ABSTRACTS

PLENARY AND SPECIAL PUBLIC LECTURES

Denis Auroux, University of California at Berkeley, USA

Title: An Invitation to Homological Mirror Symmetry

Abstract: We will give a gentle introduction to some recent developments in the area of mirror symmetry, focusing on two key conjectures in the field: Kontsevich's homological mirror symmetry (1994), which relates the Fukaya category of a symplectic manifold to the derived category of coherent sheaves of a mirror space, and the Strominger-Yau-Zaslow (SYZ) conjecture (1996), which gives a geometric underpinning for the construction of mirror spaces. We will use simple examples to illustrate these conjectures and their extension beyond the Calabi-Yau setting in which they were first formulated. Specifically, we will focus on two one-dimensional examples, the cylinder and the pair of pants, to give a flavor of the geometric concepts involved in a general formulation of homological mirror symmetry.

Michael Eichmair, University of Vienna, Austria

Title: On Scalar Curvature, Minimal Surfaces, and the Isoperimetric Problem in the Large

Abstract: A small geodesic ball at a point of positive scalar curvature has more volume than a Euclidean ball with the same perimeter. In fact, the magnitude of the scalar curvature can be computed as an isoperimetric deficit of the geodesic ball.

This classical observation has a global counterpart that we have recently established in joint work with O. Chodosh, Y. Shi, and H. Yu: Let $(M, g) \neq \mathbb{R}^3$ be an asymptotically flat Riemannian 3-manifold with nonnegative scalar curvature. For every sufficiently large amount of area, there is a unique region of largest volume whose perimeter has that area. Moreover, these large solutions of the isoperimetric problem are nested and their isoperimetric deficit from Euclidean space encodes the ADM mass of (M, g). This confirms a longstanding conjecture of H. Bray, G. Huisken, and S.-T. Yau.

The goal of my lecture is to explain this effective version of the positive mass theorem, its relation with a conjecture of R. Schoen (established in joint work with O. Chodosh), and several repercussions on classical rigidity questions in geometry.

Mark Lewis, University of Alberta, Canada

Title: Population Dynamics in Moving Environments

Abstract: Classical population dynamics problems assume constant unchanging environments.However, realistic environments fluctuate in both space and time.My lectures will focus on the analysis of population dynamics in environments that shift spatially, due either to advective flow (eg., river population dynamics) or to changing environmental conditions (eg., climate change).The emphasis will be on the analysis of nonlinear advection-diffusion-reaction equations in the case where there is strong advection and environments are heterogeneous.I will use methods of spreading speed analysis, net reproductive rate and inside dynamics to understand qualitative outcomes. Applications will be made to river populations in one- and two-dimensions and to the genetic structure of populations subject to climate change.

Victor Reiner, University of Minnesota, USA

Title: Finite Reflection Groups and General Linear Groups

Abstract: We discuss some remarkable counting formulas over finite fields that have arisen in recent years, coming from thinking of finite general linear groups as reflection groups, and pursing their analogy to Weyl groups.

Yuri Tschinkel, New York University and Simons Institute, USA

Title: Building Institutes

Abstract: I will discuss the role of foundations in the creation of mathematical centers.

ALGEBRAIC GEOMETRY AND TOPOLOGY

Lino Grama, Universidade Estadual de Campinas, Brazil

Title: On the Construction of LG Models on Coadjoint Orbits

Abstract: In this talk we describe the LG models associated to coadjoint orbits of complex simple Lie groups. We also discuss its Fukaya-Seidel category in low dimensional examples as well as geometric information about the mirror manifold.

Andrew Harder, University of Miami, USA

Title: Pseudolattices, del Pezzo Surfaces, and Elliptic Fibrations

Abstract: I will explore the relationship between factorizations of certain elements in SL2(Z), elliptic fibrations over the disc, and del Pezzo surfaces. It turns out that all three of these things can be modelled linear algebraically by objects called pseudolattices, and this fact implies that their classifications are closely related. Finally, I will explain how this can be seen as a manifestation of homological mirror symmetry.

