2007 Canadian Operator Symposium

June 5 to 9

University of Guelph

SCHEDULE & ABSTRACTS

Co-organizers:

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2007 COSy Timetable

	Tuesday	**Wednesday**	**Thursday**	**Friday**	**Saturday**
850-900	*Opening Remarks*				
900-950	Putnam	Junge	Elliott	Katsoulis	Davidson
1000-1025	Farenick	Spronk	Kucerovsky	Dean	Yang
1030-1100	*Break*	*Break*	*Break*	*Break*	*Break*
1100-1150	Gottesman	Ruskai		Paulsen	
1100-1125			Censor		Bernik
1130-1155			Ng		Yahaghi
1200-1225			Massey		Radjavi
1200-1400	*Lunch*	*Lunch*	*Free*	*Lunch*	
1400-1450	Markopoulou	Nica	*Afternoon*	Choi	
1500-1525	Konopka	Samei		Pereira	
1530-1600	*Break*	*Break*		*Break*	
1600-1625	Zorboska	Martinez-Avendano		Beny	
1630-1655	Gutoski	Robert		Lesosky	
1700-1725	Mastnak			Shamoyan	
1800-2200		*Banquet*			

Notes. There will be a Reception from 7pm to 9pm on Monday evening in the University Club. All talks will be held in Rozanski Hall, Room 102. The Banquet will take place on Wednesday in the University Club, with a cash bar from 6pm and dinner at 7pm. Registration will take place during the Reception, and during the day on Tuesday and Wednesday.

2007 COSy Titles & Abstracts

Speaker: Cedric Beny, University of Waterloo
Title: *Operator algebra quantum error correction*
Abstract: We characterize the finite-dimensional operator algebras on which a unital CP map has a CP inverse. This result generalizes quantum error correction to the case of hybrid classical and quantum information when the algebra is interpreted as the span of sharp observables. We also discuss the case of more general operator spaces, spanned by unsharp observables. This talk is based on joint work with Achim Kempf and David Kribs.

Speaker: Janez Bernik, University of Ljubljana, Slovenia
Title: *Invariant subspaces and triangularization of semitransitive spaces*
Abstract: A linear space L of n-by-n complex matrices is semitransitive if, given two nonzero vectors x, y, there exists a matrix A in L such that either Ax=y or Ay=x. In contrast with transitive spaces, semitransitive ones may well have (common) invariant subspaces. We give an intrinsic characterization of when this is the case and use it to prove that a semitransitive space L of minimal possible dimension n is triangularizable. This talk is based on joint work with R. Drnovsek, D. Kokol Bukovsek, T. Kosir, and M. Omladic.

Speaker: Aviv Censor, Technion - Israel Institute of Technology
Title: *Taking Groupoid C*-Algebras to the Limit*
Abstract: Let T be a compact Hausdorff space. Raeburn and Taylor associated groupoid C*-algebras to open covers of T, and showed that any element in the Brauer group of T can be realized by such an algebra.

We study the asymptotic behavior of the Raeburn-Taylor C*-algebras related to a sequence of open cover refinements. This is accomplished via a limit groupoid G which we construct, along with a groupoid 2-cocycle. Our main result presents the groupoid C*-algebra of G as a certain generalized direct limit of the Raeburn-Taylor algebras. As a special case, our construction produces all UHF C*-algebras as algebras of the form C*(G). This talk is based on joint work with Daniel Markiewicz.

Speaker: Man-Duen Choi, University of Toronto
Title: *Wonders of non-commutative computations*
Abstract: Suddenly, I fell into the era of quantum computers. I have no magic hands, but I need to play tricks on non-commutative computations at all times.

For example, if A and B are two positive semi-definite matrices between O and I , what is the ultimate lower bound of the Jordan product AB + BA? There are all sorts of nonlinear inequalities of rich meanings in matrix analysis.

Speaker: Kenneth R. Davidson, University of Waterloo
Title: **-Representations of rank 2 graphs*
Abstract: In this talk, we will survey recent joint work with Stephen Power and Dilian Yang on the operator algebras of rank 2 graphs on a single vertex. We show that every defect free row contractive representation of the graph has a unique dilation to a *-representation. This leads to the conclusion that the C*-envelope of the nonself-adjoint operator algebra of the graph is the Kumjian-Pask C*-algebra. Atomic *-representations act on a basis by permuting the basis up to unimodular scalar multiples. We completely classify these representations, and show how they are decomposed into direct sums or direct integrals of irreducible atomic *-representations.

