Journées d'Analyse Mathématique et Applications 2022 (JAMA2022), En l'honneur du Professeur Mohamed Sifi, Hammamet 07–09 Novembre 2022.

Programme

	Lundi 07 novembre 2022	Mardi 08 novembre 2022	Mercredi 09 novembre 2022
08h40	Cérémonie d’ouverture		
09h00	Aline Bonami (Université d’Orléans)	Sami Mustapha (Université Paris VI)	Jean-Philippe Anker (Université d’Orléans)
10h00	Ali Baklouti (Université de Sfax)	Marc Peigné (Université de Tours)	Ewa Damek (en ligne)
11h00	Pause Café	Pause Café	Pause Café
11h30	Lazhar Dhaouadi (Université de Carthage)	Samir Kabbaj (Université Ibn Toufail)	Abderrazek Karoui (Université de Carthage)
12h30	Déjeuner	Déjeuner	Cérémonie de clôture Déjeuner
14h00	Jacek Dziubanski (Université Wrocław) (en ligne)	Frej Chouchene (Université de Monastir)	
15h00	Selma Negzaoui (Université de Monastir)	Fethi Soltani (Université de Carthage)	
16h00	Hejna Agnieszka (Université Wrocław) (en ligne)	Salma Azouazi (Université de Sfax)	
16h30		Zeineb Ghardallou (Université de Tunis ElManar)	

Soirée à l’honneur du Pr. Mohamed Sifi
Lundi 07 novembre 2022 à 20h30

Hejna Agnieszka.

L^p-estimates for Riesz transforms and vectors of Riesz transforms in the rational Dunkl setting.

Abstract. In 1989, Charles F. Dunkl defined new commuting differential-difference operators

$$T_\xi f(\mathbf{x}) = \partial_\xi f(\mathbf{x}) + \sum_{\alpha\in R} \frac{k(\alpha)}{2}\langle\alpha,\xi\rangle \frac{f(\mathbf{x}) - f(\sigma_\alpha(\mathbf{x}))}{\langle\alpha,\mathbf{x}\rangle}$$

associated with a finite reflection group G which is related to a root system R on a Euclidean space $\mathbb{R}^N$. They turn out to be a key tool in the study of special functions with reflection symmetries and allow to built up the framework for the theory of special functions and integral transforms in several variables related with reflection groups. In particular, in this framework, we have the Dunkl transform $\mathcal{F}$ and the Dunkl-Laplacian Δ_k which play the roles of the Fourier transform and the Laplacian respectively. They can be treated as a starting point for studying harmonic analysis and theory of singular integrals in the Dunkl setting. In particular, for $f \in \mathcal{S}(\mathbb{R}^N)$ and $j \in \{1,\dots,N\}$, the Riesz transforms R_j in the Dunkl setting are defined by

$$\mathcal{F}(R_j f)(\xi) = -i\frac{\xi_j}{\|\xi\|}(\mathcal{F}f)(\xi).$$

The vector of the Riesz transforms in the Dunkl setting is defined by

$$\mathcal{R}f(\mathbf{x}) = \left(\sum_{j=1}^{N} |R_j f(\mathbf{x})|^2\right)^{1/2}. \tag{1}$$

The Riesz transforms in the Dunkl setting were introduced in [4, Theorem 5.3]. Then, in [1, Theorem 3.3], Amri and Sifi proved that they extend to a bounded operators $L^p(dw) \longmapsto L^p(dw)$ for $p > 1$.

A well-known result concerning the classical Riesz transforms, proved by E.M. Stein in [3], stated that in the case $k \equiv 0$, there are upper bounds for the L^p-norm of the vector of the Riesz transforms independent of the dimension N. Therefore, the natural question which one can ask is if the result of that spirit holds also in the Dunkl setting. During the talk, we will discuss the estimates of the type

$$\|\mathcal{R}f\|_{L^p(dw)} \le C\|f\|_{L^p(dw)} \text{ for all } f \in L^p(dw), \tag{2}$$

where $C > 0$ is independent of the dimension of the space $\mathbb{R}^N$. Our main tool will be the adaptation of the Bellman function technique in the Dunkl setting. The talk will be mainly based on [2].

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Jean-Philippe Anker.

Equations de Schrödinger et des ondes sur les espaces symétriques non compacts.

