications. In particular, we will describe an important application related to the number theory, namely equidistribution of Hecke points, recently obtained in a joint work with L. Clozel and E. Ullmo.

A. Okounkov: *Applications of representation theory to probability theory*

I will survey recent progress in applying representation theory to various classical problems of probability theory such as distribution of increasing subsequences in a random permutation of $\{1, \ldots, n\}$ as $n \to \infty$.

G. Ólafsson: *The H-spherical distribution character for the Holomorphic Discrete Series of G/H*

Let $M = G/H$ be a semisimple affine symmetric space. To each discrete series representation (ρ, E) of G we can associate a spherical distribution Θ_E defined by

$$C_c^\infty(G/H) \ni f \mapsto \mathrm{pr}_E(f)(x_o) \in \mathbb{C}, \quad x_o = \{H\} \in G/H\,.$$

Here $\mathrm{pr}_E : L^2(G/H) \to E$ stands for the orthogonal projection onto E. The distribution Θ_E is called the *H-spherical distribution character* of (ρ, E). Even if the abstract Plancherel formula for G/H is by now known by the work of P. Delorme, E. van den Ban, and H. Schlichtkrull, little is known about the H-spherical characters. We consider the case where (ρ, E) is a *holomorphic discrete series representation of* G/H. In this case the character can be realized as a limit

$$\Theta_E(f) = \lim_{t \to 0} \int_M f(m)\theta_E(\exp(-tiZ^0)m)\,dm$$

where θ_E is a holomorphic function on a complex domain $\Xi \subset G_{\mathbb{C}}/H_{\mathbb{C}}$, and Z^0 is a central element in $\mathfrak{k}$. Let π be the lowest K-type of E and let μ be the highest weight of π. Let $\mathfrak{a}$ be a Cartan subspace of G/H contained in a maximal compact subalgebra $\mathfrak{k}$. Then $\mu \in \mathfrak{a}$. Let $2\rho = \sum_{\alpha \in \Delta^+(\mathfrak{g}_{\mathbb{C}}, \mathfrak{a}_{\mathbb{C}})} m_\alpha \alpha$ and $\lambda = \mu + \rho$. Then up to a constant c we have for "big" parameters

$$\theta_\pi(a) = c\varphi_\lambda(a)$$

where $\varphi_\lambda(a) = c_\Omega(\lambda) \sum_{w \in W_o} \Phi_{w\lambda}(a)$ is a spherical function on the dual symmetric space G^c/H. Using results of B. Krötz this gives the character formula

$$\theta_\pi = d(\mu)\varphi_\lambda$$

where $d(\mu)$ is given by the same product formula as the formal degree of the holomorphic discrete series of G.

A. Paul: *Equal rank dual pairs* In joint work with Jian-shu Li, Eng Chye Tan, and Chenbo Zhu, we have determined the Howe correspondence for the dual pairs $(Sp(p,q), O^*(2n))$ for the cases $p + q \leq n$ in terms of Langlands parameters, starting with the equal rank case. This (almost) completes the list of reductive dual pairs of equal rank over $\mathbb{R}$ for which the correspondence is explicitly known. The techniques we used work especially well in the equal rank case, and this provides a starting point for determining the full correspondence. We sketch the result and idea of proof for $(Sp(p,q), O^*(2n))$. We can summarize the main theorem as follows:

The Howe correspondence gives rise to a bijection between $\widehat{O^*(2n)}$ and $\cup_{p+q=n,n-1} \widehat{Sp(p,q)}$ (admissible duals).

This constitutes a suitable version for these dual pairs of "Theta Dichotomy" which Steve Kudla has conjectured for unitary groups of equal size over non-archimedian fields. Then we look at the complete list of equal rank dual pairs and discuss to which extent theta dichotomy holds in each case. We conclude by listing a few more phenomena which are particular to dual pairs of the same rank.

R. Penney: *Helgason-harmonic, Hua-harmonic and pluriharmonic functions on bounded homogeneous domains in* $\mathbb{C}^n$

A function F on a Riemannian-symmetric space $\mathcal{D} = G/K$ is harmonic if it is annihilated by the algebra $D_G(\mathcal{D})$ of G-invariant differential operators without constant term. The Helgason theorem states that F is harmonic if and only if it is the Poisson integral of a hyperfunction over the Furstenberg boundary. There are generalizations that describe the Poisson integrals of hyperfunctions over other boundaries. Most notably, in the tube case, the Hua-Johnson-Koranyi system ("HJK") describes Poisson integrals over the Shilov boundary $\mathcal{B}$.

