Program of Cincinnati Symposium on Probability Theory and Applications, 2014

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September 19, Friday
Taft Research Center, Edwards One, 45–51 Cory Boulevard

13:50-14:25 **Joseph Najnudel**, Institut de Mathématiques de Toulouse
A limiting random analytic function related to the CUE
14:25-15:00 **Abey Lopez-Garcia**, University of South Alabama
The normal matrix model with monomial potential and multi-orthogonality on a star
15:00-15:30 Coffee Break
15:30-16:30 **Stilian Stoev**, University of Michigan, Ann Arbor
Implicit extremes and implicit max-stable laws
16:45-17:45 Taft Lecture
Gennady Samorodnitsky, Cornell University
Beyond the color of the noise: what is "memory" in random phenomena?
Reception to follow

September 20, Saturday
60 West Charlton, Room 277

09:30-10:30 **Paul Bourgade**, New York University
Fixed energy universality for generalized Wigner matrices
10:30-11:00 Coffee Break
11:00-12:00 **Tiefeng Jiang**, University of Minnesota
Moments of Traces for Circular Beta-ensembles
12:00-14:00 Lunch (participants on their own)
14:00-14:35 **Antonio Auffinger**, Northwestern University
Strict convexity of the Parisi functional
14:35-15:10 **Seung-Yeop Lee**, University of South Florida
Asymptotics of orthogonal polynomial in random normal matrices: higher order correction
15:10-15:45 Coffee Break
15:45-16:45 **Jack Silverstein**, North Carolina State University
The Stieltjes transform and its role in eigenvalue behavior of large dimensional random matrices
17:00-18:30 Poster forum and reception

September 21, Sunday
60 West Charlton, Room 277

09:30-10:30 **Florence Merlevède**, Université Marne-la-Vallée
Strong approximation for additive functionals of geometrically ergodic Markov chains
10:30-11:00 Coffee Break
11:00-12:00 **Dalibor Volný**, Université de Rouen
Bernoulli dynamical systems and limit theorems
12:00-13:45 Lunch (participants on their own)
13:45-14:20 **Paul Jung**, University of Alabama, Birmingham
Levy-Khintchine random matrices and the Poisson weighted infinite skeleton tree
14:20-14:55 **Thomas Bothner**, Concordia University
Universality results for the Cauchy-Laguerre chain matrix model
14:55-15:15 Coffee Break
15:15-15:50 **Cheng Ouyang**, University of Illinois, Chicago
Geometric deviation of the Lévy's occupation time arcsine law
15:50-16:25 **Jana Klicnarová**, University of South Bohemia
Invariance principle for weakly dependent random fields

Taft Lecture

September 19, Friday, 16:45–17:45pm

Beyond the color of the noise: what is "memory" in random phenomena?

Gennady Samorodnitsky, Cornell University

Randomness, by some definitions, means absence of intelligible patterns in a series of observations. Since the term "a probability law" is very commonly used, some patterns must still be present. A special type of patterns in a random phenomena is related to temporal (or spatial) memory. In science and engineering, absence or presence of temporal memory is often understood through the lenses of white or colored noises.

In many applications, however, the color of the noise does not carry nearly enough information. This is particularly true when one is interested in extremes. We will discuss a variety of ways to think about memory in random processes. We will also discuss stochastic models with a broad range of memory properties.

Talks

September 19, Friday

13:50-14:25

A limiting random analytic function related to the CUE

Joseph Najnudel, Institut de Mathématiques de Toulouse

In a joint work with R. Chhaibi and A. Nikeghbali, we show that, when properly rescaled in time on in space, the characteristic polynomial of a random unitary matrix converges almost surely to a random analytic function whose zeros, which are on real line, form a determinantal point process with sine kernel. We conjecture that this random function is also related to the short-scale behavior of the Riemann zeta function near the critical line.