Résumé : L'équation de Schrdinger et l'équation des ondes ont été étudiées de manière approfondie il y a 10-20 ans sur les espaces hyperboliques, et plus généralement sur les espaces symétriques non compacts de rang un. Le passage au rang supérieur requérait de nouvelles idées, qui ont été principalement élaborées en collaboration avec mon ex-doctorant Hong-Wei Zhang au cours de son travail de thèse. Dans cet exposé, je présenterai les résultats obtenus et les principaux outils utilisés dans [arXiv:2010.08467v1] et [arXiv:2104.00265v3].

Schrdinger and wave equations on noncompact symmetric spaces.

Abstract. The Schrdinger and the wave equations were thoroughly investigated 10-20 years ago on hyperbolic spaces, and more generally on noncompact symmetric spaces of rank one. Handling the higher rank case required new ideas, which were mainly developed in collaboration with my former Ph.D. student Hong-Wei Zhang during his thesis. In this talk, I will explain the results obtained and the main tools used in [arXiv:2010.08467v1] and [arXiv:2104.00265v3].

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Salma Azouazi.

Müntz-Szász theorems for some Lie groups.

Abstract. The classic Müntz-Szász theorem proved way back in 1914, states that for a strictly increasing sequence of positive real numbers Λ, the family $\{x^\lambda, \lambda \in \Lambda\}$ is total in $L^2([0,1])$, if and only if $\sum_{\lambda\in\Lambda} \frac{1}{\lambda} = +\infty$. Among the versions proved of Müntz-Szász theorem there is the full Müntz-Szász theorem in the case of $L^p([0,1])$. This theorem requires, from a sequence Λ of distinct real numbers greater than $-1/p$, the criterion $\sum_{\lambda\in\Lambda} \frac{\lambda+1/p}{(\lambda+1/p)^2+1} = +\infty$, as a necessary and sufficient condition to obtain the density of

span$\{x^\lambda;\ \lambda \in \Lambda\}$ in $L^p([0,1])$).
One can afford to announce this result as the perfect version of polynomial approximation results.
The Müntz-Szász theorem was treated in the case of nilpotent Lie groups, in the case of compact extensions of the Heisenberg group and the Euclidean motion groups then more generally in the case of compact extensions of $\mathbb{R}^n$. The representation theory and a Plancherel formula play an important role in the proofs.

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Ali Baklouti.

On the L^p-Fourier transform norm for compact extensions of locally compact groups.

Abstract. Let G be a separable locally compact unimodular group of type I, and $\widehat{G}$ the unitary dual of G endowed with the Mackey Borel structure. We regard the Fourier transform $\mathcal{F}$ as a mapping of $L^1(G)$ to a space of μ-measurable field of bounded operators on $\widehat{G}$ defined for $\pi \in \widehat{G}$ by $L^1(G) \ni f \mapsto \mathcal{F}f : \mathcal{F}f(\pi) = \pi(f)$, where μ denotes the Plancherel measure of G. The mapping $f \mapsto \mathcal{F}f$ extends to a continuous operator $\mathcal{F}^p : L^p(G) \to L^q(\widehat{G})$, where $p \geq 1$ is real number and q its conjugate. We are concerned in this talk with the norm of the linear map $\mathcal{F}^p$. We first record some results on the estimate of this norm for some classes of solvable Lie groups and their compact extensions and discuss the sharpness problem. We look then at the case where G is a separable unimodular locally compact group of type I. Let N be a unimodular closed normal subgroup of G of type I, such that G/N is compact. We show that $\|\mathscr{F}^p(G)\| \leq \|\mathscr{F}^p(N)\|$. In the particular case where $G = K \ltimes N$ is defined by a semi-direct product of a separable unimodular locally compact group N of type I and a compact subgroup K of the automorphism group of N, we show that equality holds if N has a K-invariant sequence $(\varphi_j)_j$ of functions in $L^1(N) \cap L^p(N)$ such that $\|\mathscr{F}\varphi_j\|_q/\|\varphi_j\|_p$ tends to $\|\mathscr{F}^p(N)\|$ when j goes to infinity.
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Aline Bonami.

Global versions of Stein's Theorem on the maximal operator.