The goal of our continuing work is to generalize Helgason theory to non-symmetric homogeneous Kähler manifolds in general, and bounded homogeneous domains in $\mathbb{C}^n$ in particular. (Recall that every homogeneous Kähler manifold fibers, with compact fiber, over such a domain.) Some of the difficulties which must be overcome include

(i) In general, the maximal compact subgroup K of G is very small. Hence, most arguments based in it do not extend beyond the semi-simple case – entirely new proofs must be found.

(ii) In the Hermitian-symmetric case, the Shilov boundary is a homogeneous space (of K). In the general case it need not even be a manifold. The best that can be said is that it contains a dense, open homogeneous space $\mathcal{B}_0 \subseteq \mathcal{B}$ for an at most 2-step nilpotent subgroup of G. This, however, is not sufficient to be able to define notions such as hyperfunctions on the boundary.

(iii) The structure of $D_G(\mathcal{D})$ is not at all well understood. Also, if K is "small", $D_G(\mathcal{D})$ can be so large as to have no interesting harmonic functions. In particular, as opposed to the Hermitain symmetric case, holomorphic functions need not be harmonic.

Despite all of these difficulties, considerable progress has been made. In place of $D_G(\mathcal{D})$, which is typically too large, we use invariant systems defined intrinsically from the curvature operator. Our systems reduce to the classical ones in the symmetric case. The majority (but not all) of our recent work (much of it joint with A. Hulanicki and E. Damek) has focussed on the Shilov boundary and generalizations of the HJK system. Some of our main results for an HJK harmonic function F are

(a) If F is bounded, F is the Poisson integral of an element of $L^\infty(\mathcal{B}_0)$ against the Shilov-boundary kernel function for the Laplace-Beltrami operator. In the tube case, the Cauchy-Szegö Poisson kernel may also be used.

(b) For a tube-type domain, the space of boundary functions for the HJK harmonic functions is dense in $L^\infty(\mathcal{B}_0)$ if and only if the domain is symmetric. In the non-symmetric case, the HJK boundary functions may be characterized by the fact that their Euclidean Fourier transforms must be supported in a certain finite set of non-convex cones.

(c) If F satisfies an $\mathcal{H}^2$ like growth condition as we approach $\mathcal{B}_0$, and $\mathcal{D}$ is "sufficiently non-tube like", then f is the sum of a holomorphic and anti-holomorphic function. In the symmetric case "sufficiently non-tube like" means that $\mathcal{D}$ is a Siegel II domain.

(d) If F grows at most exponentially as we approach $\mathcal{B}_0$, then F has a van den Ban-Schlichtkrull type asymptotic expansion where the coefficients are distributions on $\mathcal{B}_0$. This expansion is explicitly computable from its "leading" terms, which are, by definition, the boundary distributions for F. They uniquely determine the solution F. The inverse map to the boundary map is, by definition, the Poisson transform.

Property (c) seems to be new, even in the Hermitian-symmetric case. It represents a partial solution to the problem, proposed in 1980 by Berline and Vergne, of desribing the boundary values for the HJK system in the non-tube case.

The fact that many of our results require the assumption that F be bounded is traceable to the fact that the boundary value is a function and we only need to know it a.e. to form its Poisson integral. Hence, it is sufficient to work with $\mathcal{B}_0$.

In the symmetric case, the boundary object for an unbounded solution might be a distribution or a hyperfunction on $\mathcal{B}$. The boundary distributions referred to in (d) are their restrictions to $\mathcal{B}_0$, which do not, on general principals, determine them on all of $\mathcal{B}$. Thus, (d) is quite striking in that we only need to know the boundary values on $\mathcal{B}_0$ to form the Poisson transformation, avoiding the problems mentioned in (ii). The idea that such a result could be true was suggested by a theorem of van den Ban-Schlichtkrull which states that in the symmetric case, the restriction of the boundary distributions to any open subset of $\mathcal{B}$ uniquely determines the solution. Our (d) may be viewed as a partial generalization of this result.

