NSF-CBMS Conference
Gaussian Random Fields, Fractals, SPDEs and Extremes
August 2-6, 2021, University of Alabama in Huntsville
(In Person and/or Remotely)
Tentative Schedule and Abstracts

TENTATIVE SCHEDULE

All the lectures and talks, including coffee breaks, will be in Room 109, Shelby Center for Science and Technology (SST), delivered in person and/or remotely. Breakfasts and lunches will be served either in Conference Training Center/Charger Cafe (CTC) or Room 109, SST.

Sunday, August 1

6:30p.m.-8:00p.m. Informal Reception at Room 126 A, CTC

Monday, August 2 (Chair: Toka Diagana)

7:00-8:15 Breakfast at Room 109, SST

8:15-8:45 Onsite registration in front of Room 109, SST

8:45-9:00 Opening, **Dr. Rainer Steinwandt** (Dean, College of Science)

9:00-10:00 **Yimin Xiao**, Lecture 1

10:00-10:30 Coffee Break

10:30-11:30 **Yimin Xiao**, Lecture 2

11:30-12:30 **Carl Mueller** (University of Rochester), *The radius of a moving polymer*

12:30-2:00 Lunch at CTC

2:00-3:00 **Yimin Xiao**, Lecture 3

3:00-3:30 Coffee Break

3:30-3:55 **Chunsheng Ma** (Wichita State University), *Peakedness comparison for hyperbolic cosine and sine ratio random fields*

3:55-4:20 **Sefika Kuzgun** (University of Kansas), *Convergence of densities for stochastic heat equation*

4:20-4:45 **Ruxiao Qian** (Lehigh University), *Intermittency property of stochastic heat and wave Equations with Dobrić Ojeda type noise*

Tuesday, August 3 (Chair: Erkan Nane)

7:00-8:30 Breakfast at CTC

8:30-9:00 Onsite registration in front of Room 109, SST

9:00-10:00 **Yimin Xiao**, Lecture 4

10:00-10:30 Coffee Break

10:30-11:30 **Yimin Xiao**, Lecture 5

11:30-12:30 **Vladas Pipiras** (University of North Carolina at Chapel Hill), *Some extreme value problems arising with ship motions*

12:30-2:00 Lunch at CTC

2:00-3:00 **Raluca Balan** (University of Ottawa), *Stratonovich solution for the wave equation*

3:00-3:30 Coffee Break

3:30-3:55 **Hailin Sang** (The University of Mississippi), *Local limit theorem for linear random fields*

3:55-4:20 **Jeonghwa Lee** (Truman State University), *Hurst estimation for operator scaling Random fields*

4:20-4:45 **Yanghui Liu** (CUNY), *Numerical stochastic integrations and limit theorems*

Wednesday, August 4 (Chair: Xia Chen)

7:00-8:30 Breakfast at Room 109, SST

9:00-10:00 **Yimin Xiao**, Lecture 6

10:00-10:30 Coffee Break

10:30-11:30 **Yimin Xiao**, Lecture 7

11:30-12:30 **Yaozhong Hu** (University of Alberta), *Stochastic heat equation with general nonlinear spatial rough Gaussian noise*

12:30-2:00 Lunch at Room 109, SST

2:00-2:25 **Youssef Hakiki** (Cadi Ayyad University, Morocco), *Images of fractional Brownian motion with deterministic drift: Positive Lebesgue measure and non-empty interior*

2:25-2:50 **Yassine Nachit** (Cadi Ayyad University, Morocco), *Local times for systems of non-linear stochastic heat equations*

2:50-3:30 Coffee Break

3:30-3:55 **Yujia Ding** (Claremont Graduate University), *Linear multifractional stable sheets in the broad sense: Existence and joint continuity of local times*

3:55-4:20 **Nhu Nguyen** (University of Connecticut), *Stochastic Lotka-Volterra competitive reaction-diffusion systems eerturbed by space-time white noise: Modeling and analysis*

4:20-4:45 **Han Yu** (University of Northern Colorado), *The SPDE/GMRF-based approach to the spatio-temporal dynamics of crowdfunding campaign,* 6:00-9:00 Conference Banquet at Room 126 A, CTC

Thursday, August 5 (Chair: Oana Mocioalca)