Abstract. A classical theorem of E. Stein states that, for a nonnegative integrable function f supported in a ball B, the maximal function Mf is in $L^1(B)$ if and only if $f\ln_+(|f|)$ is integrable on B. This is a local statement. What would be a global statement on $\mathbb{R}^n$? We prove that an integrable function f that satisfies the two conditions

(i)

$$\int_{\mathbb{R}^n} f(x)dx = 0,$$

(ii)

$$\int_{\mathbb{R}^n} |f(x)| \left(\ln_+(|f(x)|) + \ln_+(|x|)\right) dx < \infty.$$

is in the Hardy space $H^1(\mathbb{R}^n)$. Moreover, the conditions are necessary for functions that may be written as $g - K\chi_B$ with g non negative. This second condition is reminiscent of the space $H^{\log}$ that has been introduced in relation with the product of functions $f \times g$ (in the distributions sense) such that f belongs to $H^1(\mathbb{R}^n)$ and g belongs to $BMO(\mathbb{R}^n)$. Namely, f is in $H^{\log}$ if $g = Mf$ satisfies

$$\int_{\mathbb{R}^n} \frac{|g(x)|}{\ln_+(|g(x)|) + \ln_+(|x|)} dx < \infty.$$

One has same kind of conditions (i), (ii) for g belonging to $H^{\log}$, but with ln replaced by $\ln\ln$.

The same kind of theorems may be developed in the context of holomorphic functions in the upper half space and the Bergman projection.

This is joint work with S. Grellier and B. Sehba.

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Frej Chouchene.

A contribution in harmonic analysis to the study of a family of differential-reflection operators.

Abstract. We introduce a family of differential-reflection operators acting on smooth functions defined on R. As special cases, we recover Dunkl, Jacobi-Dunkl and Jacobi-Cherednik operators. We obtain suitable growth estimates for the eigenfunction of such an operator. Thus we define and study intertwining operators and a generalized Fourier transform. Then, for the last transform, we develop an Lp-harmonic analysis, we prove an Lp-Schwartz space isomorphism theorem and we establish various versions of uncertainty principles.

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Ewa Damek.

Stochastic difference equation with diagonal matrices.

Abstract. Let $\mathbf{A} = diag(A_1, ..., A_d)$ be a random diagonal matrix and X, B random vectors in $\mathbb{R}^d$ We assume that $\mathbf{A}$ and X are independent and

$$X \stackrel{in\ law}{=} \mathbf{A}X + B. \tag{3}$$

We do not assume that X and B are independent. Under appropriate (Goldie-Kesten type) conditions we prove that X is *regularly varying in a nonstandard way.* Namely, suppose that for every j, there is α_j such that

$$\mathbb{E}|A_j|^{\alpha_j} = 1.$$

We define

$$\delta_{t^{-1}}X = \left(t^{-1/\alpha_j}X_1, ..., t^{-1/\alpha_d}X_d\right).$$

Then the sequence of measures

$$\Lambda_t(W) = t\mathbb{P}\left(\delta_{t^{-1}}X \in W\right), \quad W \subset \mathbb{R}^d, \tag{4}$$

tends in a weak sense to a random measure Λ and $\Lambda(\mathbb{R}^d \setminus B_r(0)) < \infty$ for every ball $B_r(0)$. *Analytic aspects of arguments will be underlined to stress interplay between analysis and probability.*

We also provide conditions for $\Lambda \neq 0$. In particular, for coordinates X_j, $j = 1, ..., d$ of X, (4) means

$$\lim_{t\to\infty} \mathbb{P}(\pm X_j > t)t^{\alpha_j} = c_{\pm}.$$

The most common example of (3) comes form the stochastic recurrence equation

$$\mathbf{X_n} = \mathbf{A_n}\mathbf{X_{n-1}} + \mathbf{B_n}, \quad \mathbf{n} \in \mathbb{N}, \tag{5}$$

where $(\mathbf{A}_n, \mathbf{B}_n)$ is an i.i.d. sequence, $\mathbf{A}_n$ are $d \times d$ matrices, $\mathbf{B}_n$ are vectors and $\mathbf{X}_0$ is an initial distribution independent of the sequence $(\mathbf{A}_n, \mathbf{B}_n)$. Under mild contractivity hypotheses the sequence $\mathbf{X}_n$ converges in law to a random vector X that is the unique solution to the equation (3). In this case X is independent of $(\mathbf{A}, \mathbf{B})$.

