Multiplicative Function on Spaces of Analytic Functions

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Summary
The main objective of this research is to study the multiplicative functions of analytic functions spaces, especially in the Hardy spaces. First, the introduction and definitions of the used theorems are expressed and then the analysis of the Hardy space H2 is analyzed by Blaschke multiplications. Based on Beurling theorem, each subspace dependent on Hardy space H2 and steady under multiplicative function M2 can be expressed as M = bH2 and b is an internal function in it. In this study, this theorem is supposed to be generalized as a Hardy space H2 to De Branges spaces. Assume that M is a Hilbert space, so M is a De Branges space. We want to analyze the existence of an analytic and unique function b that created the relationship M=bH2 condition 1. In includes two parts and in the first part the included De Branges spaces studied analytic functions in some of the Banach spaces. In the second part, an extension of Buerling theorem is represented on a Hilbert space of analytic functions.

***Keywords**:*
Function, analysis, multiplicative

1. Introduction

Bergman spaces include combining analytic function theory with functional analysis and the theory of functions. In addition, this theory has a lot of common concepts with Hardy theory that has new elements such as Two Green's function – harmonic, and regenerating cores. With the arrival of concepts such as analysis and interpolation theories, the ease of using the thesis of Hardy spaces is reduced. For this reason, Bergman spaces solve this challenge. By the appearance of functional analysis in the 1930s, other issues are proposed and solved about Hardy spaces. In particular, in 1949 Arne Beurling, a mathematician from Uppsala University, in an article in Acta Mathematica Journal could present a description of the structure of invariant subspaces in H^2. It should be mentioned that the close subspace M from H^p is invariant when $zM \subseteq M$ i.e. M is multiplied by polynomials. Also, analytic functions are functions that locally characterized by a convergent power series. Analytic functions are in fact, a bed between polynomials and the whole functions.

In theory, these operators can be analyzed from three perspectives. These three perspectives of field spaces that these operators are defined on include the features of the operators including bounded set, compactness, having closed range, normality, and super-normality. Given the importance of operators in the analysis of topological of algebraic structures of field spaces which its analysis is not an easy task, mathematicians facilitated the analysis of operators with presenting a wide range of operators combinational from two multiplicative or combinational operators, or weighted combinational operator. Moreover, another wide range of operators belongs to multiplicative operators and images. Weighted combinational operators are analyzed on different spaces including Hilbert, Hardy, and Banach spaces. Banach functional spaces use functional spaces and functions that are locally convex that first analyzed by Parrot. One of the main reasons that this type of operators is important is because they can remove a wide range of bounded operators on Banach spaces. This type of operators is considered from two perspectives and they are defined on the Hp spaces of these operators.

2. Bergman Spaces

Theorem 1: Ω is a bounded area in the complex plane $\mathbb{C}$ and $\circ < p < \infty$. Bergman space $A^p(\Omega)$ consists of all the analytic functions on Ω that $|f|^p$ is integrable than the area extent in:

$$A^p(\Omega) = \left\{ f \in Hol(\Omega) : \left| \int_\Omega \left| f(z) \right|^p dxdy < +\infty \right\} .$$

The theory of Bergman spaces began with the progressive work of Stephen Bergman (1895-1977) that

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basically limited to a specific mode P=2 and the ranges C^n for n>2. It is clear that in this situation $A^2(\Omega)$ with internal multiplication $\langle f, g\rangle = \int_\Omega f(z)g(z)dA(z)$ is a Hilbert space (where $dA(z)$ is the Lévesque volume measure in C^n space). As a result, orthogonal devices of regenerative functions and cores play a significant role in the study of Bergman spaces. A book that Bergman himself written [1] and [24].

It is assumed that the area Ω the open unit tablet is mixed. The area extent of normalized Lévesque will be shown with $dA(z) = \frac{dxdy}{\pi}$. Therefore, $A^p(D) = A^p$ consists of all the analytic functions f: D→ c for which $\int_D |f(z)|^p dA(z) < \infty$ norm in A^p is defined in the form: $\|f\| Ap = \left(\int_D |d(z)|^p dA(z)\right)^{\frac{1}{p}}$. When

$p \geq 1$, the equation above is a real norm and A^p is along with this Banach space norm. It is clear from this definition that $A^p(D)$ is a subcategory of $L^p(D)$. Hence, some authors use the symbol L^p_α instead of A^p. The symbol B^p should be used in some older mathematical books for Bergman spaces. This symbol is less used today because the different forms of b are used for showing block spaces and also roofless spaces [25].