7:00-8:30 Breakfast at Room 109, SST

9:00-10:00 **Yimin Xiao**, Lecture 8

10:00-10:30 Coffee Break

10:30-11:30 **Yimin Xiao**, Lecture 9

11:30-12:30 **Xia Chen** (University of Tennessee), *Necessary and sufficient condition for the solvability of the hyperbolic Anderson models with Gaussian noise that is fractional in times*

12:30-2:00 Lunch at CTC

2:00-2:25 **Ummugul Bulut** (Texas A&M University-San Antonio), *A stochastic model of Avian Influenza in the migratory birds*

2:25-2:50 **S. Y. Samadi and T. P. D. Alwis** (Southern Illinois University Carbondale), *Fourier method on sufficient dimension reduction in time series*

2:50-3:30 Coffee Break

3:30-5:00 **Problems and Discussion**

Friday, August 6 (Chair: Dongsheng Wu)

7:00-8:30 Breakfast at CTC

9:00-10:00 **Yimin Xiao**, Lecture 10

10:00-10:30 Coffee Break

10:30-11:30 **Davar Khoshnevisan** (University of Utah), *Phase analysis of a family of stochastic reaction-diffusion equations*

11:30-11:55 **Marek Slaby** (Fairleigh Dickinson University), *Explicit solutions of the extended Skorokhod problems in affine transformations of time-dependent strata*

11:55-12:20 **Olena Atlasiuk** (Institute of Mathematics of the National Academy of Sciences of Ukraine), *On generic boundary-value problems for differential systems in Sobolev spaces*

12:30-2:00 Lunch at CTC

2:00-3:30 **Problems and Discussion**

ABSTRACTS

Ten Lectures on Gaussian Random Fields, Fractals, SPDEs and Extremes

Yimin Xiao (Michigan State University)

Lecture 1: An introduction on random fields

Abstract: We present an overview on univariate and multivariate random fields and introduce important statistical characteristics such as spectral representations, self-similarity, anisotropy of random fields. Important examples of random fields include Gaussian random fields with stationary increments and solutions to stochastic partial differential equations.

Lecture 2: General results on regularity of Gaussian random fields

Abstract: Regularity properties such as continuity and differentiability of the sample functions of Gaussian processes are important topics in probability theory and essential for statistical applications. Necessary and sufficient conditions for sample path continuity based on the metric entropy or majorizing measure were established by Dudley (1967), Fernique (1975), and Talagrand (1987).

This lecture recalls briefly some general methods for studying the regularity properties of Gaussian random fields. These include bounds on expectations of the supremum of Gaussian processes in terms of metric entropy and majorizing measure, sample path continuity, and differentiability. These methods are applicable to the Gaussian random fields described in Lecture 1.

Lecture 3: Exact results on regularity of Gaussian random fields

Abstract: The purpose of this module is to present methods for establishing exact uniform and local modulus of continuity results for Gaussian random fields. In particular, we prove four types of limit theorems: the law of the iterated logarithm, uniform modulus of continuity, Chung's law of the iterated logarithm, and the modulus of nondifferentiability.

For this purpose, we formulate a framework that will be convenient for studying the solutions of stochastic partial differential equations. An important condition in this framework is the property of strong local nondeterminism.

Lecture 4: Fractal properties of random fields

Abstract: Fractal geometry is important for studying random fields with nondifferentiable sample functions. We introduce Hausdorff and packing measure and dimensions and main techniques for their computation.

We determine the Hausdorff dimensions of various random sets generated by multivariate Gaussian random fields including the range, graph, level sets, and set of multiple points.

We determine the exact Hausdorff measure functions for the range, graph and level sets of a large class of Gaussian random fields.

Lecture 5: Strong local nondeterminism

Abstract: Sufficient conditions in terms of spectral measures or covariance functions for the properties of strong local nondeterminism for Gaussian random fields

will be provided. A comparison theorem allows to study Gaussian random fields with stationary increments with discrete or singular spectral measures.

Properties of strong local nondeterminism are proved for solutions to stochastic heat and wave equations with colored or fractional noises.

Lecture 6: Hitting probabilities, polarity, and self-intersections

Abstract: The lecture is concerned with hitting probabilities of Gaussian random fields and their applications in studying the existence and Hausdorff dimensions of intersections.