Paul Horja, University of Miami, USA

Title: Toric Schobers and D-modules

Abstract: Many classical mirror symmetry results can be recast using the recent language of perverse sheaves of categories and schobers. In this context, I will explain a Riemann-Hilbert type conjectural connection with the D-modules naturally appearing in mirror symmetry. This is joint work with Ludmil Katzarkov.

Gabriel Kerr, Kansas State University, USA

Title: Spheres in Complex Hypersurfaces

Abstract: Given a hypersurface X of the complex torus, mirror symmetry predicts a quasi-equivalence between the Fukaya category F(X) of X and a certain category of graded matrix factorizations MF (W) on a toric Calabi-Yau variety. In this talk, I will describe this correspondence, as well as how it fits in the larger picture of homological mirror symmetry. Exploring the algebraic side, one finds there are many spherical objects in MF (W) which have combinatorial descriptions. Using phase tropical varieties, I will provide a prediction of the topological mirrors to these objects in F(X) and discuss some generalizations. This is based on joint work with Ilia Zharkov.

Ernesto Lupercio, Cinvestav, México

Self-Organized Critical Complex Systems and Algebraic Geometry in the Tropical Limit

Abstract: In this talk I will survey our recent work relating the mathematics of complex systems and power laws and the tropical geometry of curves in toric manifolds. Collaborators on this project include N. Kalinin, A. Guzmán, Y. Prieto, M. Shkonivkov, V. Kalinina, L. Katzarkov, L. Meersseman, and A. Verjovsky.

Jacob Mostovoy, Cinvestav, México

Title: The Pure Braid Group and the Pure Cactus Group

Abstract: The topology of the real part of the moduli space of stable curves of genus zero with n marked points is known to be determined completely by its fundamental group, known as the pure cactus group. In this talk I will describe the analogy between the pure cactus group and the pure braid group and show how it leads to an elementary proof of the residual nilpotency of the pure cactus group, conjectured by Etingof et al.

Manuel Rivera, University of Miami, USA, and Cinvestav, México

Title: Higher Categories, Loop Spaces, and Local Systems

Abstract: I will describe how basic results of the "brave new homotopy theory" a la Lurie may be applied to improve classical results. More precisely, I will explain how unraveling the combinatorics behind the "rigidification functor" of Lurie (the left adjoint of the homotopy coherent nerve functor) leads to the improvement of a classical result of Adams' which relates the based loop space on a space and the algebraic cobar construction. Then I will explain the following applications: 1) we obtain algebraic models for different types of path spaces of connected (possibly non-simply connected) spaces, 2) our results lead to a transparent and concrete approach to the homotopy theory of (infinity) local systems, 3) we may deduce that the singular chains on a space with its natural algebraic structure, under a notion of weak equivalence stronger than quasi-isomorphism, encodes the fundamental group.

Andrei Teleman, Aix- Marseilles Universite, France

Title: New Methods in the Classification of Class VII Surfaces

Abstract: The classification of complex surfaces is not completed yet. The most important gap in the Kodaira-Enriques classification table concerns the Kodaira class VII, i.e. the class of surfaces X having $(X) = 1$, $b_1(X) = 1$. These surfaces are also interesting from a differential topological point of view, because they are non-simply connected 4-manifolds with definite intersection form.

The GSS conjecture, which, if true, would complete the classification of this class, can be stated as follows: Any minimal class VII surface with $b_2 > 0$ is a Kato surface.

The standard approach for proving the GSS conjecture has two steps corresponding to the following two conjectures considered by experts to be more accessible: Any minimal class VII surface with $b_2 > 0$ has a cycle of rational curves.

Any minimal class VII surface with $b_2 > 0$ containing a cycle of rational curves is a Kato surface.

My method for proving Conjecture starts with the observation that the absence of a cycle of curves in a class VII surface X implies the appearance of a smooth compact connected component in a certain moduli space of polystable bundles ((2)-instantons) on X. For $b_2(X) \leq 3$ I showed that the presence of such a component leads to a contradiction.