However, there are natural examples related to random Gaussian field when X and B in (3) may be dependent. Moreover, it turns out that only independence of A and X is really essential in the proof of regular variation.

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Lazhar Dhaouadi.

Harmonic analysis associated to the canonical Fourier Bessel transform.

Abstract. During the last few years a gigantic investigations and efforts have been provided by several authors to study linear canonical transform (LCT) [2, 3] by consideration of its broad field of applications, especially that it encompasses several integral transformations. In particular cases we can note: the Fourier transform, Hankel transform, Laplace transform, Fresnel transform, Fractional Fourier transform.

Linear canonical transform (LCT) represents a class of integral transforms indexed by a matrix parameter $\mathbf{m} \in SL(2,\mathbb{R})$ [4]. The (LCT) play an important role in many fields of optics, radar system analysis, GRIN medium system analysis, filter design, phase retrieval, pattern recognition and many others [5].

The purpose of the present presentation is to review the harmonic analysis associated to the following Bessel type operator

$$\Delta_\nu^{\mathbf{m}} = \frac{d^2}{dx^2} + \left(\frac{2\nu+1}{x} - 2i\frac{d}{b}x\right)\frac{d}{dx} - \left(\frac{d^2}{b^2}x^2 + 2i\,(\nu+1)\,\frac{d}{b}\right), \quad \mathbf{m} = \begin{pmatrix} a & b \\ c & d \end{pmatrix} \in SL(2,\mathbb{R})$$

which is closely related to the canonical Fourier Bessel transform (CFBT) $\mathcal{F}_\nu^{\mathbf{m}}$ given by [1, 8]:

$$\mathcal{F}_\nu^{\mathbf{m}} f(x) = \frac{c_\nu}{(ib)^{\nu+1}} \int_0^{+\infty} K_\nu^{\mathbf{m}}(x,y) f(y) y^{2\nu+1} dy,$$

where

$$K_\nu^{\mathbf{m}}(x,y) = e^{\frac{i}{2}\left(\frac{d}{b}x^2 + \frac{a}{b}y^2\right)}\; j_\nu\left(\frac{xy}{b}\right).$$

and j_ν is the the normalized Bessel function.

We derive Riemann-Lebesgue lemma, inversion formula, operational formula, Paley-Wiener theorem, Plancherel theorem and Babenko type inequality. Also we present some uncertainty principles: Heisenberg inequality and Hardy theorem. Nash-type inequality and the logarithmic uncertainty principle in terms of entropy. Also the Miyachi uncertainty principle.

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Keywords: Fourier Bessel transform, linear canonical transform, uncertainty principle.

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Jacek Dziubanski.

Remarks on generalized translations of radial and non-radial kernels.

Abstract. On $\mathbb{R}^N$ equipped with a normalized root system R and a multiplicity function $k > 0$ we study the generalized (Dunkl) translations

$$\tau_{\mathbf{x}} g(-\mathbf{y}) = c_k^{-1} \int_{\mathbb{R}^N} E(i\xi, \mathbf{x}) E(-i\xi, \mathbf{y}) \mathcal{F}g(\xi)\, dw(\xi),$$

where $E(\mathbf{x}, \mathbf{y})$ is the Dunkl kernel, $dw(\mathbf{x}) = \prod_{\alpha\in R} |\langle \mathbf{x}, \alpha\rangle|^{k(\alpha)}\, d\mathbf{x}$ is the associated measure, and $\mathcal{F}g(\xi) = c_k^{-1} \int_{\mathbb{R}^N} g(\mathbf{x}) E(-i\xi, \mathbf{x})\, dw(\mathbf{x})$ is the Dunkl transform. Let G denote the reflection group generated by $\sigma_\alpha(\mathbf{x}) = \mathbf{x} - \langle \mathbf{x}, \alpha\rangle\alpha$, $\alpha \in R$.