Speaker: Andrew Dean, Lakehead University
Title: *Classification of C*-dynamical systems*
Abstract: We shall discuss several results in which C*-dynamical systems arising as inductive limits are classified using K-theoretic and spectral data.

Speaker: George Elliott, University of Toronto
Title: *Is the Cuntz semigroup K-theory?*
Abstract: This question suggests implicitly the question whether the Cuntz semigroup could be considered admissible as an invariant for classification. While this question is perhaps premature as the Cuntz semigroup has not yet been used to prove isomorphism of two C*-algebras which lie outside the class for which ordinary K-theory (including traces) has been shown to be sufficient, this invariant has already been used both to separate a C*-algebra from this class (Toms) and to include it in this class (Coward, Elliott, and Ivanescu).

Speaker: Doug Farenick, University of Regina
Title: *The gap between the local multiplier algebras of a C*-algebra*
Abstract: The local multiplier algebra of a C*-algebra A is the C*-algebra $M_{loc}(A) = lim_{\rightarrow} M(K)$, where the direct limit is considered with respect to the directed system of multiplier algebras $M(K)$ of the essential ideals K of A. Local multiplier algebras have the property that $M_{loc}(A)$ is a C*-subalgebra of $M_{loc}(M_{loc}(A))$. By a recent result of P. Ara and M. Mathieu, there is a separable, antiliminal C*-algebra A for which the inclusion of local multipier algebras is proper. In this lecture, I will give an example of a separable, liminal C*-algebra A for which $M_{loc}(A) \neq M_{loc}(M_{loc}(A))$. This talk is based on joint work with M. Argerami and P. Massey.

Speaker: Daniel Gottesman, Perimeter Institute
Title: *Introduction to quantum error correction*
Abstract: Quantum computers offer the possibility of some dramatic computational speedups, the most famous being Shor's factoring algorithm. However, quantum states are very delicate, and we won't be able to realize the benefits of quantum computation without a way to correct errors. I will describe the basics of quantum error correction and show how it becomes easier to understand and create quantum error-correcting codes if we define the codes via groups of operators rather than considering them as linear subspaces of Hilbert space.

Speaker: Gus Gutoski, University of Waterloo
Title: *Toward a general theory of quantum games*
Abstract: We study properties of quantum strategies, which are complete specifications of a given party's actions in any multiple-round interaction involving the exchange of quantum information with one or more other parties. In particular, we focus on a representation of quantum strategies that generalizes the Choi-Jamiolkowski representation of quantum operations. This new representation associates with each strategy a positive semidefinite operator acting only on the tensor product of its input and output spaces. Various facts about such representations are established, and two applications are discussed: the first is a new and conceptually simple proof of Kitaev's lower bound for strong coin-flipping, and the second is a proof of the exact characterization QRG = EXP of the class of problems having quantum refereed games.

This talk is based on joint work with John Watrous. To appear in STOC 2007. Online version at http://arxiv.org/abs/quant-ph/0611234.

Speaker: Marius Junge, University of Illinois at Urbana-Champaign
Title: *Noncommutative Riesz transforms*
Abstract: For a Riemanian manifold the distance between two points is given by

$$d(p,q) = \sup_{\|\nabla f\|_\infty \leq 1} |f(p) - f(q)|.$$

This concept has been generalized in the theory of semigroups of positive maps $T_t = e^{-tA}$ to

$$d_A(p,q) = \sup_{\|\Gamma_A(f,f)\|_\infty \leq 1} |f(p) - f(q)|.$$

Here

$$2\Gamma_A(f,g) = A(\bar{f}g) - A(\bar{f})g - \bar{f}A(g)$$

is the positive form associated to the generator A considered by Sauvageot and many others. For a Riemanian manifold with $A = -\Delta$, the Laplace-Beltrami operator we have $d = d_A$ and

$$\Gamma_A(f, f) = (\nabla f, \nabla f).$$

For many semigroups in the commutative setting one can show Paul Andre Meyer's inequality

$$c_p^{-1} \|A^{1/2} f\|_p \leq \|\Gamma_A(f, f)^{1/2}\|_p \leq c_p \|A^{1/2} f\|_p.$$

The main intention of this talk is to show the upper estimate for $p > 2$ and certain semigroups of completely positive maps on noncommutative L_p spaces. Here free products and free groups are particularly interesting. We also discuss applications of the lower estimate for quantum metric spaces (in the sense of Rieffel) for hyperbolic groups with the Haagerup property.