Recently, in a joint article with G. Dloussky, we have developed a new strategy for Conjecture : the idea is to study algebraic deformations of the singular surface Y obtained by contracting a cycle C of r rational curves in a minimal class VII surface X. We proved that, assuming $r < b_2(X) \leq 11$, the singular contraction Y will be smoothable by rational surfaces. This result leads to an interesting problem relating projective algebraic geometry to non-Kählerian complex geometry: classify families $(X_z)_{z\in D^*}$ of rational surfaces which converge to a surface Y with a single singularity, which is a cusp.

Bernardo Uribe, Universidad del Norte, Colombia

Title: The Evenness Conjecture on Equivariant Unitary Bordism

Abstract: The evenness conjecture for the equivariant unitary bordism groups states that these bordism groups are free modules over the unitary bordism ring in even dimensional generators. In this talk I will review the cases where the conjecture is known to hold and I will highlight the properties that permit one to prove the conjecture in these cases.

COMBINATORICS

Marcelo Aguiar, Cornell University, USA

Title: Topics in Hyperplane Arrangements

Abstract: We will discuss a number of geometric and algebraic constructions associated to real hyperplane arrangements, focusing on the monoid of faces and the category of lunes of the arrangement. Basics on hyperplane arrangements will be reviewed. We will then discuss the beginnings of a theory of noncommutative Mobius functions and its connections to the structure of the algebra of faces. We will also discuss an extension of a theorem of Joyal, Klyachko and Stanley relating the homology of the partition lattice to free Lie algebras. These topics are from recent and ongoing joint work with Swapneel Mahajan.

Carolina Benedetti, Universidad de Los Andes, Colombia

Title: A Murnaghan-Nakayama Rule for Quantum Cohomology of the Flag Manifold

Abstract: In this talk, we provide a combinatorial rule for the product of a quantum power-sum by a quantum Schubert polynomial. This expansion is known, in the classical setting as Murnaghan-Nakayama rule. Our expansion involves chains and intervals in the quantum Bruhat order, and cyclic shifts of those. In geometry, a Murnaghan-Nakayama formula computes the intersection of Schubert cycles with tautological classes coming from the Chern character.

Sara Billey, University of Washington, USA

Title: Boolean Product Polynomials and Schur-Positivity

Abstract: We study a family of symmetric polynomials that we refer to as the Boolean product polynomials. The motivation for studying these polynomials stems from the computation of the characteristic polynomial of the real matroid spanned by the nonzero vectors in R^n all of whose coordinates are either 0 or 1. To this end, one approach is to compute the zeros of the Boolean product polynomials over finite fields. The zero loci of these polynomials cut out hyperplane arrangements known as resonance arrangements, which show up in the context of double Hurwitz polynomials. By relating the Boolean product polynomials to certain total Chern classes of vector bundles, we establish their Schur-positivity by appealing to a result of Pragacz relying on earlier work on numerical positivity by Fulton-Lazarsfeld. Subsequently, we study a two-alphabet version of these polynomials from the viewpoint of Schur-positivity. As a special case of these polynomials, we recover symmetric functions first studied by Desarmenien and Wachs in the context of descents in derangements.

This is based on joint work with Lou Billera and Vasu Tewari.

Rafael González D'León, Universidad Sergio Arboleda, Colombia

Title: The Whitney Duals of a Graded Poset

Abstract: Two posets are Whitney duals to each other if the (absolute value

of their) Whitney numbers of the first and second kind are switched between the two posets. We introduce new types of edge and chain-edge labelings of a graded poset which we call Whitney labelings. We prove that every graded poset with a Whitney labeling has a Whitney dual and we show how to explicitly construct a Whitney dual using a technique that involves quotient posets. As an application of our main theorem, we show that geometric lattices, the lattice of noncrossing partitions, the poset of weighted partitions studied by González D'León-Wachs and the R*S-labelable posets studied by Simion-Stanley all have Whitney duals. We also show that a graded poset P with a Whitney labeling admits a local action of the 0-Hecke algebra on the set of maximal chains of P. The characteristic of the associated representation is Ehrenborg's flag quasisymmetric function of P. This is joint work with Josh Hallam (Wake Forest University).