14:25-15:00

The normal matrix model with monomial potential and multi-orthogonality on a star

Abey Lopez-Garcia, University of South Alabama

In this talk I will discuss the normal matrix model with a monomial potential of arbitrary degree and its connection with a class of multiple orthogonal polynomials associated with certain analytic weights defined on a star-like set. It turns out that in a subcritical regime, one can establish a close relation between the zero limiting distribution of the multiple orthogonal polynomials and the eigenvalue distribution in the model. The former can be expressed in terms of the solution to a vector equilibrium problem which will be discussed. The talk is based on a recent work with A. Kuijlaars, and our approach is derived from a simplification of a recent approach of Bleher and Kuijlaars to the model in terms of the analysis of a certain class of complex sesquilinear forms.

15:30-16:30

Implicit extremes and implicit max-stable laws

Stilian Stoev, University of Michigan, Ann Arbor

Let $X_1, \cdots, X_n$ be iid random vectors and $f \geq 0$ be a non–negative function. Let also $k(n) = \mathrm{Argmax}_{i=1,\cdots,n} f(X_i)$. We are interested in the distribution of $X_{k(n)}$ and their limit theorems. In other words, what is the distribution the random vector where a function of its components is extreme. This question is motivated by a kind of inverse problem where one wants to determine the extremal behavior of X when only explicitly observing $f(X)$. We shall refer to such types of results as to *implicit extremes*. It turns out that as in the usual case of explicit extremes, all limit *implicit extreme value* laws are *implicit max–stable*. We characterize the regularly varying implicit max–stable laws in terms of their spectral and stochastic representations and illustrate the theory with examples drawing connections to *hidden regular variation* and regular variation on general cones. Joint work with Hans-Peter Scheffler.

September 20, Saturday

09:30-10:30

Fixed energy universality for generalized Wigner matrices

Paul Bourgade, New York University

I will explain the proof (with Erdos, Yau, Yin) of the Wigner-Dyson-Mehta conjecture at fixed energy in the bulk of the spectrum for generalized symmetric and Hermitian Wigner matrices. Previous results concerning the universality of random matrices either require an averaging in the energy parameter or they hold only for Hermitian matrices if the energy parameter is fixed. We develop a homogenization theory of the Dyson Brownian motion and show that microscopic universality follows from mesoscopic statistics.

11:00-12:00

Moments of Traces for Circular Beta-ensembles

Tiefeng Jiang, University of Minnesota

For the random eigenvalues from Dyson's circular beta-ensemble, we obtain inequalities of the moments of power-sum symmetric function for a partition. When $\beta = 2$, our inequalities recover an identity by Diaconis and Evans for Haar-invariant unitary matrices. Further, we have limit results on the moments. These results apply to the three important ensembles: Circular Orthogonal Ensemble ($\beta = 1$), Circular Unitary Ensemble ($\beta = 2$) and Circular Symplectic Ensemble ($\beta = 4$). The central limit theorems for the three cases are also obtained. The main tool is the Jack function. This is a joint work with Sho Matsumoto.

14:00-14:35

Asymptotics of orthogonal polynomial in random normal matrices: higher order correction

Seung-Yeop Lee, University of South Florida

We conjecture a formula for the correction to the orthogonal polynomials that appears in random normal matrices. The leading asymptotics of orthogonal polynomial has been conjectured though the complete proof is yet missing. Our conjecture of the correction term is based on a few exact results obtained from the simple case of Hermite polynomial. This is based on the joint work with Roman Riser.

14:35-15:10

Strict convexity of the Parisi functional

Antonio Auffinger, Northwestern University

Spin glasses are magnetic systems exhibiting both quenched disorder and frustration, and have often been cited as examples of "complex systems." As mathematical objects, they provide several fascinating structures and conjectures. This talk will cover recent progress that shed more light in the mysterious and beautiful solution proposed 30 years ago by G. Parisi. We will focus on properties of the free energy of the famous Sherrington-Kirkpatrick model and we will explain a recent proof of the strict convexity of the Parisi functional. Based on a joint work with Wei-Kuo Chen.

15:45-16:45

The Stieltjes transform and its role in eigenvalue behavior of large dimensional random matrices

Jack Silverstein, North Carolina State University

The talk will focus on my work on the limiting spectral properties of three classes of Hermitian random matrices as the dimension increases. These matrices appear in various areas of science, including multivariate statistics, multivariate statistics, signal processing, wireless communications, and genetics. Limiting results will be presented along with the main steps used in proving them, with special emphasis on the primary tool used, the Stieltjes transform.