If g is radial (continuous) function with a rapid decay at infinity, then the Rösler's formula for translations of radial functions combined with estimates on the Dunkl heat kernel $h_t(\mathbf{x}, \mathbf{y})$ imply

$$|\tau_{\mathbf{x}} g(-\mathbf{y})| \le C w(B(\mathbf{x}, 1 + d(\mathbf{x}, \mathbf{y})))^{-1} (1 + \|\mathbf{x} - \mathbf{y}\|)^{-2} (1 + d(\mathbf{x}, \mathbf{y}))^{-M},$$

where $d(\mathbf{x}, \mathbf{y}) = \min_{\sigma\in G} \|\mathbf{x} - \sigma(\mathbf{y})\|$ is the distance of the orbit of $\mathbf{x}$ to the orbit of $\mathbf{y}$ with respect to the actions of the reflection group G and $B(\mathbf{x}, r)$ denotes the Euclidean ball centered at $\mathbf{x}$ and radius r. It turns out that the estimate can be improved by products of other factors of the form $(1 + \|\mathbf{x} - \sigma(\mathbf{y})\|)^{-2}$, whose occurrences depend on positions of the Weyl chambers of $\mathbf{y}$ and $\mathbf{x}$.

During the talk we shall study the generalized translations of non-radial functions. We prove, assuming some regularity on (non-radial) g, that similarly to the radial situation, the function $\tau_{\mathbf{x}} g(-\mathbf{y})$ have a decay at infinity with respect to the Euclidean distance $\|\mathbf{x} - \mathbf{y}\|$.

Further we shall discuss how the presence of the Euclidean decay factor $(1 + \|\mathbf{x} - \mathbf{y}\|)^{-\varepsilon}$, $\varepsilon > 0$, in the bounds for $\tau_{\mathbf{x}} g(-\mathbf{y})$ can help in handling some harmonic analysis problems, including characterizations of Hardy spaces and study of singular integrals.

The results are joint works (listed below) with Agnieszka Hejna (University of Wrocław and Rutgers University).

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Zeineb Ghardallou.

Existence and some properties of solutions to a sublinear elliptic problems.

Abstract. We study existence of nonnegative continuous solutions to the equation

$$Lu(x) - \varphi(x, u(x)) = 0 \;, \text{ in } \Omega \tag{6}$$

where $\Omega \subset \mathbb{R}^d$ is a Greenian domain (bounded or unbounded) ($d \geq 3$), L represents a second order elliptic operator with smooth coeffcients satisfying $L1 = 0$, φ belongs locally to the Kato class with respect to the first variable and it grows sublinearly with respect to the second variable. A Harnack-type inequality for positive continuous solutions is also proved.

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Samir Kabbaj.

On frames generated by bilinear mappings.

Abstract. In this work, we define a new generalization of frames on Hilbert spaces. Indeed and by defining a bilinear mapingp b from HXB to Z where H and Z are Hilbert spaces and B a Banach space, we manage to define a duality product between Z and B that we have studied. Then, as applications we define the concept of K-b-frame that we studied and we gave examples.

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Abderrazek Karoui.

Orthogonal systems, positive-definite random matrices and a regression problem.

Abstract. In this talk, we first give a review of some asymptotic as well as non-asymptotic behaviors and estimates of the spectrum of the truncated Fourier transform operator. Some extensions of these estimates are also given in the framework of the weighted truncated Fourier transform as well as the truncated Hankel transform. Note that these different integral operators have the common important property that they commute with some Sturm-Liouville (SL) differential operators. These last differential operators are perturbations of some known SL operators associated with classical orthogonal systems, such as the Legendre and the Gegenbauer polynomials systems. Then, we use some concentration inequalities from mathematical statistics and show that the spectrum of a random Gram matrix with positive-definite kernel is well approximated by the spectrum of the associated integral operator. A special interest is devoted to the Sinc kernel case, which is related to the truncated Fourier transform operator. ALso, by using some concentration inequalities from the theory of positive definite random matrices, we give an estimate for the extreme eigenvalues of random projection matrices associated with $d-$variate Jacobi polynomials. Finally, we show how to use the spectral properties of the previous positive-definite random matrices to solve a multidimensional non-parametric regression problem. That is the approximation of an unknown function from the knowledge of its noised values at some random n inputs $X_i \in \mathbb{R}^d$.

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Sami Mustapha.

Théorie du potentiel en combinatoire.