Speaker: Elias Katsoulis, East Carolina University
Title: *Operator algebras for multivariable dynamics*
Abstract: Let X be a locally compact Hausdorff space with n proper continuous self maps $\tau_i : X \to X$ for $1 \leq i \leq n$. To this we associate two topological conjugacy algebras which emerge as the natural candidates for the universal algebra of the system, the tensor algebra $A(X, t)$ and the semi-crossed product $C0(X) \times_\tau F_n$.

We introduce a concept of conjugacy for multidimensional systems, which we coin piecewise conjugacy. We prove that the piecewise conjugacy class of the system can be recovered from either the algebraic structure of $A(X, t)$ or $C0(X) \times_\tau F_n$. Various classification results follow as a consequence. For example, for $n = 2, 3$, the tensor algebras are (algebraically or even completely isometrically) isomorphic if and only if the systems are piecewise topologically conjugate. In order to establish these results we make use of analytic varieties as well as homotopy theory for Lie groups

We define a generalized notion of wandering sets and recurrence. Using this, it is shown that $A(X, t)$ or $C0(X) \times_\tau F_n$ is semisimple if and only if there are no generalized wandering sets. In the metrizable case, this is equivalent to each τ_i being surjective and v-recurrent points being dense for each $v \in F_n$.

This talk is based on joint work with Kenneth Davidson.

Speaker: Tomasz Konopka, Perimeter Institute & University of Waterloo
Title: *Applications of passive quantum error correction in mechanics*
Abstract: Systems with constraints are often of practical interest in the context of classical and quantum mechanics. In this talk, I will review how solutions to mechanical problems with constraints can be described using the methods of passive quantum error correction. I will discuss in particular

what this connection can teach us about the problem of time in quantum gravity. This talk is based on joint work with Fotini Markopoulou.

Speaker: Dan Kucerovsky, University of New Brunswick
Title: *Purely infinite elements in corona algebras*
Abstract: Consider the corona of a real rank zero algebra. In the case of a simple algebra, we establish a connection between purely infinite corona (in the sense of Rordam and Kirchberg) and finitely many corona ideals. Other conditions on ideals, for example $I_{fin}(A) = L(A)$ are considered also. We prove that the multiplier algebra of a real rank zero simple algebra is almost always weakly divisible – this can be thought of as a very strong form of refinement property. This is joint work with F. Perera.

Speaker: Maia Lesosky, University of Guelph
Title: *Fredholm integral equations on the Euclidean motion group*
Abstract: The Euclidean motion group, SE(2), is a simple example of a non-compact, non-commutative group that poses some challenges when attempting to solve ill-posed deconvolution problems. Defining an irreducible unitary representation from SE(2) to the dual object allows for well defined Fourier analysis. Properties of the Fourier transform and the inverse Fourier transform follow from properties of the irreducible representation and allow for the solution of some generalized Fredholm integral problems. This talk is based on joint work with Peter Kim and David Kribs.

Speaker: Fotini Markopoulou, Perimeter Institute
Title: *Operator algebras in quantum gravity*
Abstract: The search for a quantum theory of gravity is the effort to reconcile deep contradictions between the two fundamental theories describing nature: general relativity and quantum theory. A successful quantum theory of gravity needs to explain spacetime as an effective, approximate description of something more fundamental.

I describe an approach to quantum gravity in which the pre-spacetime structure is a directed graph of operator algebras. They may also be thought of as a network of quantum information flow. I describe how excitations emerge which may be used to define classical spacetime. I will discuss the problem of showing how classical spacetime may emerge in this setup.

Speaker: Ruben A. Martinez-Avendano, Universidad Autonoma del Estado de Hidalgo, Mexico
Title: *Higher-rank numerical range of operators in infinite-dimensional Hilbert space*
Abstract: The higher-rank numerical range was introduced by Choi, Kribs and Zyczkowski in the context of the theory quantum error correction.