3. Hilbert Spaces

Hilbert spaces are established on quaternions and the internal multiplication of such Hilbert spaces has quaternions of the amount. After analyzing the features of such spaces, linear and bounded operators are defined on them and it generalizes important theorems such as open mapping theorem, closed graph theorem, and Reese display theorem on these spaces. Finally, the range and the collection of the solvent of the bounded linear operator and their features are generalized. According to the fact that the multiplication of quaternions is irreplaceable, problems occur to the quaternion mode in the different stages of generalization of features that make the procedure of proofs more complicated [18] and [11].

4. Principles of Quantum Mechanics in Hilbert Space

- Hilbert space is a vector space which has internal multiplication and it completes than the norm its internal multiplication induces, according to the fact that internal spaces multiplications are always complete with the final dimension. Also in the first principle, there is a Hilbert space in lieu of every physical system and it determined by a nonzero vector in Hilbert space. Moreover, if two vectors belong to one common factor, it, in fact, explains a physical mode, as a result, it determines the system mode in the form of a vector with one (vector unit) length [13] and [16].
- Second principle: the time change in Hilbert space explains a unitary operator on Hilbert space. If U: H → H, then, | ψ ′ is. It means if the system mode is $|\psi\rangle$, in the time t0 and is $|\psi'\rangle$ at the time t_1. And | ψ⟩ is from the independent unit variable U .U |ψ⟩ = |ψ ′. This principle is, in fact, another formulation of Schrödinger equation. This equation defines the time transformation of a quantum system as:

$$ih\frac{d}{dt}|\psi(t)\rangle = H|\psi(t)\rangle|$$

Where H → H : H is a Hermitian operator which is called Hamiltonian. If H is independent of time, the answer to the following equation is as follow [9]:

$$|\psi(t)\rangle = e^{-\frac{it}{h}}H|\psi(0)\rangle$$

Now if it places in equation 1

$$U = e^{-\frac{it}{h}H}$$

Then $\left|\psi(t)\right\rangle = U\left|\psi(0)\right\rangle$. We claim that U is unitary; it means that you should consider $U^{\dagger}U = IUU$ Taylor expansion formula function $\left|\psi(t)\right\rangle = U\left|\psi(0)\right\rangle$ in which a_n are real number.

$$U = \sum_n a_n \left(-\frac{it}{h}H\right)^n$$

As a result

$$U^{\dagger} = \left[\sum_n a_n \left(-\frac{it}{h}H\right)^n\right]^{\dagger}$$
$$= \sum_n a_n \left[\left(-\frac{it}{h}H\right)^n\right]^{\dagger}$$
$$= \sum_n a_n \left[\left(-\frac{it}{h}H\right)^{\dagger}\right]^n$$
$$= \sum_n a_n \left(-\frac{it}{h}H^{\dagger}\right)$$
$$= \sum_n a_n \left(-\frac{it}{h}H\right)^n$$
$$= e^{\frac{it}{h}H}$$

For this reason, the output order of that U is unitary. There is a Hamiltonian H for each Unitary U. Therefore, the second principle is that the expressed time evolution of a quantum system with unitary operators, in fact, it is another formulation of the Schrödinger equation [13]. Third principle: measuring on a system with Hilbert space H with a collection can be determined as follow:

$$\{M_i : \quad M_i : H \to H, i \in S\}$$

Where $\sum_{i \in S} M_i^{\dagger} M_i = I \quad (Completeness)$

In this case, the Mis are called measurement operators, if the product of measurement is S ∈ i, the system mode changes to the equation:

$$\left|\psi'\right\rangle = \frac{M_i\left|\psi\right\rangle}{\sqrt{\left\langle\psi\right|M_i^{\dagger}M_i\left|\psi\right\rangle}}$$

It should be mentioned that $p(i)$ is a probability distribution which is as follow:

1. $p(i)$ Is nonnegative because it is equal with the vector norm of $M_i\left|\psi\right\rangle$ to the power of two.
2. The sum of $p(i)$s are one and it results from $\sum M_i^{\dagger}M_i = I$.