Let $X = \{X(t), t \in \mathbb{R}^N\}$ be a Gaussian random field with values in $\mathbb{R}^d$. For any compact sets $E \subset \mathbb{R}^N$ and $F \subset \mathbb{R}^d$, we study conditions on E and F for $\mathbb{P}\big\{X(E) \cap F \neq \varnothing\big\} > 0$. Only in a few special cases, this hitting probability problem has been completely solved [e.g., Khoshnevisan and Shi (1999), Khoshnevisan and Xiao (2007, 2015)].

We will present some necessary conditions and sufficient conditions that improve those in Biermé, Lacaux, and Xiao (2009). In some special cases such as F is a singleton, more precise results have been proven in Dalang, Mueller, and Xiao (2017). This method has been extended by Dalang, Lee, Mueller, and Xiao (2021) to study the existence of multiple points of Gaussian random fields.

Lecture 7: Local times of Gaussian random fields

Abstract: Besides of the interest on their own, local times and self-intersections local times of Gaussian random fields are important for studying fractal properties of the level sets and the set of multiple points. The properties of strong local nondeterminism are applied to establish sharp regularity results on the local times.

Lecture 8: Properties of linear stochastic heat and wave equations

Abstract: We consider linear stochastic heat and wave equations with Gaussian noise (including "white-colored" and "fractional-colored" noises). By applying general methods for Gaussian random fields, we describe various regularity, singularity, and fractal properties of the solutions to these SPDEs that highlight the effects of the equations and noises on the behavior of the solutions.

Some of the techniques that are useful for analyzing more complicated SPDEs.

Lecture 9: Properties of nonlinear stochastic heat equation

Abstract: Let $(t\,, x) \mapsto u_t(x)$ denote the solution to the stochastic heat equation with multiplicative noise

$$\partial_t u = -\frac{1}{2}(-\Delta)^{\alpha/2} u_t(x) + \lambda \sigma(u_t(x))\dot{W},$$

where the variable x ranges over $\mathbb{R}$, $t > 0$, $-(-\Delta)^{\alpha/2}$ denotes the generator of a symmetric α-stable Lévy process on $\mathbb{R}$, and $\dot{W}$ denotes the space-time white noise on $(0\,,\infty) \times \mathbb{R}$. Based on a quantitative version of the intuitively-appealing statement that "locally, $t \mapsto u_t(x)$ behaves as a conditionally-Gaussian process", We derive a number of results about the local behavior of $t \mapsto u_t(x)$, where $x \in \mathbb{R}$ is fixed.

If time permits, we will also study the polarity of the solution to the a system of the stochastic heat equations with multiplicative noise.

Lecture 10: Extreme values of random fields

Abstract: General bounds for the excursion probabilities of real-valued Gaussian random fields can obtained by applying the general methods (e.g., the metric entropy method). These results have found many applications in mathematics and statistics. However, studies on multivariate Gaussian random fields are scarce.

In this lecture, we consider a class of bivariate Gaussian random fields and apply the double sum method to establish more precise approximations to the excursion probabilities.

Invited Talks

Stratonovich solution for the wave equation, *Raluca Balan* (University of Ottawa)

Abstract: In this talk, we define a Stratonovich solution for the stochastic wave equation in spatial dimension $d \leq 2$, with time-independent noise and linear term $\sigma(u) = u$ multiplying the noise. The noise is spatially-homogeneous and its spectral measure satisfies an integrability condition which is stronger than Dalang's condition. We give a probabilistic representation for this solution, similar to the Feynman-Kac-type formula given by Dalang, Mueller and Tribe (2008) for the solution of the stochastic wave equation with spatially-homogeneous Gaussian noise, that is white in time. We also give the chaos expansion of the Stratonovich solution and we compare it with the chaos expansion of the Skorohod solution.

Necessary and sufficient condition for the solvability of the hyperbolic Anderson models with Gaussian noise that is fractional in times, *Xia Chen* (University of Tennessee)

Abstract: In the Ito-Skorohkod regime, the solution of the hyperbolic Anderson models is formally written in the form of Ito-Wiener chaos expansion and the uniqueness/existence of the system is equivalent to the convergence of the expansion in L_2. In this report, we find the condition that is necessary and sufficient for such convergence in the setting where the system is driven by a Gaussian noise that is fractional in times.

The work is based on part of the collaborative project with Jian Song and Samy Tindal.