In this talk, we show how to calculate the higher-rank numerical ranges of some classes of operators in infinite-dimensional Hilbert space, including self-adjoint operators and nonunitary isometries.

Speaker: Pedro Massey, University of Regina
Title: *On Kadison's Carpenter's Theorem*
Abstract: Let M be a II_1 factor and let A be a maximal abelian subalgebra of M. If $t \in [0,1]$ then let P_t denote the set of all projections p in M with $t(p) = t$, where t denotes the trace of M. Kadison (PNAS 99, 2002) conjectured the equality of sets

$$E_A(P_t) = \{a \in A : 0 \leq a \leq 1, t(a) = t\}.$$

where E_A denotes the trace preserving conditional expectation of M onto A. Although we have previously obtained some weak versions of this equality, this problem is still open. In this talk we propose a setting (that essentially deals with the Cartan subalgebras of the hyperfinite II_1 factor R) within which we prove that the set on the left-hand side of the equality above is -dense in the set on the right-hand side. This is achieved by constructing an explicit family of non-discrete operators in $E_A(P_t)$.

This talk is based on joint work with Martin Argerami.

Speaker: Mitja Mastnak, University of Waterloo
Title: *Approximate permutability of traces on semigroups of matrices*
Abstract: A collection of matrices is said to be (simultaneously) triangularizable if it is simultaneously similar to a collection of upper triangular matrices. It is known that if trace is permutable on a semigroup S of complex matrices, i.e., $tr(ABC) = tr(BAC)$ for all A, B, C in S, then S is triangularizable. In joint work with J. Bernik, R. Drnovsek, T. Kosir, M. Omladic and H. Radjavi, we study an approximate version of this condition. Somewhat surprisingly, it turns out that for a unitary group of matrices, the condition $-tr(ABC) - tr(BAC) - < 3$ implies commutativity.

Speaker: Ping Wong Ng, University of Louisiana
Title: *A measure-theoretic uniqueness theorem and the unitary group of an injective type III factor*
Abstract: Norm topology existence and uniqueness theorems play a fundamental role in classification theory as well as extension theory. We believe that measure theoretic versions of these theorems will also be interesting. We show that for a type III von Neumann factor M with separable predual, M is injective if-and-only-if M has a Voiculescu-type theorem. We use this to show that the unitary group of an injective type III factor, given the weak* topology, is extremely amenable. We finally give results on the Kirchberg property for the unitary group of an injective type III factor. This talk is based on joint work with Thierry Giordano.

Speaker: Alexandru Nica, University of Waterloo
Title: *Infinite divisibility for free additive convolution, and a semigroup of transformations related to it*
Abstract: Free additive convolution is an operation $\boxplus$ with probability measures on the real line, which reflects the addition of free selfadjoint elements in a C*-probability space. The property of infinite divisibility with respect to $\boxplus$ was thoroughly studied in papers from the 80's and 90's by Voiculescu, Bercovici-Voiculescu, Bercovici-Pata. It is known to parallel quite nicely the the classical theory of infinite divisibility with respect to the usual convolution of probability measures.

The definition of $\boxplus$ and of infinite divisibility with respect to it extend naturally to the multi-variable framework of (non-commutative) distributions for k-tuples of selfadjoint elements in a C*-probability space. In this talk I will present some recent results obtained in joint work with Serban Belinschi, which go in the multi-variable framework. We put into evidence a multi-variable counterpart for an important bijection found by Bercovici and Pata in their study of relations between infinite divisibility in free and in Boolean probability. We observe a semigroup B_t, $t \geq 0$, of transformations of the space of distributions, where the multi-variable Bercovici-Pata bijection appears at $t = 1$. We prove that the transformations B_t are multiplicative with respect to an operation of "free multiplicative convolution", and that they have an interesting relation with the free Brownian motion.

Speaker: Vern Paulsen, University of Houston
Title: *A dynamical approach to the Kadison-Singer problem*
Abstract: The Kadison-Singer problem asks whether or not pure states on a discrete MASA in $B(H)$ extend uniquely to states on $B(H)$. If one uses the bounded functions on a countable discrete group G for the MASA, then the pure states are identified with points in the Stone-Cech compactification of G and G acts on this latter space. We conjecture that some states have unique extensions while others do not and that the difference has to do with the dynamical properties of the states under this action. We provide some results to, hopefully, justify this conjecture.

