

# Archived Seminars

## 2007/08

**September 13, 2007: Andrzej Piotrowski (CSUF)**

**Title:** *Easy to State and Difficult to Solve*

**Abstract:** There are several open problems regarding the distribution of zeros of polynomials which are easily stated, yet remain unsolved. In this talk, some of these problems, along with some historical context and recent progress, will be presented.

**September 20, 2007: Andrzej Piotrowski (CSUF)**

**Title:** *Easy to State and Difficult to Solve II*

**Abstract:** See Part I - September 13, 2007.

**September 27, 2007: Tamas Forgacs (CSUF)**

**Title:** *Notions of Uniform Flatness*

**Abstract:** The notion of uniform flatness is a crucial one in interpolation problems in the setting of several complex variables. This talk aims to introduce the concept of uniform flatness and discuss how this notion is captured in increasingly more general settings. The talk will assume basic familiarity with results from complex analysis but will attempt to paint an intuitive picture for the audience.

**October 4, 2007: Tamas Forgacs (CSUF)**

**Title:** *A Primer on Rational Addiction*

**Abstract:** In this talk I will introduce the basic terminology of the area and we will discuss a model of Becker-Murphy on rational addiction. I will then indicate how we attempt to use a variant of this model to describe the effects of parity legislation on mental health care utilization. The work on mental health care utilization is joint work with Attila Cseh at Valdosta State University.

**October 11, 2007: Larry Cusick (CSUF)**

**Title:** *Finite Groups of Derangements on the  $n$ -Cube*

**Abstract:** The group of symmetries of the  $n$ -cube is understood to be the group of signed permutations, the so-called hyperoctahedral group. The question we explore is this: for a given  $n$ , what finite groups act as derangements of the set of  $k$ -faces?

October 18, 2007: Oscar Vega (CSUF)

**Title:** *Symplectic Geometry Over Finite Fields 1: One Form, Many Objects*

**Abstract:** In this talk I will survey what it is known (by me) about objects, mostly geometric, associated to symplectic forms of vector spaces over finite fields. In particular, I will talk about generalized quadrangles, spreads, ovoids, Kerdock codes, and a particular class of strongly regular graphs.

Students are welcome to attend. Just some linear algebra and algebra will be needed to follow the talk.

October 25, 2007: Oscar Vega (CSUF)

**Title:** *Symplectic Geometry Over Finite Fields 2: A Wonderful Connection*

**Abstract:** There is a beautiful connection between generalized quadrangles, ovoids and symplectic translation planes that exists only when the characteristic of the field used in the constructions is even. This threeway link has brought several people working in different areas to care about similar problems. In this talk I will describe this connection and I will present some recent work I have done towards proving a theorem that has already been proved (Why would anyone do that?!).

This is, sort of, the continuation of last week's talk, but also independent from it, as the main results needed from last week's presentation will be recalled.

November 1, 2007: Andrey Babichev (CSUF)

**Title:** *A Few Things About Ergodic Theory*

**Abstract:** This talk will have some intersections with my previous talks on the subject, and some new things as well. It is intended as an introduction to the general ideas of ergodic theory.

November 8, 2007: Maria Nogin (CSUF)

**Title:** *Topological Semantics of Modal Logics*

**Abstract:** We will discuss how different logics describe properties of various topological spaces. Namely, we start with the classical logic which describes the algebra of sets (with no topology): conjunction corresponds to intersection, disjunction corresponds to union, negation corresponds to complement, etc. A modal logic is the classical logic extended with one or more additional operations (with certain axioms), called modalities. These additional operations may have various interpretations in topology. For example, we can interpret a unary logical operation as the interior of a set. In this talk we will describe known correspondences between logics and topological spaces as well as present a few open questions.

This talk and some of the open questions presented will be accessible to graduate and advanced undergraduate students.

**November 15, 2007: Carmen Caprau (CSUF)**

**Title: *Categorification and Topological Quantum Field Theory, Part I***

**Abstract:** Categorification stands for the passage from a traditional mathematical object to its higher categorical analogue, and it has been a topic of considerable interest to mathematicians. After a brief introduction to the subject, we will show how one can categorify the classical Jones polynomial invariant for knots and links via a topological quantum field theory (TQFT), to obtain a stronger, richer invariant, yet computable.