Stochastic heat equation with general nonlinear spatial rough Gaussian noise, *Yaozhong Hu* (University of Alberta)

Abstract: In this talk, we consider the following one dimensional (in space variable) nonlinear stochastic heat equation driven by the Gaussian noise which is white in time and fractional in space:

$$\frac{\partial u(t,x)}{\partial t} = \frac{\partial^2 u(t,x)}{\partial x^2} + \sigma(u(t,x))\dot{W}(t,x),$$

where $W(t,x)$ is a centered Gaussian process with covariance given by

$$\mathbf{E}[W(t,x)W(s,y)] = \frac{1}{2}\left(|x|^{2H} + |y|^{2H} - |x-y|^{2H}\right)(s \wedge t).$$

Here the Hurst parameter H is between 1/4 and 1/2 and $\dot{W}(t,x) = \frac{\partial^2 W}{\partial t \partial x}$. We remove the technical condition $\sigma(0) = 0$ previously assumed. The idea is to introduce a weight for the solution. When $\sigma(t,u)$ is a constant the solution is a Gaussian random field and we obtain the bound of the solution $\sup_{0\le t\le T, |x|\le L} |u(t,x)|$ when T and L goes to infinity. This is a joint work with Xiong Wang.

Phase analysis of a family of stochastic reaction-diffusion equations, *Davar Khoshnevisan* (University of Utah)

Abstract: We consider a reaction-diffusion equation driven by a multiplicative space-time white noise, for a large class of reaction terms that include well-studied examples, such as the Fisher-KPP and the Allen-Cahn equations. We prove that, in the "intermittent regime": (1) If the equation is "sufficiently noisy," then the resulting stochastic PDE has a unique invariant measure; and (2) If the equation is in a "low-noise regime," then there are infinitely many invariant measures, and the collection of all invariant measures is a certain line segment in path space. This endeavor gives a proof of earlier predictions due to Zimmerman et al (2000), discovered first through experiments and computer simulations. The quoted terms will be defined carefully in the talk.

This is based on ongoing joint work with Carl Mueller (University of Rochester), Kunwoo Kim (Pohang University of Science and Technology), and Shang-Yuan Shiu (National Central University).

The radius of a moving polymer, *Carl Mueller* (University of Rochester)

Abstract: This is joint work with Eyal Neuman.

Polymer models give rise to some of the most challenging problems in probability and statistical physics. For example, the typical end-to-end distance of a self-avoiding simple random walk is known only in one dimension and in dimensions greater than or equal to 5. The parameter n in the walk does not represent physical time, but rather the distance from one end of the polymer. There has been very little work on moving polymers, in spite of the obvious physical motivation.

We consider Funaki's random string, which was also known to polymer scientists as the continuum limit of the Rouse model. Consider the stochastic heat equation with vector-valued solutions $u(t,x) \in \mathbf{R}^d$ for $x \in [0,J]$. Then t represents physical time and x is the length along the polymer, while $u(t,x)$ is the position of the polymer. The SPDE is:

$$\partial_t u = \partial_x^2 u + \dot{W}(t,x)$$

with Neumann boundary conditions, where $\dot{W}$ is a d-dimensional vector of independent white noises. Next we impose an exponential weighting which penalizes self-intersection. In dimension $d = 1$, we study the radius $R = R(t)$ of the polymer at a typical time t, where $R(t)$ measures the typical distance a point on the polymer from its center of mass.

Some extreme value problems arising with ship motions, *Vladas Pipiras* (University of North Carolina at Chapel Hill)

Abstract: For a number of years, I have been collaborating with US Navy researchers, as well as academics, on understanding and quantifying extreme (rare)

events related to ship motions and other characteristics of interest, for example, extreme roll, capsizing, extreme loads, etc. In this talk, I will discuss several problems pursued in this collaboration. I will show how the approaches based on statistical Extreme Value Theory (EVT) need to be informed by the underlying physics of the considered system to provide meaningful estimation of probabilities of rare events. I will describe how estimation of extreme value statistics can benefit from the availability of multi-fidelity computer codes used to generate ship motions. Apart from EVT and multi-fidelity, stochastic dynamics, reduced-order models (such as random oscillators) and insights from Naval Architecture are other important components of the considered approaches.