Speaker: Rajesh Pereira, University of Saskatchewan
Title: *Characteristic polynomials, sign patterns and the geometry of polynomials*
Abstract: A sign pattern matrix S is an n by n matrix whose entries are all in $\{-1, 0, +1\}$. The sign pattern corresponding to S is the set of all n by n real matrices A with the property that $sgn(a_{ij}) = s_{ij}$ for all i, j. An n by n sign pattern is called spectrally arbitrary if given any nth degree polynomial p with real coefficients, there is a matrix in the sign pattern whose characteristic polynomial is p. We first review some of the history

of this area (especially open problems) and then prove some new results on spectrally arbitrary sign patterns.

Speaker: Ian F. Putnam, University of Victoria
Title: *C*-algebras from hyperbolic dynamical systems*
Abstract: A Smale space, as defined by David Ruelle, is a topological dynamical system having a type of hyperbolic structure. Examples include Anosov diffeomeorphisms, certain solenoids, certain substitution tiling systems, shifts of finite type and basic sets from Smale's axiom A system. It is possible to construct C*-algebras from such systems. In the case of shifts of finite type, these are AF-algebras. The talk will describe the basic ideas of Smale spaces, along with examples, the construction of the C*-algebras and various properties which they possess. In particular, I will describe a homology theory from such systems which is closely related to the K-theory of the C*-algebras.

Speaker: Heydar Radjavi, University of Waterloo
Title: *Invariant Sublattices*
Abstract: Let X be a real L_p space, and consider it as a lattice under the usual order. In this joint work with Vladimir Troitsly, we are interested in a special type of invariant subspaces for operators on X: closed sublattices of X. The well-known Perron-Frobenius theorem and its extensions to compact operators state, among other things, that every positivity-preserving compact operator has a one-dimensional invariant sublattice. We investigate the following questions: Which general operators have no non-trivial, closed invariant sublattices? Can a positivity-preserving compact operator have none but the obligatory one? When does a semigroup of operators have a common invariant sublattice?

Speaker: Leonel Robert, Fields Institute
Title: *Classification of certain nonsimple AH C*-algebras by their traces and K-theory*
Abstract: I will introduce the notion of triangular lattice and triangular elements of a lattice. This concept is then used to define a class of nonsimple, nonunital, AH algebras that are classified solely by their traces. Namely, they are the limits of homogeneous algebras over a collection of trees with the roots removed, and such that the lattice of closed two-sided ideals of the algebra is triangular. The traceless C*-algebras with an ideal preserving 0-homotopy studied by Kirchberg and Rordam belong to this class. There are also examples in this class that posses an ideal preserving 0-homotopy and nontrivial traces.

The same methods also yield a classification, by their K-theory and traces, of certain nonsimple unital AH C*-algebras closely related to the class of the

previous paragraph. This second class of C*-algebras includes C*-algebras previously classified like the AI C*-algebras with the ideal property.

The tracial information used in the two preceding classification theorems consists of a diagram of cones (of traces) indexed by the lattice of closed two-sided ideals. I will describe the appropriate category for this object and how to build approximate intertwinings in this category.

Speaker: Mary Beth Ruskai, Tufts University
Title: *How can the environment's view of a quantum channel help us understand some types of capacity?*
Abstract: In quantum information theory, a noisy channel is represented by a completely positive, trace-preserving (CPT) map acting on the algebra of the input system. Stinespring showed that this can be represented as a subalgebra of a larger system. One can then interpret the commutant as the algebra of the "environment" causing the noise. Arveson's commutant lifting theorem then defines a complementary channel from the system algebra to that of the environment. We will discuss the way that this complementary channel can be used in questions about two different types of channel capacity. If times permits, we will consider some related open questions.

Speaker: Ebrahim Samei, University of Waterloo
Title: *On local properties of Hochschild cohomology of a C*- algebra*
Abstract: In this talk, we first generalize the definition of the reflexivity to the linear subspaces of bounded n-linear maps from Banach spaces. We then show that if A is a C*-algebra and n is a positive integer, the space of bounded n-cocylces from $A(n)$ into any Banach A-bimodule is reflexive. This, in particular, answers affirmatively to a question raised by R. V. Kadison in a more general setting. Our approach is based on applying the theory of spectral synthesis in harmonic analysis to obtain a "locally defined characterization" for bounded n-cocycle maps from C*-algebras. We give examples of non-self adjoint operator algebras for whom the space of derivation fails to be reflexive.

