Graduate Student Paper Presentation 2024

UH AMS, SIAM, and AWM

April 12th, 2024

Schedule

Venue: PGH 232 (in-person) and via Teams (virtual)

03:00 pm	Welcome Remarks
03:10 pm	Existence of Weak Solutions to the Nonlocal Klausmeier Model *Cristian Meraz*
03:30 pm	Reduced Order Modeling of the Kuramoto Shivshisky Equation using Proper Orthogonal Decomposition *Md Rezwan Bin Mizan*
03:50 pm	Topologically mixing suspension flows over shift spaces *Jason Day*
04:10 pm	**Break**
04:20 pm	Stochastic Switching Blows up Stable Systems with Stable Average Behavior *Sean Campbell*
04:40 pm	Accumulation points of normalized approximations *Kavita Dhanda*

Abstracts

Existence of Weak Solutions to the Nonlocal Klausmeier Model
Cristian Meraz

We establish the existence and uniqueness of weak solutions for a nonlocal Klausmeier model, a nonlinear system of reaction-advection-diffusion governing plant biomass and water dynamics in semiarid regions. We use a nonlocal diffusive operator, aligned with ecological data validating long-range plant dispersion. To handle the nonlocality, we employ a nontraditional Galerkin method. Key challenges include the lack of regularity due to the nonlocal operator and the inability to use Aubin's compactness theorem. We address this by introducing two additional equations for the spatial derivatives of plant biomass and water. This allows us to establish compactness and prove weak convergence of approximate solutions within a small time interval.

Reduced Order Modeling of the Kuramoto Shivshisky Equation using Proper Orthogonal Decomposition
Md Rezwan Bin Mizan

Proper Orthogonal Decomposition (POD) techniques are widely utilized in various scientific fields to streamline complex, data-driven spatio-temporal dynamics. In this study, we present a POD-Reduced Order Model (POD-ROM) for the one-dimensional Kuramoto-Sivashinsky (KS) equation, known for its chaotic attractor. Our FOM simulation was conducted over an extended time period to capture snapshots within this attractor. We constructed our basis using truncated Singular Value Decomposition (SVD), effectively representing the attractor. This single basis was then employed to construct our ROM using Galerkin projection. We demonstrate that the POD-ROM can accurately reproduce the statistical features of the KS equation's attractor, independent of initial conditions. Additionally, we show that this basis allows short-term predictions of the KS dynamics. Our findings suggest that a POD-ROM, based on a single basis, is effective for both long-term and short-term predictions of the chaotic KS dynamics. Furthermore, we have developed a criteria for the automatic selection of the reduced model's dimension, based on the cumulative variance of the singular values.

Topologically mixing suspension flows over shift spaces
Jason Day

Topological mixing is a common property present in many chaotic dynamical systems. Results about topological mixing for Anosov flows on a smooth manifold were established by Bowen and Plante in 1972. This talk will examine how their results translate to the setting of symbolic dynamics.

Stochastic Switching Blows up Stable Systems with Stable Average Behavior
Sean Campbell

I will present a counter-intuitive result by the University of Utah's Professor, Sean Lawly in which contractive planar linear systems with contractive average behavior can be stochastically switched at a medium rate in order to blow up.

Accumulation points of normalized approximations
Kavita Dhanda

Building on classical aspects of the theory of Diophantine approximation, we consider the collection of all accumulation points of normalized integer vector translates of points $q\boldsymbol{\alpha}$ with $\boldsymbol{\alpha} \in \mathbb{R}^d$ and $q \in \mathbb{Z}$. Here we derive measure theoretic and Hausdorff dimension results about the set of $\boldsymbol{\alpha}$ whose accumulation points are all of $\mathbb{R}^d$.