Contributing Talks

On generic boundary-value problems for differential systems in Sobolev spaces, *Olena Atlasiuk* (Institute of Mathematics of the National Academy of Sciences of Ukraine)

Abstract: For the systems of ordinary differential equations of arbitrary order on a compact interval, we study a character of solvability of the most general linear boundary-value problems in the Sobolev spaces W_p^n, with $n \in \mathbb{N}$ and $1 \leq p \leq \infty$. We find the indices of these Fredholm problems and obtain a criterion of their well-posedness. Each of these boundary-value problems relates to a certain rectangular numerical characteristic matrix with kernel and cokernel of the same dimension as the kernel and cokernel of the boundary-value problem. The condition for the sequence of characteristic matrices to converge is found. We obtain a constructive criterion under which the solutions to these problems depend continuously on the small parameter ε at $\varepsilon = 0$, and find the degree of convergence of the solutions. Also, applications of these results to multipoint boundary-value problems are obtained.

1. Atlasiuk, O. M.; Mikhailets, V. A. Fredholm one-dimensional boundary-value problems in Sobolev spaces. Ukrainian Math. J. 70 (2019), no. 10, 1526–1537.
2. Atlasiuk, O. M.; Mikhailets, V. A. Fredholm one-dimensional boundary-value problems with parameter in Sobolev spaces. Ukrainian Math. J. 70 (2019), no. 11, 1677–1687.
3. Atlasiuk, O. M. Limit theorems for solutions of multipoint boundary-value problems in Sobolev spaces. J. Math. Sci. 247 (2020), no. 2, 238–247.

A Stochastic Model of Avian Influenza in the Migratory Birds, *Ummugul Bulut* (Texas A&M University-San Antonio)

Abstract: Avian Influenza (AI) is a zootonic disease with a 53% case fatality rate (H5N1 strain) since 2003. The number of humans infected with AI has increased in the recent epidemic wave during the period 2016-2017. In this talk, the stochastic fisher equation is used, with the time-dependent white noise, to investigate the dynamics of the susceptible-infected (SI) compartmental model. Our goal is to see whether applying the random perturbation to the migration speed of the wild bird population can eradicate the disease or not. We prove that the disease-free equilibrium is exponentially asymptotically stable almost surely for the stochastic model. The computational graphs support the theoretical results.

Linear Multifractional Stable Sheets in the Broad Sense: Existence and Joint Continuity of Local Times, *Yujia Ding* (Claremont Graduate University)

Abstract: We introduce the notion of linear multifractional stable sheets in the broad sense (LMSS) with $\alpha \in (0, 2]$, to include both linear multifractional Brownian sheets ($\alpha = 2$) and linear multifractional stable sheets ($\alpha < 2$). The purpose is to study the existence and joint continuity of the local times of LMSS. We provide a sufficient and necessary condition for the existence of local times and a weaker sufficient condition for the joint continuity of local times of LMSS. We also prove a local Hölder condition for the local times of LMSS. All these results significantly improve the existing results for the local times of multifractional Brownian sheets and linear multifractional stable sheets in the literature. This is a joint work with Qidi Peng and Yimin Xiao.

Images of fractional Brownian motion with deterministic drift: Positive Lebesgue measure and non-empty interior, *Youssef Hakiki* (Cadi Ayyad University, Morocco)

Abstract: We provide sufficient conditions for the image $(B^H + f)(A)$ to have a positive Lebesgue measure or to have a non-empty interior. This is done through the study of the properties of the density of the occupation measure of $(B^H + f)$. Precisely, we prove that if the parabolic Hausdorff dimension of the graph of f is greater than Hd, then the density is a square-integrable function. If, on the other hand, the Hausdorff dimension of A is greater than Hd, then it even admits a continuous version. This allows us to establish the result already cited.

Convergence of Densities for Stochastic Heat Equation, *Sefika Kuzgun* (University of Kansas)

Abstract: In this talk, we will consider two cases of stochastic heat equation in dimension one, driven by a space-time white noise. First, we present the one-dimensional stochastic heat equation driven by a space-time white noise with constant initial condition and then we continue with parabolic Anderson model with delta initial condition. The purpose of this talk is to show a recent result on the uniform convergence of the density of the normal- ized spatial averages on an interval $[R, R]$, as R tends to infinity, to the density of the standard normal distribution, assuming some non-degeneracy and regularity conditions on the nonlinear coefficient σ in the first case and after renormalization of the solution in the second case. The proof is based on a combination of the techniques of Malliavin calculus with Steins method for normal approximations. This is a joint work with David Nualart.