Analytic functions

In mathematics, an analytic function is a function that locally characterized by a convergent power series. Analytic functions can be considered as a bridge between polynomials and functions in general. Here are real and complex analytic functions that have similarities and differences. A function is analytic if it is equal to its Taylor series in proximity [15].

Analytic functions features

Collections, multiplications, and analytic functions combinations are analytic.

The reverse of an analytic function that is not zero anywhere is analytic.

Every analytic function is even [11].

A polynomial cannot be zero at a large number of spots unless the polynomial is zero (more exactly, the maximum number of zeros can be as much as the degree of the polynomial). There is a similar but weaker rule for analytic functions. If the set of zeros of analytic function f has a spot of accumulation in its domain, then f is zero in the whole connective component which includes the spot of accumulation [13].

5. The Study of Hardy Spaces

The Study of the structural characteristics of Hp elements was conducted in the years between 1915 and 1930. It began with an article critical from G·H. Hardy. Hardy showed that any $F \in H^p$ function has radial limit almost everywhere on $T = \partial D$ and plus the border function $f^*\left(e^{i\theta}\right) = \lim_{r \to 1} f\left(re^{i\theta}\right)$ cannot be under a set with a positive value from T with zero unless it is $f \equiv \circ$. In addition, Fatou has proved that every bounded analytic function in the unit tablet has a non-tangent extent almost everywhere on the unit circle. Nevertheless, the term Hardy space was not invented yet until Frederick Reese named these spaces as Hardy spaces in an article in 1923. The reason for this name was that Hardy proved in an article in 1915 that $\|f_r\|_{Lp(T)}$ is an ascending function compared with r, it means for every analytic function and the numbers $\circ < r_1 < r_2 < 1$ we have [5].

Today, this rule is known as Hardy inequality (see page 337 from [13] for the proof of it). In 1923, Reese introduced the method of removing zeroes or factoring by a Blaschke product. This was a beginning for describing the zero of the collections of the Hardy spaces H^P (or Bergman spaces A^P). Anytime a function like f is found in H^P (or in A^P) which is exactly zero on $\{z_k\}$, in fact, it was proved that $\{z_k\}$ is a zero of the collection H^P, if or only if $\{z_k\}$ applied in $\sum_{k=1}^{\infty}\left(1-|z_k|\right) < \infty$ called Blaschke condition.

The noticeable point, in this case, is the independency of Blaschke condition from p. In other words, every zero of the collection H^p is also the zero of the collection H^q [18].

With the appearance of functional analysis in the 1930s, other problems about Hardy spaces also raised and solved. In particular, in 1949 Arne Beurling, a mathematician from Uppsala University, in an article in Acta Mathematica Journal could present a description of the structure of invariant subspaces in H2. We remind that the close subspace M from HP is called invariant each time M is multiplied by polynomials. The operator of $f \to zf$ is called the transfer operator. Additionally, there is an operator on the sequence space ℓ^2 (the sequences that their squares of elements absolute value are additive) that transfer the vector $(a_1, a_2, \ldots)$ to the vector $(\circ, a_1, a_2, \ldots)$. Be careful that if we consider f with the Taylor coefficients of the other as equal, then we consider each f as equal with a member of ℓ^2. In this condition, zf is equal with the sequence $(\circ, a_1, a_2, \ldots)$. Therefore, the transfer operator on ℓ^2 is the same as the operator $z \to zf$ on H^2 [7].

Hardy spaces

Because these spaces are raised from L^p and A^p spaces, H^p Hardy spaces need to be introduced. It can be observed that $H^p \subseteq A^p \subseteq L^p$, as a result A^p is needed without the study of H^p and sometimes their comparison. We say that the analytic function $f : D \to \square$ belongs to the Hardy space H^p and each time the equation $\sup_{\circ < e < 1} \frac{1}{2\pi} \int_{\circ}^{2\pi} \left|f\left(re^{i\theta}\right)\right|^p d\theta < \infty$ of the function norm of $f \in H^p$ is defined in the form of $\|f\| Hp = \sup_{\circ < r <} \left(\frac{1}{2\pi} \int_{\circ}^{2\pi} \left|f\left(re^{i\theta}\right)\right|^p d\theta\right)^{\frac{1}{p}}$ so that if we define the function $f_r : \mathrm{T} = \partial D \to \square$ instead of $\circ < r < 1$ with the criterion $f_r\left(e^{i\theta}\right) = f\left(re^{i\theta}\right)$, then $\|f\| Hp = \sup_{\circ < r < 1} \|f_r\| Lp(T)$ in a specific condition that $H^P, p = \infty$, turns to bounded analytic function:

$$H^{\infty} = \left\{ f \in Hol(D) : \sup_{|z|<1} |f(z)| < \infty \right\}$$

The norm in this space defined as

$$\|f\| H\infty = \sup_{|z|<1} |f(z)|$$

It is clear from the definition that $(\circ < p < \infty) H^{\infty} \subseteq H^{p}$. Similar to what we had in A^p space, there is a Banach space H^2 instead of $p \geq 1$, and a complete metric space instead of $\circ < p < 1$. In p = 2 modes, H^2 is Hilbert space. With a simple calculation, it is determined that the function $f(z) = \sum_{n=\circ}^{\infty} a_n z^n$ belongs to H^2 space, if and only if

$$\|f\|_{H^2}^2 = \sum_{n=\circ}^{\infty} |a_n|^2 < \infty$$

6. The Conclusions

It is concluded from here that $H^2 \subseteq A^2$ if P is a positive desirable number from the inequality

$$\|f\|_{Ap}^{p} = \frac{1}{\pi} \int_{\circ}^{1} \int_{\circ}^{2\pi} \left| f\left(re^{i\theta}\right) \right|^{p} r dr d\theta$$

$$\leq \int_{\circ}^{1} \|f\|_{Hp}^{p} r dr = \frac{1}{2} \|f\|_{Hp}^{p}$$

We find that H^p is, in fact, a closed subspace A^p [10].

$$f^{*}\left(e^{i\theta}\right) = \lim_{r \to 1} f\left(re^{i\theta}\right)$$

$$\int_{\circ}^{2\pi} \left| f\left(r1e^{i\theta}\right) \right|^{p} d\theta \leq \int_{\circ}^{2\pi} \left| f\left(r2e^{i\theta}\right) \right|^{p} d\theta$$

$$\sum_{k=1}^{\infty} \left(1 - |z_k|\right) < \infty$$

$$f(z) = \sum_{n=\circ}^{\infty} \frac{z^n}{\sqrt{n+1}}$$

$$\sum_{n=\circ}^{\infty} \frac{|a_n|^2}{n+1} = \sum_{n=\circ}^{\infty} \frac{1}{(n+1)^2} < \infty$$

$$M = \left\{ f \in A^2 : \quad f(a) = \circ \quad \forall a \in A \right\}$$

$$b_k(z) = \frac{|z_k|}{z_k} \cdot \frac{z_k - z}{1 - \overline{z_k z}} \quad z_k \neq \circ$$

$$h(z) = \prod_k b_k(z)\left(2 - b_k(z)\right)$$

$$M = [f] = cl\left\{ p(z) f(z) : \quad f \in H^p \left(or \quad A^p\right) \right\}$$

Analyzing the performance of multiplication on the spaces of analytic functions

Let $\{\beta_n\}$ be the set of real positive numbers with $\beta(0) = 1$. For $1 \leq p \leq \infty H^{P}(\beta)$, let $\{f : f(z) = \sum_{n=0}^{\infty} f_n z^n\}$ be the space of the formal set of the formula in which $\{f_n\}_{n=0}^{\infty}$, and order of complex numbers is in a form that $\sum_{n=0}^{\infty} |f_n|^p \beta_n^p < \infty$. So $H^p(\beta)$ of Banach space is under the form of $\left\{ f : f(z) = \sum_{n=0}^{\infty} f_n z^n \right\}$ [11].

For $p = 2$, space $H^2(\beta)$ is defined as a Hilbert space under the internal responsibility and also as $\sum_{n=0}^{\infty} a_n \bar{b}_n \beta_n^2$ in which $f(z) = \sum_{n=0}^{\infty} a_n z^n$ and $g(z) = \sum_{n=0}^{\infty} b_n z^n$ are the elements.

The secondary result 1: Ω and area in c let Banach space formula be Holomorphic functions that are defined on $H(\Omega)$. If $\theta : \Omega \to \mathbb{C}$ is a coefficient in the form of $\theta \cdot f \in H(\Omega)$, everywhere that $f \in \Omega$, exists, the multiplicative transfer

$M_\theta : H(\Omega) \to H(\Omega)$ defined by $M_\theta f = \theta \cdot f$. If M_θ is continues, then the induced operator is θ. The importance of multiplicative operators derived from spectral theorem and the normal operator on Hilbert spaces are equal with multiplicative operator [3].

