

# Carolina Dynamics Symposium - Titles and Abstracts

Furman University

Friday, April 1st - Sunday April 3rd, 2016

## **Richard Evan Schwartz**

### **Outer billiards and the plaid model**

#### **Abstract:**

Outer billiards is a geometrically motivated dynamical system which is similar in spirit to inner billiards but less practical to play, because the ball is "bouncing around" the outside of the table. When the table is a convex polygon, the system can produce orbits with an intricate combinatorial structure. The speaker will explain a combinatorial model he devised which gives (in some sense) a complete picture for what happens when the table is a kite. A kite is a quadrilateral with bilateral symmetry. Along the way, Schwartz explains his solution to the Moser-Neumann problem, which asks if outer billiards can ever have an unbounded orbit.

## **Vladimir Dragovi**

### **Pseudo-integrable billiards**

#### **Abstract:**

We introduce a class of nonconvex billiards with a boundary composed of arcs of confocal conics which contain reflex (nonconvex) angles. We present their basic dynamical, topological, and arithmetic properties. We study their periodic orbits and establish a local Poincaré theorem. A connection with interval exchange transformation is established together with the Keane-type conditions for minimality. A transformation from pseudo-integrable billiards to rectangular billiards is constructed. This research is done jointly with M. Radnovic.

## **Emily Burkhead**

### **Topological Properties of Stochastic Cellular Automaton Models for Diseases**

#### **Abstract**

In analyzing Stochastic Cellular Automaton (SCA) Models for HIV (with Jane Hawkins and Donna Molinek) and for Ebola (with Jane Hawkins), we have stated that after a long enough time passes, the spatial configurations obtained from iteration of the SCA appear to be completely random, where any state can be adjacent to any other state. Here, we present some formalization of these observations in response to questions raised by Karl Petersen regarding whether these SCAs are onto and/or topologically transitive. The model for HIV is both onto and transitive, though the model for Ebola has neither property. However, we characterize the Garden of Eden configurations, those which are not the image of any initial configuration, under the Ebola model and discuss transitivity of this SCA when restricting the codomain of the map to its image.

## Russel Jeter

### Synchronization in Stochastically Evolving Dynamical Networks: Discrete- and Continuous-Time Models

#### Abstract

We study dynamical networks that stochastically change in time, on a time scale that ranges from fast to slow. For continuous-time, when switching is fast, the stochastic network converges to the neighborhood of the solution of the averaged network, which is obtained by replacing the random variables by their mean. We apply a recently developed general theory of blinking systems to prove global stability of synchronization in the fast switching limit. Going beyond fast switching, we reveal unexpected windows of intermediate switching frequencies in which synchronization in the switching network becomes stable even though it is unstable in the averaged/fast-switching network.

## 1 Kelly Yancy

### Topological Entropy and Finite Automata

#### Abstract

: A problem that has emerged in computer science is determining the similarity between regular languages. We will represent a regular language by a deterministic finite automata (a directed graph with some marked data) and then use ideas from symbolic dynamics to define a metric between the languages. We will also discuss other distances based on the classical Jaccard distance and how they are related to the topological entropy of a regular language. There will be no prior knowledge of automata theory assumed.

## David Aulicino

### Weak Mixing for Translation Surfaces with Intermediate Orbit Closures

#### Abstract:

Work of Avila and Forni established weak mixing for the generic straight line flow on generic translation surfaces, and the work of Avila and Delecroix determined when weak mixing occurs for the straight line flow on a Veech surface. Following the work of Eskin, Mirzakhani, Mohammadi, which proved that the orbit closure of every translation surface has a very nice structure, one can ask how the orbit closure affects the weak mixing of the straight line flow. In this talk all of the necessary background on translation surfaces and weak mixing will be presented followed by the answer to this question. This is a joint work in progress with Artur Avila and Vincent Delecroix.

## Kevin McGoff

### Optimal tracking for dynamical systems

#### Abstract:

This talk concerns preliminary results from ongoing work with Andrew Nobel. We study the limiting behavior of the average per-state cost when trajectories of a topological dynamical system are used to track a trajectory from an observed ergodic system. We establish a variational characterization of the limiting average cost in terms of the joinings of the two systems, and we show that the set of optimal joinings is convex and compact in the weak topology. Using these results, we establish a general convergence theorem for the limiting behavior of statistical inference procedures based on optimal tracking. After presenting some basic results, I will discuss implications of this work for statistical inference, as well as connections to ergodic optimization.

## **Donna Molinek**

### **Zero forcing on graphs as a model of the spread of disease**

#### **Abstract:**

Zero (and more generally  $k$ ) forcing is an iterative process on a graph that changes vertices of one color to another via a color change rule. This concept is applied to small world graphs which reflect characteristics of the brain and then used to model the spread of neurodegenerative disease. We give basic definitions, some known bounds for the size of a zero forcing set, relationships with the nullity of associated matrices, and some biological motivation. This exploratory work is based on a summer research project with Davidson College student, Courtney Cochrane, 16. Comments, questions, suggestions will be very welcome.

## **Renato Feres**

### **From billiards to thermodynamics**

#### **Abstract:**

Starting from simple billiard systems, which may be broadly defined as dynamical systems comprised of rigid masses that interact through elastic collisions, and by judiciously allowing some of the dynamical variables of the system to be random, one obtains interesting examples of Markov chains that model classical statistical physics phenomena. Using such random billiard models we will explore elements of thermodynamics from a dynamical systems and stochastic processes viewpoint.

## **Sam L Robinson and Predrag Punosevac**

### **On the Spreading of Certain Semiclassical Quantum States**

#### **Abstract:**

We consider solutions of the time-dependent Schrodinger equation in one spatial dimension under reasonable assumptions on the potential energy. For certain Gaussian initial conditions we analyze an underlying dynamical system determined purely by classical mechanics and obtain a fairly complete understanding of semiclassical asymptotic approximations for the time evolution of the quantum position and momentum uncertainties.

## **Chris Johnson**

### **Cutting sequences on square-tiled surfaces**

#### **Abstract:**

The cutting sequence of a geodesic on a surface is a sequence of labels of preselected curves on the surface given in the order in which the geodesic intersects the curves. Given a sequence of labels, is there a way to determine whether or not the sequence is the cutting sequence of some geodesic on the surface? This question has been studied for various families of translation surfaces with special symmetries such as regular polygon surfaces and Bouw-Moeller surfaces. In this talk we will give a characterization for cutting sequences on square-tiled surfaces.