

DEPARTMENT OF MATHEMATICS

SPECIAL LECTURE

January 16, 2007 4:00 pm

250 Mathematics Building

Dr. Takashi Nishikawa
Southern Methodist University

Title: *“Maximizing growth reduces the number of active reactions in cellular metabolic networks.”*

Abstract: *Constructing computational models from the stoichiometric information on individual metabolic reactions in cellular organisms is a powerful tool used in systems biology for understanding and predicting the organisms' behavior. In this talk, I will review one type of such models and study their properties using the mathematical theory of linear optimization, as well as numerical stimulations. In particular, I will show that single-cell organisms in stable environmental condition tend to significantly reduce the number of active reactions as they evolve to maximize their growth. I will show that part of the reduction results directly from the interplay between the growth maximization and the irreversibility of reactions. The remaining part is due to cascading propagation of inactivity over the metabolic network, triggered by the inactivity caused by the first mechanism. More generally, I will show that single-cell organisms experience a similar reduction in optimizing a typical linear objective function. I will also provide experimental evidence for these results by re-analyzing existing data on flux measurements in the literature. These results suggest that increasing the fitness of a single-cell organism in a fixed environment is not achieved by recruiting more biochemical reactions, but instead by operating with only a portion of the set of available reactions..*

* Coffee 3:30 pm in the Common Room

DEPARTMENT OF MATHEMATICS

SPECIAL LECTURE

January 18, 2007 4:00 pm

250 Mathematics Building

Dr. Milen Yakimov
University of California, Santa Barbara

Title: *“Poisson structures on flag varieties.”*

Abstract: *The geometry of Poisson structures originating from Lie theory found numerous applications in representation theory, ring theory, and dynamical systems. The linear Poisson structure on the dual of a Lie algebra provides the setting for the orbit method of Kirillov, Kostant, and the Dixmier for the study of the unitary duals of Lie groups and the spectra of universal enveloping algebras.*

In this talk, we will describe in detail the geometry of a class of Poisson structures on complex flag varieties and some of their relations to combinatorics (Schubert cells and their Deodhar partitions, cluster algebras, total positivity, the Springer and the Lusztig partitions of wonderful compactifications), ring theory (spectra of algebras of quantum matrices and other quantized algebras), integrable systems (Kogan-Zelevinsky systems). In the special case of hermitian symmetric spaces of compact type, these Poisson structures further elucidate the works of Wolf, Richardson, Röhrie, and Steinberg on the structure of the orbits of certain Levi factors.

The talk is intended for a general audience and we will not assume any background in the subject.

* Coffee 3:30 pm in the Common Room

DEPARTMENT OF MATHEMATICS

SPECIAL LECTURE

January 19, 2007 4:00 pm

250 Mathematics Building

Dr. Corina Drapaca
of
Mayo Clinic, College of Medicine
Rochester Minnesota

***Title: "Mathematical Modelling of Hydrocephalus:
A Confluence of the Mathematical and Biomedical
Sciences."***

*** Coffee immediately following the talk in the Common Room**

DEPARTMENT OF MATHEMATICS

SPECIAL LECTURE

January 23, 2007 4:00 pm

250 Mathematics Building

Dr. Jasang Yoon
Iowa State University

Title: "Reconstruction of the Berger measure when the core of a 2-variable weighted shift is of tensor form."

Abstract: We study commuting pairs $T := (T_1, T_2)$ of subnormal operators on Hilbert space, specifically 2-variable weighted shifts, which act on the space $\ell^2(\mathbb{Z}_+^2)$ of square summable double indexed sequences of complex numbers. Individually, T_1 and T_2 are operator weighted shifts, associated with weight sequences $\alpha_{i,j}$ and $\beta_{i,j}$, respectively; in symbols $T_1 e_{i,j} = \alpha_{i,j} e_{i+1,j}$ and $T_2 e_{i,j} = \beta_{i,j} e_{i,j+1}$. Thus, T_1 (resp. T_2) is an orthogonal direct sum of subnormal unilateral weighted shifts, and is therefore associated with a family of Berger measures $\xi \equiv \xi_j$ (resp. $\eta \equiv \eta_i$) supported in $[0, +\infty)$. On the other hand, when the pair is (jointly) subnormal, it admits a (joint) Berger measure μ , supported in the quarter plane $[0, +\infty)^2$.

The Reconstruction-of-the-Measure Problem (ROMP) asks for necessary and sufficient conditions on the families ξ and η to be the marginal measures of a 2-variable measure μ . We apply operator-theoretic techniques to solve the ROMP in a special case, intimately connected with the so-called Lifting Problem for Commuting Subnormals.

Let \mathfrak{S}_0 denote the class of commuting pairs of subnormal operators on Hilbert space, and let $TC := \{T \in \mathfrak{S}_0 : c(T) \text{ is of tensor form}\}$, where $c(T)$ denotes the core of T . In joint work with R. Curto and S.H. Lee, we obtain a concrete necessary and sufficient condition for the subnormality of $T := (T_1, T_2) \in TC$, in terms of $c(T)$, the marginal Berger measures of T_1 and T_2 , and the weight $\alpha_{0,1}$. This provides a complete solution to the ROMP under the specified conditions.