Patricia Hersh, North Carolina State University, USA

Title: Topology and Combinatorics of Totally Nonnegative Spaces

Abstract: We will discuss results, both old and new, regarding the topological and combinatorial structure of totally nonnegative varieties. Interest in these varieties comes from geometric representation theory and from the theory of cluster algebras. In many cases, these varieties arise as images of quite interesting maps, with the fibers of these maps describing relations for instance amongst exponentiated Chevalley generators. We will discuss not only the structure of some of these spaces themselves but also of these fibers. Parts of this are joint work with James Davis and Ezra Miller and with Drew Armstrong.

Alejandro Morales, University of Massachusetts at Amherst, USA

Title: Hook Formulas for Skew Shapes

Abstract: The celebrated hook-length formula of Frame, Robinson and Thrall from 1954 gives a product formula for the number of standard Young tableaux of straight shape. No such product formula exists for general skew shapes, though there are determinantal formulas or positive formulas involving Littlewood-Richardson coefficients. In 2014, Naruse announced a new positive formula coming from geometry that is very close to the formula for

straight shapes and has spurred new interest in tableaux enumeration. I will talk about this formula and how it has led to new results about semi-standard tableaux and reverse plane partitions, asymptotics of the number of standard tableaux, and new product formulas for the number of tableaux of certain skew shapes. This is joint work with Igor Pak and Greta Panova.

José Alejandro Samper Casas, University of Miami, USA

Title: Matroid Independence Complexes with Prescribed Homotopy Type

Abstract: It is well known that the independence complex of any matroid without coloops is homotopy equivalent to a wedge of $k > 0$ equidimensional spheres. We prove that if the dimension and the number of spheres is fixed, then only finitely many such independence complexes exist. This counterintuitive property leads to new structural questions such as upper and lower bound theorems/conjectures for matroids based on the two parameters mentioned. New theorems about the face numbers of the independence complex also show up. If time permits we will discuss similar results for geometric lattices. This is joint work with F. Castillo.

John Shareshian, Washington University, USA

Title: Regular Hessenberg Varieties and Characters of Hecke Algebras

Abstract: Combining results of Brosnan-Chow andClearman-Hyatt-Shelton-Skandera, one sees that Poincaré polynomials of type A regular Hessenberg varieties give values of parabolic characters of the type A Hecke algebras evaluated at certain Kazhdan-Lusztig basis elements. I will describe joint work with Ryan Schneider, along with work of Alex Woo, in which it is shown that, although the corresponding result does not always hold in all Lie types, it does hold in many cases.

Stephanie van Willigenburg, University of British Columbia, Canada

Title: The e-Positivity of Chromatic Symmetric Functions

Abstract: The chromatic polynomial was generalized to the chromatic sym-

metric function by Stanley in his seminal 1995 paper. This function is currently experiencing a flourishing renaissance, in particular the study of the positivity of chromatic symmetric functions when expanded into the basis of elementary symmetric functions, that is, e-positivity.

In this talk we approach the question of e-positivity from various angles. Most pertinently we resolve the 1995 statement of Stanley that no known graph exists that is not contractible to the claw, and whose chromatic symmetric function is not e-positive.

This is joint work with Soojin Cho, Samantha Dahlberg and Angele Foley, and no prior knowledge is assumed.

DIFFERENTIAL GEOMETRY AND GEOMETRIC ANALYSIS

Lucas Ambrozio, University of Warwick, UK

Title: Free Boundary Minimal Surfaces

Abstract: In recent years, the theory of free boundary minimal surfaces, that is, of critical points of the area functional on the space of surfaces whose boundaries are contained inside the boundary of the ambient manifold, has been developing fast into several directions: construction of new examples by several methods (e.g. maximisation of Steklov eigenvalues), classifications theorems, index estimates, compactness results. In this talk we will present an overview of some of these recent developments.

Otis Chodosh, Princeton University, USA

Title: Minimal Surfaces and the Allen-Cahn Equation on 3 manifolds, Part II

Abstract: We will describe recent work on the Allen-Cahn semilinear PDE on 3 manifolds including curvature, multiplicity, and index estimates.