**November 29, 2007: Carmen Caprau (CSUF)**

**Title: *Categorification and Topological Quantum Field Theory, Part II***

**Abstract:** See Part I - November 15, 2007.

**December 6, 2007: Sean Fulop (Linguistics Department, CSUF)**

**Title: *From Grammar to Knot Theory via Logic, Categories, and Quantum Groups***

**Abstract:** In this prospective and general talk, I will lay out a broad set of mathematical interconnections that provide a research program in the proof theory of grammar. I begin with something simple, namely classical propositional logic. A very interesting "matrix method" for checking the provability of a formula in this logic was developed by Wallen (1990); it is a simple graphical criterion deriving from an arrangement of the logical atoms found within the formula. The matrix of a formula can be viewed as a "compressed proof object," since it eliminates so much logical machinery found in ordinary proofs. The main goal of this research program is to develop a general theory of compressed proof objects for a variety of logics.

Why would a linguist pursue such a thing? Because some logics can serve as engines of "grammatical deduction," allowing the proof that a certain structured sequence of words is a sentence in a language. I will show how such logics are close relatives of another species, Linear Logic (Girard 1987), which also has a developed theory of its compressed proof objects which are called "proof nets." Such proof objects for grammatical logics either haven't been discovered yet, or are entirely cumbersome, and this is because a general theory of how to create compressed proof objects has not been formulated. Grammatical proofs are quite unwieldy, and do not admit efficient computation except by some ad hoc tricks. In order to propose such a mechanism as a true cognitive engine behind the production and comprehension of sentences, it is imperative that sentences can be proven with some degree of efficiency.

**February 7, 2008: Andrey Babichev (CSUF)**

**Title: *Is This Intuitionistically Valid?***

**Abstract:** I will try to overview some ideas leading to intuitionistic approach to mathematics. Developed by Luitzen Egbertus Jan Brouwer in the beginning of the last century,

it challenges traditional classical logic, particularly the laws of excluded middle and double negation. We will analyse some proofs. Hopefully, difference of opinions leading to a friendly discussion will arise.

**February 14, 2008: Andrey Babichev (CSUF)**

**Title:** *Is This Intuitionistically Valid, II?*

**Abstract:** See Part I - February 7, 2008.

**February 21, 2008: Oscar Vega (CSUF)**

**Title:** *Parallelisms of  $PG(3, q)$  and a 'New' Polynomial Invariant for Spreads*

**Abstract:** I will define the three-dimensional projective space over the field  $GF(q)$ , known as  $PG(3; q)$ , and I will review its main properties, and the (interesting) ways of partition it using lines, spreads, and parallelisms. A few results on parallelisms of  $PG(3; q)$  will be mentioned.

An attempt to solve a very old conjecture on parallelisms will be presented, the main tool used is a 'new' invariant for spreads of  $PG(3; q)$  that I am working on (unpublished work). This talk should be accessible to students. I will just use linear algebra and very little abstract algebra.

**February 28, 2008: Oscar Vega (CSUF)**

**Title:** *Parallelisms of  $PG(3, q)$  and a 'New' Polynomial Invariant for Spreads (II)*

**Abstract:** See Part 1 - February 21, 2008.

**March 6, 2008: Katherine Kelm (CSUF)**

**Title:** *Fox Derivatives*

**Abstract:** If we start with a 2-dimensional CW-complex  $X$ , we may form the chain complex of the universal cover of  $X$ . The boundary maps for this exact chain complex can be obtained by a derivation, similar in many ways to that of calculus, known as the Reidemeister-Fox derivative (or simply Fox derivative, for short). We use the Fox derivative to compute the boundary maps for an interesting 2-complex  $X$ .

**March 12, 2008: Emil Akhmedov (Institute for Theoretical and Experimental Physics, Moscow)**

**Title:** *Gluing Surfaces with Polygonal Holes*

**Abstract:** By pairwise gluing of sides of a polygon, one produces two-dimensional surfaces with handles and boundaries. In this paper, we count the number  $\mathcal{N}_{g,L}(n_1, n_2, \dots, n_L)$  of different ways to produce a surface of given genus  $g$  with  $L$  polygonal boundaries with given

numbers of sides  $n_1, n_2, \dots, n_L$ . Using combinatorial relations between graphs on real two-dimensional surfaces, we derive recursive relations between  $\mathcal{N}_{g,L}$ . We show that Harer-Zagier numbers appear as a particular case of  $\mathcal{N}_{g,L}$  and derive a new explicit expression for them.

**March 13, 2008: Carmen Caprau (CSUF)**

**Title:** *Khovanov Homology*

**Abstract:** There is a chain complex naturally associated with a planar projection of a knot (or link), whose homology-known as the Khovanov Homology-is an invariant of the underlying knot, and whose Euler characteristic is the Jones polynomial of the knot. We will look at Bar-Natans approach to this homology theory via "cobordisms" modulo local relations, which simplifies and at the same time extends Khovanovs treatment to tangles (knot pieces).