DEPARTMENT OF MATHEMATICS

SPECIAL LECTURE

January 24, 2007 4:00 pm

250 Mathematics Building

Dr. David Hemmer

The University of Toledo

Title: *“Tilting modules for the symmetric group?”*

Abstract: *We begin with an introduction to representation theory of finite groups, including examples that illustrate the difference between the ordinary (characteristic zero) theory and the modular (characteristic p) theory.*

Next we discuss some representation theory of the symmetric group and the general linear group, and describe how one can pass information back and forth between the two settings. We discuss modules with Specht filtrations for the symmetric group. Until recently, it was believed no nice theory of such modules could exist, since well-known examples in characteristic two and three demonstrated that filtration multiplicities are not even well-defined. In 2004 the speaker and Nakano proved the surprising result that this bad behavior occurs only in these small characteristics, opening up the possibility of developing a general theory.

We will discuss this result and then present some more recent work on developing a theory for the symmetric group partially analogous to the theory of good filtrations for algebraic groups, including a conjectural description of the symmetric group analogue of tilting modules and a recent result about irreducible Specht modules that provides evidence for this conjecture. Along the way we will encounter many of the important open problems in the field.

This talk should be accessible to advanced undergraduates or graduate students who have taken group theory and linear algebra.

* Coffee 3:30 pm in the Common Room

DEPARTMENT OF MATHEMATICS

SPECIAL LECTURE

January 26, 2007 4:00 pm

250 Mathematics Building

**Dr. Remus Nicoara,
Vanderbilt University**

Title: *“Subfactors and quantum symmetries.”*

Abstract: *The theory of subfactors was initiated by V. Jones in the eighties as a Galois theory for inclusions of von Neumann algebras. Subfactors can be used to capture certain symmetries of various mathematical or physical objects. Part of this structure can be uncovered by computing the standard invariant of the subfactor, which is a system of inclusions of finite dimensional $*$ -algebras naturally associated to it. We present some recent results investigating to what extent the standard invariant determines the subfactor and the data it was constructed from. We consider two types of constructions: subfactors arising from Hadamard matrices and other algebraic-combinatorial structures, and subfactors arising from actions of groups on von Neumann algebras.*

* Coffee 3:30 pm in the Common Room

DEPARTMENT OF MATHEMATICS

SPECIAL LECTURE

January 22, 2007 4:00 pm

250 Mathematics Building

Dr. Ana-Maria Castravet
University of Massachusetts, Amherst

Title: *"Hilbert's 14'th Problem and Cox Rings."*

Abstract: *We give a description of the generators of the total coordinate ring of the blow-up of a projective space in any number of points that lie on a rational normal curve. As a corollary we show that the algebra of invariants of the action of a two-dimensional vector group introduced by Nagata is finitely generated by certain explicit determinants. We also prove the finite generation of the algebras of invariants of actions of vector groups related to T-shaped Dynkin diagrams introduced by Mukai. This is a joint work with J. Tevelev.*

* Coffee 3:30 pm in the Common Room

DEPARTMENT OF MATHEMATICS

SPECIAL LECTURE

January 29, 2007 4:00 pm

250 Mathematics Building

**Dr. Jonathan Kujawa,
University of Georgia**

Title: *“Support Varieties for Lie Superalgebras.”*

Abstract: *Support varieties are geometric objects which were first introduced to study the representation theory of finite groups over a field of positive characteristic. They have since become an essential tool. Because of their importance, much effort has gone into developing such theories for other objects (e.g. finite group schemes and quantum groups).*

In recent work with Brian Boe and Daniel Nakano, we develop a support variety theory for Lie superalgebras over the complex numbers. In this talk we will discuss what is currently known and conjectured about these geometric objects. In particular, we will see that they give new insights into the representation theory and combinatorics of Lie superalgebras.

* Coffee 3:30 pm in the Common Room

DEPARTMENT OF MATHEMATICS

SPECIAL LECTURE

January 30, 2007 4:00 pm

250 Mathematics Building

**Dr. Avner Peleg,
University of Arizona**

Title: *“Intermittent dynamics in massive multichannel optical fiber communication systems.”*

Abstract: *We investigate the effects of Raman scattering on soliton propagation in multichannel optical fiber communication systems. When two solitons propagating in a fiber with different group velocities (corresponding to different frequency channels) collide in the presence of Raman scattering they exchange energy, and as a result, their amplitudes change. Taking into account this energy exchange and the random character of pulse sequences in different frequency channels we show that soliton propagation is described by a perturbed stochastic nonlinear Schrodinger equation with weak disorder in the linear gain coefficient. As a result, the soliton amplitude and frequency become random variables whose normalized n -th moments increase exponentially with both propagation distance and n^2 . This implies that the soliton parameters in these weakly nonlinear systems exhibit intermittent dynamics, a surprising result, since intermittency is typically associated with strongly nonlinear phenomena such as turbulence and chaotic flow. Moreover, we show that the discrete dynamic equation for the soliton amplitude has the same form as the equation for the local average energy dissipation in random cascade models employed in turbulence theory. The exponential growth of the amplitude and frequency variance with propagation distance is much stronger than the algebraic growth of the variance of soliton parameters due to amplifier noise and birefringence disorder, which are the most harmful noisy phenomena in single-channel transmission. Furthermore, we demonstrate that the intermittent dynamics of soliton parameters in multichannel transmission has important practical consequences, by leading to relatively large values of the bit-error-rate via an unusual mechanism for error generation.*