September 21, Sunday

09:30-10:30

Strong approximation for additive functionals of geometrically ergodic Markov chains

Florence Merlevède, Université de Marne-la-Vallée, France

The talk will focus on a Komlos-Major-Tusnady type strong approximation for additive functionals of Markov chains. We will show that if we consider bounded functionals of a stationary Harris recurrent geometrically ergodic Markov chain on a countably generated state space, then we obtain the almost sure strong approximation of their associated sums by the partial sums of a sequence of independent and identically distributed Gaussian random variables with the optimal rate O (log n). The talk is based on a joint work with E. Rio.

11:00-12:00

Bernoulli dynamical systems and limit theorems

Dalibor Volný, Université de Rouren

In applications, many stationary processes are Bernoulli and for several decades, in probabilists community there was known a conjecture saying that every stationary process is Bernoulli. From Bernoulli processes, the most different ones are those of zero entropy. We will study impact of these properties of dynamical system on limit theorems both for stationary processes and for random fields.

13:45-14:20

Levy-Khintchine random matrices and the Poisson weighted infinite skeleton tree

Paul Jung, University of Alabama, Birmingham

We consider a class of Hermitian random matrices which includes and generalizes Wigner matrices, heavy-tailed random matrices, and sparse random matrices such as the adjacency matrices of Erdos-Renyi random graphs with $p \sim 1/N$. The $N \times N$ random matrices have real entries which are i.i.d. up to symmetry. The distributions may depend on N, however, the sums of rows must converge in distribution; it is then well-known that the limiting distributions are infinitely divisible.

A limiting empirical spectral distribution (LSD) exists, and via local weak convergence of associated graphs, the LSD corresponds to the spectral measure at the root of a Poisson weighted infinite skeleton tree. This graph is formed by connecting infinitely many Poisson weighted infinite trees using a backbone structure of special edges called "cords to infinity". One example covered by the results are matrices with i.i.d. entries having infinite second moments, but normalized to be in the Gaussian domain of attraction. In this case, the limiting graph is just the natural numbers rooted at 1, and as expected, the LSD is Wigner's semi-circle law. The results also extend to self-adjoint complex matrices and also to Wishart matrices.

14:20-14:55

Universality results for the Cauchy-Laguerre chain matrix model

Thomas Bothner, CRM Montréal

This talk discusses certain aspects of the Cauchy matrix chain, an example of a "multi- matrix model" in which p positive-definite Hermitian matrices are coupled subject to Cauchy interaction. The eigenvalues of the model form a determinantal random point field which means that we can express all correlation functions in closed determinantal form. Starting from the latter feature, we address the important issue of scaling limits near a macroscopical point in the spectrum and identification of (universal) limiting kernels: near the hard edge in the Cauchy-Laguerre chain, the limiting field is explicitly derived in terms of Meijer G-functions. This generalizes the classical Bessel-field of the corresponding one-matrix model as well as the Meijer-G two-field for the Cauchy-Laguerre two-matrix model. Our proof uses the connection of the finite correlation kernels to the solution of a $(p \times p)$ matrix Riemann-Hilbert problem and for the scaling limit the derivation of strong asymptotics for the underlying Cauchy biorthogonal polynomials. This is joint work with Marco Bertola.

15:20-15:55

Geometric deviation of the Lévy's occupation time arcsine law

Cheng Ouyang, University of Illinois, Chicago

We study Lévy's arcsine law near a hypersurface on a Riemannian manifold. The main result is that the deviation from the arcsine law is expressed in terms of the mean curvature of the hypersurface.

15:55-16:30

Invariance principle for weakly dependent random fields.

Jana Klicnarová, University of South Bohemia

The aim of the talk is to present some new results on an Invariance Principle for weakly dependent random fields. In their paper Volný and Wang proved an Invariance Principle under Hannan's condition in case of the summation over rectangles. We will show that the theorem holds under Hannan's condition for a summation similar to that in the recent result by El Machkouri, Volný and Wu. The talk is based on joint work with Dalibor, Volný and Yizao Wang. Supported by Czech Science Foundation (project n. P201/11/P164).