Robert Haslhofer, University of Toronto, Canada

Title: Minimal Two-Spheres in Three-Spheres
Abstract: We prove that any manifold diffeomorphic to S^3 and endowed

with a generic metric contains at least two embedded minimal two-spheres. The existence of at least one minimal two-sphere was obtained by Simon-Smith in 1983. Our approach combines ideas from min-max theory and mean curvature flow. We also establish the existence of smooth mean convex foliations in three-manifolds. Finally, we apply our methods to solve a problem posed by S.T. Yau in 1987, and to show that the assumptions in the multiplicity one conjecture and the equidistribution of widths conjecture are in a certain sense sharp. This is joint work with Dan Ketover.

Chao Li, Stanford University and Princeton Unversity, USA

Title: A Polyhedron Comparison Theorem in Positive Scalar Curvature

Abstract: We establish a comparison theorem for polyhedra in manifolds with nonnegative scalar curvature, answering affirmatively a dihedral rigidity conjecture by Gromov. For a large collection of polyhedra with interior non-negative scalar curvature and mean convex faces, we prove the dihedral angles along its edges cannot be everywhere less or equal than those of the corresponding Euclidean model, unless it is a isometric to a flat polyhedron. We will start the discussion from 3-manifolds, and illustrate how our result is parallel to the positive mass theorem, and thus generalizable to higher dimensions.

Siyuan Lu, Rutgers University, USA

Title: Isometric Embedding: Old and New

Abstract: In this talk, we will first review the classic Weyl's isometric embedding theorem, solved by Nirenberg and Pogorelov. A key part of the proof is to derive the mean curvature estimate. We will discuss two different approaches for the curvature estimate: global estimate and interior estimate. We will then discuss how to extend these two approaches to general ambient space. If time permits, we will further discuss Weyl's embedding theorem in general Riemannian manifolds and its applications in general relativity.

Christos Mantoulidis, Massachusetts Institute of Technology, USA

Title: Minimal Surfaces and the Allen-Cahn Equation on 3 Manifolds, Part I

Abstract: We will describe recent work on the Allen-Cahn semilinear PDE on 3 manifolds including curvature, multiplicity, and index estimates.

Abraão Mendes, Universidade Federal de Alagoas, Brazil

Title: Rigidity of Free Boundary Surfaces

Abstract: In this lecture, we will present an analogue of the Toponogov theorem in dimension 3 for compact manifolds M^3 with nonnegative Ricci curvature and strictly convex boundary ∂M. In fact, we will obtain a sharp upper bound for the length $L(\partial\Sigma)$ of the boundary $\partial\Sigma$ of a free boundary minimal surface Σ^2 in M^3 in terms of the genus of Σ and the number of connected components of $\partial\Sigma$, assuming Σ has index one. After, under a natural hypothesis on the geometry of M along ∂M, we will prove that if $L(\partial\Sigma)$ saturates the respective upper bound, then M^3 is isometric to the Euclidean 3-ball and Σ^2 is isometric to the Euclidean disk. In particular, we will get a sharp upper bound for the area of Σ, when M^3 is a strictly convex body in $\mathbb{R}^3$, which is saturated only on the Euclidean 3-balls (by the Euclidean disks). If time permits, we will also consider similar results for free boundary stable CMC surfaces.

Martín Reiris, Universidad de la República-Montevideo, Uruguay

Title: New Techniques a la Bakry-Emery on Vacuum Static and Stationary Solutions

Abstract: The classification of static and stationary solutions of the Einstein equations is one of the oldest and most natural problems in General Relativity. The celebrated uniqueness theorem of the Schwarzschild solutions (Israel, Robinson et al, Bunting/Masood-ul-Alam) classifies all asymptotically flat (3+1) static vacuum black holes. Recently, comparison techniques la Bakry-Emery have been applied to shown that, without any asymptotic assumption, vacuum static black holes are either (i) Schwarzschild, (ii) Boosts, or (iii) of Myers/Korotkin-Nicolai type, namely their topology is that of a solid three-torus minus a finite number of open three-balls and the asymptotic is Kasner, (see arXiv:1806.00818 arXiv:1806.00819). I will

discuss how Bakry-Emery techniques could be used to shed light in the still open problem of the existence of vacuum stationary (rotating) black holes of Myers/Korotkin-Nicolai type. Achieving this goal would be a step towards the classification of vacuum stationary black holes, still an unresolved problem.