Hurst Estimation for Operator Scaling Random Fields, *Jeonghwa Lee* (Truman State University)

Abstract: Estimation method for Hurst indices in operator scaling Gaussian random field(OSGRF) is developed. OSGRF that has two Hurst parameters along the two orthogonal directions is considered. The two directions are estimated first, then Hurst indices are estimated along the estimated directions. The performance of estimator is investigated theoretically and empirically.

Numerical stochastic integrations and limit theorems, *Yanghui Liu* (CUNY)

Abstract: Rough paths techniques give the ability to define solutions of stochastic differential equations driven by low-regularity signals which are not semi-martingales. In this context, rough integrals are usually Riemann-Stieltjes integrals with correction terms that are sometimes seen as unnatural. As opposed to those somewhat artificial correction terms, in this talk I will introduce a trapezoid rule for rough integrals driven by general d-dimensional Gaussian processes. Namely we shall approximate a generic rough integral by Riemann sums avoiding the usual higher order correction terms, making the expression easier to work with and more natural. Our approximations apply to all controlled processes and to a wide range of Gaussian processes including fractional Brownian motion with a Hurst parameter $H > 1/4$. This is a joint work with Zachary Selk and Samy Tindel.

Peakedness comparison for hyperbolic cosine and sine ratio random fields, *Chunsheng Ma* (Wichita State University)

Abstract: We introduce several vector random fields whose finite-dimensional characteristic functions are of hyperbolic type, including generalized logistic, hyperbolic secant, hyperbolic tangent, hyperbolic cosine ratio, and hyperbolic sine ratio vector random fields. They are elliptically contoured (spherically invariant) vector random fields with all orders of moments, and are infinitely divisible. In the scalar case, we make the peakedness comparison among these random fields. Some related subordinators on the nonnegative line are also developed.

Local times for systems of non-linear stochastic heat equations, *Yassine Nachit* (Cadi Ayyad University, Morocco)

Abstract: We consider $u(t,x) = (u_1(t,x), \cdots, u_d(t,x))$ the solution to a system of non-linear stochastic heat equations in spatial dimension one driven by a d-dimensional space-time white noise. We prove that, when $d \leq 3$, the local time $L(\xi, t)$ of $\{u(t,x)\,,\ t \in [0,T]\}$ exists and $L(\bullet, t)$ belongs a.s. to the Sobolev space $H^{\alpha}(\mathbb{R}^d)$ for $\alpha < \frac{4-d}{2}$, and when $d \geq 4$, the local time does not exist. We also show joint continuity and establish Hölder conditions for the local time of $\{u(t,x)\,,\ t \in [0,T]\}$. These results are then used to investigate the irregularity of the coordinate functions of $\{u(t,x)\,,\ t \in [0,T]\}$. Comparing to similar results obtained for the linear stochastic heat equation (i.e., the solution is Gaussian), we believe that our results are sharp. Finally, we get a sharp estimate for the partial derivatives of the joint density of $(u(t_1,x) - u(t_0,x), \cdots, u(t_n,x) - u(t_{n-1},x))$, which is a new result and of independent interest.

Stochastic Lotka-Volterra Competitive Reaction-Diffusion Systems Perturbed by Space-Time White Noise: Modeling and Analysis, *Nhu Nguyen* (University of Connecticut)

Abstract: Motivated by the traditional Lotka-Volterra competitive models, this paper proposes and analyzes a class of stochastic reaction-diffusion partial differential equations. In contrast to the models in the literature, the new formulation enables spatial dependence of the species. In addition, the noise process is allowed to be space-time white noise. In this work, wellposedness, regularity of solutions, existence of density, and existence of an invariant measure for stochastic reaction-diffusion systems with non-Lipschitz and non-linear growth coefficients and multi-

plicative noise are considered. By combining the random field approach and infinite integration theory approach in SPDEs for mild solutions, analysis is carried out. Then this paper develops a Lotka-Volterra competitive system under general setting; longtime properties are studied with the help of newly developed tools in stochastic calculus.