**March 27, 2008: Travis Kelm (CSUF)**

**Title:** *Elementary Geometric Group Theory and Topology*

**Abstract:** Combinatorial group theory, that is the study of groups given in terms of generators and relations, has a wealth of connections to physics and topology. This talk will introduce the central question in combinatorial group theory (the word problem) and discuss some lovely geometric/topological approaches to the problem.

**April 3, 2008: Andrzej Piotrowski and Tamas Forgacs (CSUF)**

**Title:** *Laguerre Multiplier Sequences: Towards a Classification Theorem (Part I)*

**Abstract:** In the first of the two lecture sequence we review definitions and results from the theory of multiplier sequences. Whether a sequence of non-negative real numbers is a multiplier sequence depends on the chosen bases (for the appropriate polynomial space). Two bases of interest are the basis consisting of generalized Hermite polynomials and the basis consisting of generalized Laguerre polynomials. With the basic tools in hand we classify all  $H$ -multiplier sequences and present some results towards the classification of  $L$ -multiplier sequences.

**April 10, 2008: Andrzej Piotrowski and Tamas Forgacs (CSUF)**

**Title:** *Laguerre Multiplier Sequences: Towards a Classification Theorem (Part II)*

**Abstract:** See Part I - April 3, 2008.

**April 17, 2008: Doreen De Leon (CSUF)**

**Title:** *An Euler-Cauchy Surprise*

**Abstract:** The Euler-Cauchy equation is typically the first higher order non-constant coefficient equation encountered by students in an undergraduate ordinary differential equations (ODE) course. As such, the method of undetermined coefficients, which can only be applied to nonhomogeneous constant coefficient differential equations with certain right-hand side functions, cannot be applied to nonhomogeneous Euler-Cauchy equations. However, in giving exams to my ODE classes, I discovered that, for certain Euler-Cauchy problems, the method of undetermined coefficients does, in fact, give the correct solution. This talk examines under what conditions we can expect the method of undetermined coefficients to yield the correct particular solution for a nonhomogeneous Euler-Cauchy equation.

**April 24, 2008: Sean Fulop (Linguistics Department, CSUF)**

**Title:** *Type-Logical Grammars: Linguistic Applications and Linear Skein Relations*

**Abstract:** In this second talk of a series, I will show in a self-contained account a number of ways in which certain kinds of logics can be used to model and derive formal descriptions of natural language sentences. These "type logics" are employed in grammars by assigning particular logical formulae (types) to words in the language. The formulae take the place of the traditional "parts of speech" such as noun, verb, etc., and more directly indicate the structures in which different sorts of words can be involved. The logical system is then used to literally prove whether a sentence structure is grammatical in the language. Recent research indicates that such type-logical grammars are as completely descriptive as any other kind of formalized grammar, but have the advantage of more precise learning procedures which model the language acquisition process.

It was mentioned in my previous talk how these grammatical logics are close relatives of Linear Logic. The latter has a developed theory of compressed proof objects known as "proof nets" which were described last time. The proof nets of the grammatical type logics are only partially worked out at present. In the second part of this talk, I will discuss some speculations on how proof nets, which are a species of labeled graph, obey some kind of linear skein relation in the sense similar to the Conway algebra that is at the root of all the knot polynomials from Alexander (1928) to the more recent work of Jones, HOMFLY-PT, etc. In particular, one can have numerous different graphical representations of "the same" proof net; all of these representations will have an identical skein resolution tree (in the fashion of Cromwell's knot theory research), and a resolution tree of this kind can always be used to produce a polynomial.

**May 1, 2008: Iliana Perez, Maya Rodriguez, Abinet Tibebu (CSUF)**

**Title:** *P-Colorability of the Knot/Link  $(12)^n$  and  $(\bar{1}\bar{2})^n$*

**Abstract:** The respective ends of the 3-strand braids  $(12)^n$  and  $(\bar{1}\bar{2})^n$  may be joined to form knots or links. We prove

1.  $(12)^n$  is  $p$ -colorable if, and only if,  $n$  is even and  $p = 3$ .
2.  $(1\bar{2})^n$  is  $p$ -colorable if, and only if,
  - (a)  $n$  is even and  $p = 5$  or  $p$  is an odd prime that divides the  $n$ th Fibonacci number  $F_n$  or
  - (b)  $n$  is odd and  $p$  is an odd prime that divides the  $n$ th Lucas number  $L_n$ .