Speaker: Romi Shamoyan, Technische Universitat, Berlin
Title: *Some remarks on the action of the operator of polarization*
Abstract: The operator of polarization is a natural N-dimensional extention of onedimensional classical Bergman representation formula from unit disk to polydisk(see, for example, 4, 5)

I will use some estimates from 1, inequalities for Stein-type maximal functions from 2-, and inequalities for tent spaces from 3- to get new estimates from above for this operator in bidisk and polydisk-

It will be shown that these estimates extend known one dimensional inequalities for functions from classical analytic spaces in the disk. -

References-
1-J.ORTEGA, J.FABREGA;Ill.Math.Journal, 1999,
2-I.VERBITSKI;Siberian Math.Journal, 1985,
3-R.COIFMAN, Y.MEYER, E.STEIN;Journal of func. analysis;1985,
4-W.RUDIN;Function theory in the polydisc;1969,
5-REN G., SHI J.;The diagonal mapping in mixed norm spaces; Studia math. 2004.

Speaker: Nico Spronk, University of Waterloo
Title: *Operator space structure on Feichtinger's Segal algebra*
Abstract: We extend the definition, from the class of abelian groups to a general locally compact group G, of Feichtinger's remarkable Segal algebra $S_0(G)$. In order to obtain functorial properties for non-abelain groups, in particular a tensor product formula, we endow $S_0(G)$ with an operator space structure. With this structure $S_0(G)$ is simultaneously an operator Segal algebra of the Fourier algebra $A(G)$, and of the group algebra $L_1(G)$. We show that this operator space structure is consistent with the major functorial properties: (i) $S_0(G)S_0(H) = S_0(G \times H)$ completely isomorphically (operator projective tensor product), if H is another locally compact group; (ii) the restriction map $u \to u|H : S_0(G) \to S_0(H)$ is completely surjective, if H is a closed subgroup; and (iii) $T_N : S_0(G) \to S_0(G/N)$ is completely surjective, where N is a normal subgroup and $T_N u(sN) = \int_N u(sn)\, dn$. We also show that $S_0(G)$ is an invariant for G when it is treated simultaneously as a pointwise algebra and a convolutive algebra.

Speaker: Bamdad R. Yahaghi, School of Mathematics, IPM, Tehran, Iran
Title: *On one-sided ideals of rings of continuous linear operators*
Abstract: Let X be a real or complex locally convex vector space and $L_c(X)$ denote the ring (in fact the algebra) of continuous linear operators on X. In this talk, we characterize certain one-sided ideals of the ring $L_c(X)$ in terms of their rank-one idempotents. We use our main result to show that a one-sided ideal of the ring of continuous linear operators on a real or complex locally convex space is triangularizable if and only if the one-sided ideal is generated by a rank-one idempotent if and only if $\operatorname{rank}(AB - BA) \leq 1$ for all A, B in the one-sided ideal. Also, a description of irreducible one-sided ideals of the ring $L_c(X)$ in terms of their images or coimages will be given. (The counterparts of some of these results hold true for one-sided ideals of the ring of all right (resp. left) linear transformations on a right (resp. left) vector space over a general division ring.) This talk is based on joint work with Mehdi Radjabalipour.

Speaker: Dilian Yang, University of Waterloo
Title: *Periodicity in rank 2 graph algebras*
Abstract: Kumjian and Pask introduced an aperiodicity condition for higher rank graphs. We present a detailed analysis of when this occurs in certain rank 2 graphs. When the C*-algebra is aperiodic, we give another proof of its simplicity. The periodic C*-algebras are characterized, and it is shown that the C*-algebra is a tensor product of $C(\mathbb{T})$ with a simple C*-algebra. This talk is based on joint work with Kenneth R. Davidson.

Speaker: Nina Zorboska, University of Manitoba
Title: *Isometric Composition Operators on Bloch-type Spaces*
Abstract: Characterizing the isometric Composition Operators on many different types of spaces of analytic function has been of interest for a number of years. One of the more recent such results includes the the case of the classical Bloch space. We will describe the Composition Operators that are isometries on all of the other Bloch-type spaces.