* Coffee 3:30 pm in the Common Room

DEPARTMENT OF MATHEMATICS

SPECIAL LECTURE

February 1, 2007 4:00 pm

250 Mathematics Building

**Dr. Robert Sims,
University of California, Davis**

Title: *“Lieb-Robinson Bounds and Related Results.”*

Abstract: *Locality in quantum spin systems can be described in terms of a bound on the commutator of local observables with disjoint supports. The first proof of such estimates was given by Lieb and Robinson in 1972. In my talk, I will discuss a generalization of these results and a variety of applications. For example, these new results imply the existence of the dynamics for a wider class of interactions, a bound on the propagation of correlations through the system, and a proof of exponential decay of (spatial) correlations in the ground state of gapped Hamiltonians. Moreover, combining the above mentioned applications, we were recently able to prove a multi-dimensional Lieb-Schultz-Mattis theorem concerning the existence of low-lying excitations for the spin-1/2 antiferromagnetic Heisenberg model.*

* Coffee 3:30 pm in the Common Room

DEPARTMENT OF MATHEMATICS

SPECIAL LECTURE

February 2, 2007 11:00 am

122 Mathematics Building

Dr. Mihran Papikian,
Stanford University

Title: *“Drinfeld modular varieties and the Weil-Deligne bound.”*

Abstract: *We show that appropriate quotients of Drinfeld modular varieties and the modular varieties of D -elliptic sheaves have many rational points over finite fields compared to their Betti numbers. This is a generalization of some well-known results for modular curves to higher dimensions.*

* Coffee 3:30 pm in the Common Room

DEPARTMENT OF MATHEMATICS

SPECIAL LECTURE

February 2, 2007 4:00 pm

250 Mathematics Building

**Dr. Nora Ganter,
University of Illinois at Urbana- Champaign**

Title: *“The relationship between elliptic cohomology and string theory - orbifold genera, product formulas and cohomology operations.”*

Abstract: *Elliptic cohomology is a field at the intersection of number theory, algebraic geometry and algebraic topology. Its definition is very technical and highly homotopy theoretic. While its geometric definition is still an open question, elliptic cohomology exhibits striking formal similarities to string theory, and it is strongly expected that a geometric interpretation will come from there.*

*To illustrate the interaction between the two fields, I will speak about my work on orbifold genera and product formulas:
After a very informal introduction to elliptic cohomology, I will discuss string theory on orbifolds and explain how a formula by Dijkgraaf, Moore, Verlinde and Verlinde on the orbifold elliptic genus of symmetric powers of a manifold motivated my work in elliptic cohomology. I will proceed to explain why elliptic cohomology provides a good framework for the study of orbifold genera.*

* Coffee 3:30 pm in the Common Room

DEPARTMENT OF MATHEMATICS

SPECIAL LECTURE

February 5, 2007 11:00 am

122 Mathematics Building

**Dr. Kenley Jung,
University of California- Los Angeles**

Title: *“Applications of Geometric Measure Theory to von Neumann Algebras.”*

Abstract: *One of the central problems in the study of von Neumann algebras is to find computable invariants which can distinguish nonisomorphic algebras. In the 1980s, Dan Voiculescu developed a noncommutative probability theory in order to understand a particular class of such von Neumann algebras. Specifically, he defined subsets of \mathbb{R}^n called microstate spaces which model the behavior of a generating set of a given von Neumann algebra. Since these spaces are subsets of \mathbb{R}^n , classical analytic tools such as volume can be applied to them.*

I will discuss how the application of ideas from geometric measure theory to microstate spaces has provided insight into the general problem of invariants and answered some longstanding questions in von Neumann algebras.

DEPARTMENT OF MATHEMATICS

SPECIAL LECTURE

February 5, 2007 4:00 pm

250 Mathematics Building

**Dr. Nikos Tzirakis,
University of Toronto**

Title: *“Recent progress on the L^2 -critical, defocusing semilinear Schrödinger equation.”*

Abstract: *In this talk I will describe the progress that has been made so far concerning the existence of global strong solutions to the L^2 -critical defocusing semilinear Schrödinger equation. A long standing conjecture in the area is the existence of a unique global strong L^2 solution to the equation that in addition scatters to a free solution as time goes to infinity. I will demonstrate the proofs of partial results towards an attempt for a final resolution of this conjecture. I will concentrate on the low dimensions but give the flavor of the results in higher dimensions for general or spherically symmetric initial data in certain Sobolev spaces. Many authors have contributed to the theory of this equation. I will convey my personal involvement to the problem and the results that I have obtained recently. Part of my work is in collaboration with D. De Silva, N. Pavlovic, G. Staffilani, J. Colliander and M. Grillakis..*