The study of multiplicative operators on $L^p(\lambda)$ is conducted by Sing and Kumar in which it is determined that the most features of combination operators are characteristically defined through $C_\phi^* C_\phi = M_{f_0}$ in which M_{f_0} the multiplicative operator through this formula derived from $f_0 = \frac{d\lambda\phi^{-1}}{d\lambda}$ considering this measurement. The main objective of this paper is to study the multiplicative operator and harmonic Hardy spaces. The symbol $\lambda\phi^{-1}$ shows the algebraic Banach for all the linear operators that are grouped on H and $\mathrm{B(H)}$ shows the set {0, 1, 2, 3…}.

Limited multiplication operators in weighted Hardy spaces

These operators show that the insertion of the multiplicative operator of this M_θ does not induce by $\overline{\theta}$ and it is said that in many cases it is applicable.

First principle: it prepares the adequate conditions for the grouping of the multiplicative operator, if $\theta(z) = \sum_{n=0}^{\infty} \theta^\wedge(n) z^n$ is applicable.

We should write

$$\tau_n(z) = \sum_{p=n}^{\infty} \frac{\tau_n^\wedge(\theta)(p)}{\beta_n} z^p,$$

In this case

$$\tau_n^\wedge(\theta)(p) = \theta^\wedge(p-n).$$

Let

$$S_n(\theta)(z) = \sum_{n=0}^{\infty} S_n^\wedge(\theta) z^n,$$

From this equation

$$S_n^\wedge(\theta) = \sqrt{\sum_{k=0}^{n} \left| \frac{\tau_k(\theta)(n)}{\beta_k} \right|^2}.$$

Second secondary result: let $S_n(\theta)(z) \in H^2(\beta)$ be confirmed, and then $M_\theta : H^2(\beta) \to H^2(\beta)$ is the grouped operator.

Let $f \in H^2(\beta)$ be confirmed, then we have

$$\begin{aligned} |M_\theta f||^2 &= \sum_{n=0}^{\infty}\sum_{k=0}^{n} |\theta(n-k) f(k)|^2 \beta_n^2 \le \sum_{n=0}^{\infty} \left(\sum_{k=0}^{n} |f(k)|^2 \beta_k^2 \sum_{k=0}^{n} \frac{|\theta(n-k)|^2}{\beta_k^2} \right) \beta_n^2 \\ &\le ||f||^2 \sum_{n=0}^{\infty}\sum_{k=0}^{n} \frac{|\theta(n-k)|^2}{\beta_k^2} \beta_n^2 = ||f||^2 \sum_{n=0}^{\infty}\sum_{k=0}^{n} \left| \frac{\tau_k(\theta)(n)}{\beta_k} \right|^2 \beta_n^2 \\ &= ||f||^2 \sum_{n=0}^{\infty} |S_n^\wedge(\theta)|^2 \beta_n^2 = M||f||^2, \end{aligned}$$

In this equation $M = ||S_n(\theta)||^2$ is applicable and this proves that the operator is grouped [11].

References

[1] Cao, C., Carroll, S. M., & Michalakis, S. (2017). Space from Hilbert space: Recovering geometry from bulk entanglement. Physical Review D, 95(2), 024031

[2] Mathé, P., & Pereverzev, S. V. (2017). The complexity of linear ill-posed problems in Hilbert space. Journal of Complexity, 38, 50-67.

[3] Hermes, M. R., Dukelsky, J., & Scuseria, G. E. (2017). Combining symmetry collective states with coupled cluster theory: Lessons from the Agassi model Hamiltonian. arXiv preprint arXiv:1703.02123.

[4] Reich, S., & Zalas, R. (2016). A modular string averaging procedure for solving the common fixed point problem for quasi-nonexpansive mappings in Hilbert space. Numerical Algorithms, 72(2), 297-323.

[5] Raychev, N. (2015). Encoding and decoding of additional logic in the phase space of all operators. International Journal of Scientific and Engineering Research, 6(7), 1356-1366.

[6] Harper, A. J. (2017). Moments of random multiplicative functions, I: Low moments, better than squareroot cancellation, and critical multiplicative chaos. arXiv preprint arXiv:1703.06654.