Lu Wang, University of Wisconsin, USA

Title: Self-Similar Solutions of Mean Curvature Flow

Abstract: Mean curvature flow is the negative gradient flow of the volume functional, which decreases the volume of hypersurfaces in the steepest way. The flow starting from any compact hypersurface will develop singularities in finite time. Self-similar solutions of mean curvature flow play an important role in understanding the asymptotic behavior of the flow near singularities. In this talk, I will survey some known results as well as some open problems about self-similar solutions of mean curvature flow – with a particular emphasis on properties of self-shrinking solutions.

MATHEMATICAL BIOLOGY

Carlos Castillo-Chavez, Arizona State University, USA and Yachay University of Experimental Technical Research, Ecuador

Title: Scaling up the impact of dynamic individual decisions in response to ongoing epidemic outbreaks

Abstract: The long standing challenge posed by the threat of emergent or re-emergent diseases is intimately linked to the use that individuals make of disease risk information. A modeling framework that accounts for the impact that an ongoing disease outbreak has on the decisions that individuals make based on their real or perceived risk of infection is revisited.

Recent work with collaborators at various institutions including Eli Fenichel, Charles Perrings and Ben Morin is highlighted. The research is based on a behavioral framework where individual decisions are based on the tradeoffs made in response to costs associated with the present or future risk of infection and the potential loss of benefits that may result as a consequence of risk aversion decisions - risks due in part to changes in prevalence. This

research project will be highlighted in the context of influenza.

Juan Gutierrez, University of Georgia, USA

Title: The Math of Multi-Scaling: From Molecular Dynamics to Epidemiological Processes of Malaria

Abstract: The advent of high-throughput molecular technologies in particular, and the broad availability of data, in general, have forced the quantitative biology community to rethink how to conceive, build, and validate mathematical models. In this talk I will demonstrate how molecular and cellular processes are related to the epidemiology of malaria. We will explore (i) asymptomaticity at the epidemiological level, (ii) the cellular models that explain this phenomenon as an interaction between the immune system and infected red blood cells, (iii) mathematical models that link cellular and transcriptional time series, (iv) transcriptomic analysis, and finally (vi) high-throughput in-silico drug discovery to solve an epidemiological problem. All these linked analyses provide a comprehensive picture that no single scale can produce alone. The usefulness of models under this light takes on new meanings, and this broad scope requires the cooperation of scientists coming from very different intellectual traditions. In this talk we will also explore how an information system that delivers Adaptive Learning for Interdisciplinary Collaborative Environments (ALICE) is used to train scientists in this new normal.

Xi Huo, University of Miami, USA

Title: Modelling the Antibiotic Use in Intensive Care Units - Comparing De-escalation and Continuation

Abstract: Antimicrobial de-escalation refers to the treatment mechanism of switching from empiric antibiotics with good coverage to alternatives based on laboratory susceptibility test results, with the aims of reducing costs and avoiding unnecessary use of broad-spectrum antibiotics. Though widely practiced and recommended, the benefits and tradeoffs of this strategy have not been well understood. In this talk, we will first show our preliminary simulation results of a set of multi-strain-multi-drug models in an intensive care unit setting, to numerically compare de-escalation with the

conventional strategy called antimicrobial continuation. Then we simplify the previous models to compare the long-term dynamical behaviors between de-escalation and continuation systems under a double-strain-double-drug scenario. Finally we extend our models to seek for optimal antibiotic use strategies under a triple-strain-triple-drug scenario. The major conclusion of this study shows that, if we suppose there are two identical intensive care units that separately adopt de-escalation and continuation as the major drug use strategy, then the one following de-escalation: (1) could maintain either higher or lower percentage of colonized patients in the two-strain transmission scenario; (2) is superior in preventing outbreaks of strains resistant to the empiric antibiotic.

