**SPRING 2018**

**Title:** *Spectral Gaps of the Two-Species PVBS Models in d Dimensions*

**Speaker:** Michael Bishop

**Date, Time, and Location:** April 27, 2018; 10AM in PB 136

**Abstract:** This talk will discuss the two-species Product Vacua and Boundary States (PVBS) models on the integer lattice Z^d and prove the existence and non-existence of a spectral gap for all choices of parameters. The main result is that the two-species PVBS Hamiltonians have a positive spectral gap when gapped on both of the single-species subspaces and are gapless if gapless on either single-species subspace. The addition of a new particle species and the interactions between them does not create any new gapless phases. I will provide an introduction to quantum mechanics, the mathematics of quantum spins system, the importance of emerging quantum technologies, and the role the PVBS models play in this research area.

**Title:** *On the Nature of Expansions on Totally Bounded Metric Spaes - And More*

**Speaker:** Edward Sichel

**Date, Time, and Location:** April 20, 2018; 9AM in PB 136

**Abstract:** While proving a known description of expansions on compact metric spaces, we observe that the condition of compactness appears to be excessive, so we search for a weaker, but still sufficient one.

Initially, we attempt to relax the condition of compactness to boundedness, but this falls short of being sufficient. However, compactness tempered to total boundedness, is shown to be a sufficient, but, unfortunately, not necessary condition for the description to remain true.

We also characterize boundedness in terms of certain specific type of expansions we call anticontractions.

**Title:** *On the Differentiability of Weak Solutions of an Abstract Evolution Equation with a Scalar Type Spectral Operator on the Real Axis*

**Speaker:** Marat Markin

**Date, Time, and Location:** April 13, 2018; 11AM in S 139

**Abstract:**

Found are conditions on a scalar type spectral operator $A$ in a complex Banach space necessary and sufficient for all weak solutions of the evolution equation

$$y'(t) = Ay(t),\ t \in \mathbb{R},$$

to be strongly infinite differentiable on $\mathbb{R}$. As a particular case obtained that of the equation with a normal operator in a complex Hilbert spaced. A certain interesting inherent smoothness improvement effect is observed.

The new results are to be reported for the first time.

**Title:** *Polynomials with four-term recurrences*

**Speaker:** Khang Tran

**Date, Time, and Location:** March 9, 2018; 9AM in PB 136

**Abstract:**

This research is a part of the long term goal in understanding the zero structure of a sequence of polynomials $\{H_m(z)\}$ satisfying the four-term recurrence

$$H_m(z) + C(z)H_{m-1}(z) + B(z)H_{m-2}(z) + A(z)H_{m-3}(z) = 0$$

with initial conditions $H_0(z) = 1$, $H_{-m}(z) = 0$, $m \in \mathbb{N}$, where $A(z)$, $B(z)$, and $C(z)$ are linear polynomials. In particular, we are aiming at necessary and sufficient conditions under which the zeros of $H_m(z)$ are real. The case when $A(z)$ and $B(z)$ are constant polynomials was completely studied in 2006 by Borcea, Bogvad, Shapiro. This talk will focus on our recent paper settling the case when $C(z)$ and $B(z)$ are constant polynomials and provide a quick look at our current development on the case when only $C(z)$ is a constant polynomial. The proof is approachable for undergraduate and graduate students whose are strongly encouraged to attend.

**Title:** *Figueroa planes and the unitals they (may) contain*

**Speaker:** Oscar Vega

**Date, Time, and Location:** February 9, 2018; 9AM in PB 136

One of the most useful techniques in the study of finite projective planes is to look at their group of symmetries (collineations) and to investigate how they act on the plane's points, lines, etc. Hence, the planes that are the most difficult to study are those having an 'unusual' group of collineations. One of the most desirable properties a group of collineations can have is that it acts transitively on the points of the plane. The literature on these so-called *translation planes* is abundant.

Planes that are not translation planes are fairly scarce, and difficult to study. The Figueroa planes of order $q^3$ (denoted $\mathcal{F}_{q^3}$) are examples of planes not admitting a transitive collineation group.

During the first half of this talk we will construct the family of Figueroa planes by following a synthetic approach (Grundhöfer, 1986) instead of the original construction (Figueroa, 1982). In the second part of this talk we will focus on unitals and where they can be found.

Unitals are combinatorial structures that *may* be embedded in finite projective planes. Most of what is known about unitals is on those that can be embedded in 'classical' planes. Regarding unitals in Figueroa planes, there is only one known example: the so-called Figueroa unital in $\mathcal{F}_{q^6}$ (de Resmini and Hamilton, 1998). We have only recently learned that this unital is not 'classical' (Hui and Wong, 2012).

R. Pomareda (Universidad de Chile) and I are trying to find out whether $\mathcal{F}_{q^6}$ admits any unitals besides the Figueroa unital. In order to do this, we were able to modify Grundhöfer's model so we could analyze what types of equations unitals in $\mathcal{F}_{q^6}$ may satisfy. This is work in progress.

This talk will be fairly technical and notation-heavy. Sorry.

**FALL 2017**

**Title:** *On the Gevrey Ultradifferentiability of Weak Solution of an Abstract Evolution Equation with a Scalar Type Spectral Operator*

**Speaker:** Marat Markin

**Date, Time, and Location:** October 13, 2017; 11AM in PB 103

**Abstract:** Found are conditions on a scalar type spectral operator A in a complex Banach space necessary and sufficient for all weak solutions of the evolution equation

$y'(t) = Ay(t), t \geq 0,$

to be strongly Gevrey ultradifferentiable of order $\beta \geq 1$, in particular analytic or entire, on $[0,\infty)$ or $(0,\infty)$. Certain inherent smoothness improvement effects are analyzed. It is shown that, if all weak solutions are Gevrey ultradifferentiable of orders $0 \leq \beta < 1$, then the operator A is necessarily bounded.

**Title:** Teaching and Learning in Math 111

**Speaker:** Katherine Kelm

**Date, Time, and Location:** September 22, 2017; 11AM in PB 103

**Abstract:** In this talk I will give a short history of my efforts to incorporate active learning, reflections, and group work in Transition to Advanced Mathematics (Math 111). I will describe the activities conducted during my sabbatical of Spring 2017 to study student learning in Math 111 and in subsequent courses. I will summarize my findings, what I learned about data collection, and how I plan to conduct a new study starting in Fall 2017.