Intermittency Property of Stochastic Heat and Wave Equations with Dobrić Ojeda type noise, *Ruxiao Qian* (Lehigh University)

Abstract: Research on the Stochastic Heat and Wave Equations with fractional noise has been the topic of broad literature recently. In this article, we use Dobric-Ojeda type noise, a spatially homogeneous noise that behaves in time similarly to a fractional Brownian motion . We obtain upper bound and lower bound for the moments of order $p \geq 2$ of the solution in the case $H > 1/4$, which implies the intermittency of the solution. These results match the ones obtained with fractional Brownian motion noise, but without the need for Malliavin Calculus. The method of proof is motivated by Dalang,Mueller and Tribe [Trans. Amer. Math. Soc. 360 (2008) 4681-4703] , Khoshnevisan, Foondun [Electron. J. Probab.Vol. 14 (2009), Paper no. 21, pages 548-568.] and Wildman [Lehigh University,Theses and Dissertations. 2876. This is a joint work with Professor Daniel Conus.

Fourier Method on Sufficient Dimension Reduction in Time Series, *S. Y. Samadi and T. P. D. Alwis* (Southern Illinois University Carbondale)

Abstract: Dimensionality reduction has always been one of the most important and challenging problem in high- dimensional data analysis. In the context of time series analysis, we are interested in estimating and making inference about the conditional mean and variance functions. Using the central mean and variance dimension reduction subspace, that preserve sufficient information about the response, one can estimate the unknown mean and variance functions of the time series. There are a few approaches in the literature to estimate the time series central mean subspace TS-CMS). However, those methods are computationally intensive and not feasible in practice. Using the Fourier transform, an explicit estimate of the time series central mean subspace is obtained. The proposed estimators are shown to be consistent, asymptotically normal and efficient. Simulation studies are conducted to evaluate the performance of the proposed method. The results show that our method is significantly more accurate, and computationally approximately 10,000 times faster than the existing method. The method is applied to the Canadian Lynx dataset.

Local limit theorem for linear random fields, *Hailin Sang* (The University of Mississippi)

Abstract: We establish local limit theorems for linear random fields when the i.i.d. innovations have finite second moment or the innovations have infinite second moment and belong to the domain of attraction of a stable law with index $0 < \alpha \leq 2$ under the condition that the innovations are centered if $1 < \alpha \leq 2$ and are symmetric if $\alpha = 1$. When the coefficients are absolutely summable we do not have restriction on the regions of summation. However, when the coefficients are absolutely summable we add the variables on unions of rectangle and we impose regularity conditions on the coefficients depending on the number of rectangles

considered. Our results are new also for the dimension 1, i.e. for linear sequences of random variables. The examples include the fractionally integrated processes for which the results of a simulation study is also included.

This talk is based on joint work with Timothy Fortune, Magda Peligrad, Yimin Xiao and Guangyu Yang.

Explicit Solutions of the Extended Skorokhod Problems in Affine Transformations of Time-Dependent Strata, *Marek Slaby* (Fairleigh Dickinson University)

Abstract: The main goal of the talk is to present the explicit formula for the solutions of the extended Skorokhod Problem developed earlier for a special class of constraining domains in $\mathbb{R}^n$ with orthogonal reflection fields. We examine how affine transformations convert solutions of the extended Skorokhod problem into solutions of the new problem for the transformed constraining system. We obtain an explicit formula for the solutions of the Extended Skorokhod Problem for any $\mathbb{R}^n$-valued càdlàg function with the constraining set that changes in time and the reflection field naturally defined by any basis. The evolving constraining set is a region sandwiched between two graphs in the coordinate system generating the reflection field. We discuss Lipschitz properties of the extended Skorokhod map and derive Lipschitz constants in special cases of constraining sets of this type.

The SPDE/GMRF-based Approach to The Spatio-Temporal Dynamics of Crowdfunding Campaign, *Han Yu* (University of Northern Colorado)

Abstract: We consider a hierarchical spatio-temporal model through the SPDE/GMRF-based approach motivated by the crowdfunding that quickly gained popularity in recent year as a novel additional method for financing a variety of new entrepreneurial ventures, for which it is still unknown to scholars and people who use crowdfunding services whether the crowdfunding efforts reinforce or contradict existing theories about the dynamics of successful entrepreneurial financing. To deal with the challenges of statistical inference for infinite-dimensional models involving the big dense covariance matrices when large spatio-temporal datasets are present, a class of "self-similar" functions (simple, efficient in a reusable and modular way) is introduced for the spatio-temporal process modeling. Bayesian inference is implemented for the etiology of cognitive processes of the crowdfunding.