King-Yeung Lam, Ohio State University, USA

Title: Invasion of Open Space by Two Competing Species

Abstract: I will discuss a question raised by Shigesada and Kawasaki in Chapter 7 of their monograph, concerning the spreading properties of two competing species on the real line when the initial values are null or exponentially decaying in a right half-line. In the case of compactly supported initial values, we prove that the first species spreads with the KPP speed of the single species, whereas the speed of the second species can be given by an exact formula depending on the speed of the first species. This is joint work with Leo Girardin (Paris VI). If time allows, I will also talk about some recent progress obtained with Qian Liu (OSU and Renmin Univ. of China).

Suzanne Lenhart, University of Tennessee, USA

Title: Optimal Control Techniques for Management Strategies in Biological Models

Abstract: Two examples with different optimal control techniques to choose management actions will be presented. One model is a PDE system representing Zika spreading across a state in Brazil; the control varying in space and time is a vaccination rate. Data from Brazil were used to estimate parameters. The second model represents a large scale forest fire. We incorporate the stochasticity of the time of a fire into our model and explore

the trade-offs between prevention management spending and suppression spending. A large fire event in the past was used to form an illustrative example.

Salome Martinez, Universidad de Chile, Chile

Title: Multiple Steady States for a Competition System Supporting an Ideal-Free Distribution

Abstract: In this talk we will discuss existence of steady state solutions for the competitive system

$$\begin{cases} \dfrac{\partial u}{\partial t} = \nabla \cdot \left[\alpha(x)\nabla \dfrac{u}{m}\right] + u(m(x) - u - bv) \ \text{ in } \Omega,\ t > 0, \\ \dfrac{\partial u}{\partial t} = \nabla \cdot [\beta(x)\nabla v] + v(m(x) - cu - v) \ \text{ in } \Omega,\ t > 0, \\ \nabla \dfrac{u}{m} \cdot \hat{n} = \nabla v \cdot \hat{n} = 0 \ \text{ on } \partial\Omega,\ t > 0, \end{cases}$$

which supports an *ideal free distribution* for the first species, i.e. admits a positive steady state which matches the per-capita growth rate. Previous results have stated that when $b = c = 1$ the ideal free distribution is an evolutionary stable and neighborhood invader strategy, that is the species with density v always goes extinct. We will analyze how the interaction coefficients b and c influence the structure of the steady state solutions of the system. In particular, how and to what extent the advantage derived from ideal free dispersal continues when there is a trade off relative to competitive impact, for example when $b > 1$ but $c < 1$. To understand this case, we will study the interplay between the inter-specific competition coefficients b, c and the diffusion coefficients $\alpha(x)$ and $\beta(x)$ on the critical values for stability of semi-trivial steady states. We will also show that under certain regimes the system sustains multiple positive steady states.

Nancy Rodriguez, University of North Carolina, USA

Title: Birth-Jump Processes in Plant Dynamics

Abstract: In this talk I will introduce a model for the dynamics of the growth and dispersal of plants in various environments. The discrete model is based on a birth-jump process which exhibits wave-like solutions. After discussing the continuum limit, which is an non-local reaction-diffusion equation, I will present the proof of existence of traveling waves for speeds above a critical threshold (both sharp and continuously differentiable) in the diffusion-limit assuming a logarithmic-type growth term. I will conclude by verifying the theoretical results presented via the use of numerical simulations.

Zhisheng Shuai, University of Central Florida, USA

Title: Biased Population Movement and Infectious Disease Dynamics

Abstract: Many recent outbreaks and spatial spread of infectious diseases have been influenced by human movement over air, sea and land transport networks, and/or anthropogenic-induced pathogen/vector movement. These spatial movements in heterogeneous environments and networks are often asymmetric (biased). The effects of asymmetric movement versus symmetric movement will be investigated using several epidemiological models from the literature. These investigations provide a better understanding of disease transmission and control in the real life application.

Jorge Velasco-Hernandez, Universidad Nacional Autónoma de México, México

Title: Dengue Dynamics in Southern Mexico: An Approximation to its Population Dynamics and the Role of Population Movement

Abstract: We present data and analysis of dengue incidence in several states of Mexico. A metapopulation model is presented along with further commentaries on the construction of a dengue network for mobility in these regions.