Abstract. "...Mais la méthode la plus générale et la plus directe, pour résoudre les questions de probabilité, consiste à les faire dépendre d'équations aux différences. . . "

Le but de cet exposé est d'illustrer cette citation de Laplace (Essai philosophique sur les probabilités) en développant certains aspects de la théorie du potentiel discrète attachée à une marche aléatoire dans Z^d; les équations aux différences jouant dans ce cadre le mme rôle joué par les EDP dans dans la théorie du potentiel classique. Bien que la présentation se limitera essentiellement aux marches simples dans des quadrants, certaines extensions aux marches dans des domaines discrets Lipschitziens et aux marches inhomogènes seront abordées. L'accent sera mis sur le rôle que peuvent jouer les outils de la théorie du potentiel discrète (fonctions harmoniques et fonctions caloriques discrètes, principe du maximum, inégalités de Harnack, inégalités de Harnack au bord - Cf. mini-cours N. Ben Salem, S. Mustapha & M. Sifi, HAPI2014, Hammamet) dans l'établissement d'estimations optimales pour le nombre de chemins confinés à une région ainsi que le nombre d'excursions.

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Selma Negzaoui.

A new product formula involving Bessel functions.

Abstract. Since their discovery in 1732 by the mathematician Daniel Bernoulli, the Bessel functions developed by the astronomer Friedrich Wilhelm Bessel, have continued to serve as the basis for the description of several scientific phenomena. It is in this context that the mathematics relating to these functions continued to develop. In this talk I will present the results obtained recently in a jointly work with M.A Boubatra and M. Sifi when we considered the normalized Bessel function and we found an integral representation of the product of two mixed Bessel functions with index of step an integer. It has explicit kernel invoking Gegenbauer polynomials. This allows to establish a product formula for the generalized Hankel function which is the kernel of a generalized Fourier transform arising from the Dunkl theory. As application, we define and study a generalized translation operator and a generalized convolution structure.

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Marc Peigné.

Probabilité de survie d'un processus de Galton-Watson multi-type en environnement aléatoire.

Résumé. Nous considérons une processus de Galton-Watson multi-type en environnement aléatoire i.i.d. et étudions la vitesse de convergence vers 0 de la probabilité de survie, dans les cas critique et sous-critique faible. Cette étude repose sur des résultats récents concernant les fluctuations de produits de matrices aléatoires. Nous présenterons le contexte de ce sujet, dans un premier temps en environnement fixe, et rappellerons les résultats connus pour les produits de matrices aléatoires positives et les fluctuations de leur norme. Nous énoncerons des résultats récents, obtenus en collaboration avec E. Le Page & T.D.C. Pham et essayerons d'expliquer la stratégie de la démonstration.

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Fethi Soltani.

Reproducing kernel Hilbert spaces (RKHS) for the higher-order Bessel operator.

Abstract. In 1961, Bargmann introduced the classical Fock space $F(\mathbb{C})$ and in 1984, Cholewinsky introduced the generalized Fock space $F_{2,\nu}(\mathbb{C})$. These two spaces are the aim of many works, and have many applications in mathematics, in physics and in quantum mechanics. In this work, we introduce and study the reproducing kernel Hilbert space $F_{r,\alpha}(\mathbb{C})$ associated to the Bessel operator $B_{r,\alpha}$ of r-order ($r \geq 3$). The space $F_{r,\nu}(\mathbb{C})$ is a reproducing kernel Hilbert space (RKHS). This is the reason for defining the orthogonal projection operator, the Toeplitz operators and the Hankel operators associated to this space. And, we establish Heisenberg-type uncertainty principle for this space. Furthermore, we give an application of the theory of extremal functions and reproducing kernel of Hilbert space, to establish the extremal function associated to a bounded linear operator $T : F_{r,\alpha}(\mathbb{C}) \to H$, where H be a Hilbert space. Finally, we come up with some results regarding the extremal functions, when T is a difference operator and an integral operator, respectively. Finally, we remark that it is now natural to raise the problem of studying the Bessel-type Segal-Bargmann transform associated to the space $F_{r,\alpha}(\mathbb{C})$. This problem is difficult and will be an open topic. This topic requires more details for the harmonic analysis associated to the operator $B_{r,\alpha}$. We have the idea to continue this research in a future paper.

Keywords: Higher-order Bessel operator; reproducing kernel Hilbert space; Heisenberg-type uncertainty principle; Toeplitz operators; Hankel operators; Tikhonov regularization problem; extremal function.

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