Poster presentations

(1) **Shuyang (Ray) Bai**, Boston University.
Fractional Processes on Wiener Chaos and Non-central Limit Theorems.
(2) **David Barrera**, University of Cincinnati.
Quenched Limit Theorems for Fourier Transforms.
(3) **Davide Giraudo**, Université de Rouen, France.
Lamperti Invariance Principle for Weakly Dependent Sequences.
(4) **Wenqing Hu**, University of Minnesota.
On Second Order Elliptic Equations with a Small Parameter.
(5) **Martial Longla**, University of Mississippi.
Convex combinations of copulas and mixing coefficients.
(6) **Mavis Pararai**, Indiana University of Pennsylvania.
A New Class of Generalized Inverse Weibull Distribution with Applications.
(7) **Farzad Sabzikar**, Michigan State University.
Tempered Hermite Process.
(8) **Abolfazl Safikhani**, Michigan State University.
Spectral Conditions for Equivalence of Gaussian Random Fields with stationary increments.
(9) **Emma Teal**, University of Cincinnati.
Efficient Seed Collection Strategies for the Genetic Conservation of the American Chestnut.
(10) **Ke Wang**, University of Minnesota.
Matrix perturbation bounds with random noise.
(11) **Xuan Wang**, Indiana University, Bloomington.
Invariance Principle for Critical Random Graphs.
(12) **Yiren Wang**, University of Cincinnati.
Statistical Quality Control in Longitudinal Proteomics Clinical Experiments.
(13) **Yuzhen Zhou**, Michigan State University.
Tail Asymptotics of Extremes for Bivariate Gaussian Random Field.

Fractional Processes on Wiener Chaos and Non-central Limit Theorems

Shuyang (Ray) Bai, Boston University

By fractional processes, we mean self-similar processes with stationary increments. These processes are important because of their connection to the scaling limits of sum of stationary sequences. If the scaling limit is not a Brownian motion, this type of results are called non-central limit theorems. We focus here on some fractional processes defined on a Wiener chaos of a single order. In particular, we introduce a class of processes called generalized Hermite processes, which include the fractional Brownian motion, and more generally, the Hermite processes considered in the literature. We obtain new non-central limit theorems where the generalized Hermite processes arise as the scaling limits of some long-memory nonlinear stationary sequences.

Quenched Limit Theorems for Fourier Transforms

David Barrera, University of Cincinnati

The discrete Fourier transforms of stationary, centered process in L^2 satisfy a quenched version of the Central Limit Theorem. We present this and previous, related, theorems. A discussion of examples is also presented.

Lamperti Invariance Principle for Weakly Dependent Sequences

Davide Giraudo, Université de Rouen, France

Let $(X_j)_{j\geqslant 1}$ be a strictly stationary sequence of random variables, $S_k := X_1 + \cdots + X_k$ and W_n the random function which is piecewise linear and $W_n(k/n) = S_k$. We investigate the asymptotic behavior of $n^{-1/2}W_n$

viewed as an element of the space of Hölder-regular functions of exponent $\alpha \in (0, 1/2)$. We shall consider the following cases:

- $(X_j)_j$ is a stationary ergodic sequence of martingale differences;
- $(X_j)_j$ is an α, ρ or interlaced ρ-mixing sequence.

On Second Order Elliptic Equations with a Small Parameter

Wenqing Hu, University of Minnesota

The Neumann problem with a small parameter

$$\left(\frac{1}{\varepsilon}L_0 + L_1\right) u^\varepsilon(x) = f(x) \text{ for } x \in G,\ \left.\frac{\partial u^\varepsilon}{\partial \gamma^\varepsilon}(x)\right|_{\partial G} = 0$$

is considered in this paper. The operators L_0 and L_1 are self-adjoint second order operators. We assume that L_0 has a non-negative characteristic form and L_1 is strictly elliptic. The reflection is with respect to inward co-normal unit vector $\gamma^\varepsilon(x)$. The behavior of $\lim_{\varepsilon \downarrow 0} u^\varepsilon(x)$ is effectively described via the solution of an ordinary differential equation on a tree. We calculate the differential operators inside the edges of this tree and the gluing condition at the root. Our approach is based on an analysis of the corresponding diffusion processes. This is a joint work with Professor Freidlin from University of Maryland.