H. Rubenthaler: *Infinite dimensional Lie and associative algebras related to commutative prehomogeneous vector spaces*

Let $\mathfrak{g} = \mathfrak{g}_{-1} \oplus \mathfrak{g}_0 \oplus \mathfrak{g}_1$ be a $\mathbb{Z}$-grading of a simple Lie algebra $\mathfrak{g}$. Let G denote the adjoint group of G and let G_0 be the analytic subgroup of G corresponding to $\mathfrak{g}_0$. We make the assumption that the G_0 action on $\mathfrak{g}_1$ has a relative invariant Δ_0. This setting is in one to one correspondence with Hermitian symmetric spaces of tube type. Let $\mathcal{T}$ be the associative algebra of differential operators generated by Δ_0, Δ_0^{-1}, $\Delta_0(\partial)$ and E =Euler operator. Let $\mathfrak{a}$ be the Lie algebra of differential operators generated by Δ_0, $\Delta_0(\partial)$ and E. We describe the structure of $\mathcal{T}$ and prove that $\mathfrak{a}$ is infinite dimensional except if $\partial^o\Delta_0 \leq 2$. The Lie algebras $\mathfrak{a}$ and $\mathfrak{g}_0'$ are commuting subalgebras of a bigger Lie algebra $\mathcal{L}$ ($\mathcal{L} \cong \mathfrak{sp}$ if $\partial^o\Delta_0 = 2$). The restriction of a natural representation ρ of $\mathcal{L}$ to $\mathfrak{a} \times \mathfrak{g}_0'$ decomposes multiplicity free and gives rise to a correspondance between certain representations of $\mathfrak{a}$ (lowest weight modules) and the so called harmonic representations of $\mathfrak{g}_0'$. If $\partial^o\Delta_0 = 2$ this reduces to a classical Howe correspondance for the infinitesimal Weil representation.

Y. Shalom: *Property (T) of Kazhdan: Introduction, recent results and some open problems*

We consider in the talk recent results about property (T), and related questions. One direction which we explore is to what extent property (T) of discrete subgroups is really a good geometric one. This question arises naturally following numerous recent new constructions of Kazhdan groups which involve geometric ideas. We observe that property (T) is not a quasi-isometry invariant (a famous problem of Ghys), but that one can nevertheless give geometric interpretation/characterization of (T) by means of metric properties of balls in the Cayley graph. Other related results that we discuss are a positive answer to a question of Grigorchuk and Zuk to the effect that any finitely generated Kazhdan group is a quotient of a finitely presented Kazhdan group, and a proof of a conjecture of Vershik-Karpushev: Any compactly generated locally compact group without (T) admits an irreducible representation with $H^1 \neq 0$. At the heart of our approach lies the notion of first *reduced* cohomolgy, and a non-vanishing result for that (smaller in general) cohomology group. Among the open questions we mention there the problem of existence of linear Kazhdan groups which are not lattices (or constructed trivially from such). We offer a candidate: the group $\mathrm{Sl}(3, \mathbb{Z}[t])$, and remark on the connection to K-theory and Dirichlet theorem on primes in arithmetic progressions.

T. Steger: *Free Group Representations: Not Square Integrable Implies Irreducible* (joint with W. Hebisch)

Let A_+ be a finite set and let Γ_0 be the nonabelian free group with generators A_+. The Cayley graph, $\mathcal{T}$, of Γ_0 relative to A_+ is a tree. Denote by Ω the boundary of Γ_0, meaning the boundary of $\mathcal{T}$.

Let $(\pi_s, \mathcal{H}_s)$ be one of the isotropic spherical principal series representations of Γ_0 constructed relative to A_+. Exclude from consideration the two endpoint representations and the midpoint representation of that series. Let $\mathbf{1} \in \mathcal{H}_s$ be the function identically equal to one under the usual identification $\mathcal{H}_s \cong L^2(\Omega)$. Finally, let $\Gamma \subseteq \Gamma_0$ be any subgroup, necessarily free, but possibly with infinitely many generators.

Theorem. The following are equivalent:

(i) $\pi_s|_\Gamma$ *is irreducible.*

(ii) $\langle \mathbf{1}, \pi_s(\cdot)\mathbf{1}\rangle \notin \ell^2(\Gamma)$.

(iii) *The isotropic random walk on* $\mathcal{T}/\Gamma$ *is recurrent.*

By far the most difficult part is proving irreducibility, and for this we use some machinery. The natural left action of Γ_0 on Ω yields an action of Γ_0 on the C^*-algebra $C(\Omega)$. With respect to this action, one constructs the crossed product algebra $\Gamma \ltimes C(\Omega)$. By a *boundary intertwiner* for $\pi_s|_\Gamma$ we mean a pair $(\iota, (\pi', \mathcal{H}'))$ where

(1) $(\pi', \mathcal{H}')$ is a representation of $\Gamma \ltimes C(\Omega)$.

(2) $\iota : \mathcal{H}_s \to \mathcal{H}'$ is a Γ-intertwiner.

(3) $\pi'(C(\Omega))\iota(\mathcal{H}_s)$ is dense in $\mathcal{H}'$.