[7] Golubov, B. I., & Volosivets, S. S. (2017). Integrability and Uniform Convergence of Multiplicative Transforms. In New Trends in Analysis and Interdisciplinary Applications (pp. 363-369). Birkhäuser, Cham.

[8] Gundogdu, O., Egrioglu, E., Aladag, C. H., & Yolcu, U. (2016). Multiplicative neuron model artificial neural network based on Gaussian activation function. Neural Computing and Applications, 27(4), 927-935.

[9] Tomassetti, G., Cohen, T., & Abeyaratne, R. (2016). Steady accretion of an elastic body on a hard spherical surface and the notion of a four-dimensional reference space. Journal of the Mechanics and Physics of Solids, 96, 333-352.

[10] Kedar, G., Mendelson, A., & Cidon, I. (2017). SPACE: Semi-Partitioned Cache for Energy Efficient, Hard Real-Time Systems. IEEE Transactions on Computers, 66(4), 717-730.

[11] Kucik, A. S. (2017). Carleson measures for Hilbert spaces of analytic functions on the complex half-plane. Journal of Mathematical Analysis and Applications, 445(1), 476-497.

[12] Yang, J., & Fan, Q. (2017). Interpolating Sequences and Ideals in Dirichlet Spaces of Bounded Functions. Complex Analysis and Operator Theory, 11(1), 139-149.

[13] Stenger, F., Tucker, D., & Baumann, G. (2016). Spaces of Analytic Functions. In Navier–Stokes Equations on R3× [0, T] (pp. 9-18). Springer International Publishing.

[14] Colonna, F., & Tjani, M. (2016). Operator norms and essential norms of weighted composition operators between Banach spaces of analytic functions. Journal of Mathematical Analysis and Applications, 434(1), 93-124.

[15] Albanese, A. A., Bonet, J., & Ricker, W. J. (2016). The Cesaro operator in growth Banach spaces of analytic functions. Integral Equations and Operator Theory, 86(1), 97-112.

[16] Temkin, M. (2015). Introduction to Berkovich analytic spaces. In Berkovich spaces and applications (pp. 3-66). Springer International Publishing.

[17] Li, M., & Lai, A. C. (2015). Review of analytical models for heat transfer by vertical ground heat exchangers (GHEs): a perspective of time and space scales. Applied Energy, 151, 178-191.

[18] Wang, H., Ang, B. W., & Su, B. (2017). Multiplicative structural decomposition analysis of energy and emission intensities: Some methodological issues. Energy, 123, 47-63.

[19] Xie, W. B., Lim, C. C., Zhang, J., & Huang, L. (2017). New approaches to observer design and stability analysis for T–S fuzzy system with multiplicative noise. Journal of the Franklin Institute, 354(2), 887-901.

[20] Klamt, S., Regensburger, G., Gerstl, M. P., Jungreuthmayer, C., Schuster, S., Mahadevan, R., & Müller, S. (2017). From elementary flux modes to elementary flux vectors: Metabolic pathway analysis with arbitrary linear flux constraints. PLOS Computational Biology, 13(4), e1005409.

[21] Dulat, S., Hou, T. J., Gao, J., Guzzi, M., Huston, J., Nadolsky, P., ... & Yuan, C. P. (2016). New parton distribution functions from a global analysis of quantum chromodynamics. Physical Review D, 93(3), 033006.

[22] Marsh, K., IJzerman, M., Thokala, P., Baltussen, R., Boysen, M., Kaló, Z., & Devlin, N. (2016). Multiple criteria decision analysis for health

care decision making—emerging good practices: report 2 of the ISPOR MCDA Emerging Good Practices Task Force. Value in health, 19(2), 125-137.

[23] Miihkinen, S., Nieminen, P. J., & Xu, W. (2017). Essential norms of integration operators on weighted Bergman spaces. Journal of Mathematical Analysis and Applications.

[24] Nishio, M., & Shimomura, K. (2017). Reproducing Kernels for Iterated Parabolic Operators on the Upper Half Space with Application to Polyharmonic Bergman Spaces. Complex Analysis and Operator Theory, 1-14.

[25] Choe, B. R., Koo, H., & Wang, M. (2016). Compact double differences of composition operators on the Bergman spaces. Journal of Functional Analysis.