So a boundary intertwiner for $\pi_s|_\Gamma$ is a Γ-intertwiner of π_s into some representation naturally realized on $L^2(\Omega, V, d\nu)$, where ν is a measure on Ω and V is a Hilbert space of finite or infinite dimension. One defines a simple notion of *equivalence* for boundary intertwiners.

The usual identification $\mathcal{H}_s \cong L^2(\Omega)$ gives an action of $C(\Omega)$ on $\mathcal{H}_s$ by pointwise multiplication. This in turn permits us, abusing notation, to consider π_s as a representation of $\Gamma_0 \ltimes C(\Omega)$. For $t_1 > 0$ this gives "tautological" boundary intertwiners of the form $(t_1 \,\mathrm{id}, (\pi_s, \mathcal{H}_s))$.

There exists a Γ_0-intertwiner $J_s : \mathcal{H}_s \to \mathcal{H}_{-s}$. Note that J_s does *not* intertwine the two $C(\Omega)$-actions. For $t_2 > 0$ this gives boundary intertwiners of the form $(t_2 J_s, (\pi_{-s}, \mathcal{H}_{-s}))$. One can combine the two types to form boundary intertwiners of the form $(t_1 \,\mathrm{id} \oplus t_2 J_s, (\pi_s \oplus \pi_{-s}, \mathcal{H}_s \oplus \mathcal{H}_{-s}))$.

Theorem. Suppose that $\langle \mathbf{1}, \pi_s(\cdot)\mathbf{1}\rangle \notin \ell^2(\Gamma)$. *Then any boundary intertwiner for* $\pi_s|_\Gamma$ *is equivalent to one of the intertwiners described above:* $(t_1 \,\mathrm{id}, (\pi_s, \mathcal{H}_s))$, $(t_2 J_s, (\pi_{-s}, \mathcal{H}_{-s}))$, *or* $(t_1 \,\mathrm{id} \oplus t_2 J_s, (\pi_s \oplus \pi_{-s}, \mathcal{H}_s \oplus \mathcal{H}_{-s}))$ *for appropriate values of* t_1 *and/or* t_2. Irreducibility follows immediately.

A. Valette: *Lie groups with the Haagerup property*

A locally compact group has the *Haagerup property*, or is *a-T-menable* in the sense of Gromov, if it admits a proper, isometric action on some affine Hilbert space. This class of groups appears in harmonic analysis, ergodic theory, and operator algebras (e.g. in connection with the Baum-Connes conjecture). It is clear from the definition that the Haagerup property is a strong negation of Kazhdan's property (T): the intersection of both classes is the class of compact groups. The class of groups with the Haagerup property is remarkably wide: it contains amenable groups, groups acting properly on trees, Coxeter groups, closed subgroups of $SO(n,1)$ and $SU(m,1)$, etc. We present the following result (which is part of joint work with P.-A. Cherix and M. Cowling):

Theorem. Let G be a connected Lie group. The following are equivalent:

(i) *G has the Haagerup property;*

(ii) *If H is a closed subgroup such that the pair (G,H) has the relative property (T), then H is compact;*

(iii) *G is locally isomorphic to a direct product*

$$M \times SO(n_1,1) \times \ldots \times SO(n_k,1) \times SU(m_1,1) \times \ldots \times SU(m_\ell,1),$$

where M is an amenable Lie group (i.e. M is solvable-by-compact).

C. Zhu : *Orbits of orthogonal groups and representations of symplectic groups*

We consider the action of $H = O(p,q)$ on the matrix space $M_{p+q,n}(\mathbb{R})$. We study a certain orbit $\mathcal{O}$ of H in the null cone $\mathcal{N} \subseteq M_{p+q,n}(\mathbb{R})$ which supports an eigendistribution $d\nu_{\mathcal{O}}$ for H. We determine the structure of $\widetilde{G} = \widetilde{Sp(2n,\mathbb{R})}$-cyclic module generated by $d\nu_{\mathcal{O}}$ under the oscillator representation of $\widetilde{\mathbb{G}}$ (the metaplectic cover of $\mathbb{G} = Sp(2n(p+q),\mathbb{R})$). Applications to local theta correspondence and a generalized Huygens' Principle are given. A key step of this work is to understand the $\widetilde{K} = \widetilde{U(n)}$-types of a $\widetilde{P}$-eigendistribution, where P is the Siegel parabolic subgroup of G. This is accomplished through an identity of Capelli-type satisfied by solutions of a certain system of differential equations. The talk is based on a joint work with Roger Howe of Yale University.

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