Convex combinations of copulas and mixing coefficients

Martial Longla, University of Mississippi

We show how mixing properties can be inherited from the copula of one of the distributions in a mixture of populations. We investigate uniform mixing, ρ-mixing, β-mixing, ψ-mixing and lower ψ-mixing.

A New Class of Generalized Inverse Weibull Distribution with Applications

Mavis Pararai, Indiana University of Pennsylvania

The gamma-inverse Weibull (GIW) distribution which includes inverse Weibull, inverse exponential, gamma-inverse exponential, gamma-inverse Rayleigh, inverse Rayleigh, gamma-Fréchet and Fréchet distributions as special cases is proposed and studied. This new distribution might be useful for failure time data analysis. Some mathematical properties of the new distribution including moments, mean deviations, Bonferroni and Lorenz curves, Shannon and Rényi entropies are presented. Maximum likelihood estimation technique is used to estimate the parameters and applications to real data sets are given to illustrate the usefulness of this new class of distributions.

Tempered Hermite Process

Farzad Sabzikar, Michigan State University

Tempered Hermite process (THP) modifies the power law kernel in the time domain representation of a Hermite process, adding an exponential tempering. This paper develops the basic theory of THP, including time and spectral domain representations, spectral density and sample path properties. The winner integral with respect to THP^1 which is tempered Hermite process of order one will be investigated by applying tempered fractional calculus as well. Finally, a limit theorem will be presented to show that THP^1 is the limit of the finite dimensional distribution of a time series.

Spectral Conditions for Equivalence of Gaussian Random Fields with stationary increments

Abolfazl Safikhani, Michigan State University

Space-time models have become increasingly popular in scientific studies. Recent works in this field consist of construction of non-stationary anisotropic Gaussian random fields (GRFs). However, the problem of equivalence of measures corresponding to GRFs, which has direct consequences on the study of such models, is discussed mostly for the stationary case, and results for the non-stationary case are limited. In this article, we investigate the problem of equivalence of GRFs with stationary increments, and obtain sufficient conditions for equivalence in terms of the behavior of the spectral measures at infinity. Further, the main results are applied to a rich family of non-stationary space-time models with possible anisotropy behavior.

Efficient Seed Collection Strategies for the Genetic Conservation of the American Chestnut

Emma Teal, University of Cincinnati

The American Chestnut is a North-American tree that was devastated by a blight in the early 20th century. Using the program NEWGARDEN, the population growth and genetic diversity of a chestnut stand was modeled in order to determine the most efficient and effective method to collect seed such that the reintroduced chestnut population most accurately represented the genetic composition of the original stand. A multivariate statistical analysis will then follow these simulations in order to determine which collection method captures the most alleles in the original chestnut stand and, thus, will carry on to best genetically represent the stand in the reintroduced population.

Matrix perturbation bounds with random noise

Ke Wang, University of Minnesota

Computing singular vectors of a large matrix is a basic task in high dimensional data analysis with many applications in computer science and statistics. In practice, the data is usually perturbed by noise. The following question is of importance: How much does the singular value or singular vector of data matrix change under a small perturbation? The classical perturbation results, i.e. Weyl's inequality, Davis-Kahan theorem and Wedin sin theorem, give tight estimates for the worst-case scenario. We show that better estimates can be achieved if the data matrix is low rank and the perturbation is random. This is joint work with Sean O'Rourke and Van Vu.

Invariance Principle for Critical Random Graphs

Xuan Wang, Indiana University, Bloomington

Abstract: Consider the Erdős-Rényi random graph $G(n, p)$ in the critical window, that is when $p = 1/n + \lambda/n^{4/3}$, for some fixed $\lambda \in \mathbb{R}$. Addario-Berry, Broutin and Goldschmidt (2009) shows that the largest connected components of this graph, viewed as metric spaces using the graph distance scaled by $n^{-1/3}$, converge to a sequence of continuous metric spaces. It was expected that such convergence should be universally true for a wide range of critical random graph models. However, the lack of homogeneity and independence makes it hard to recover the same result beyond the Erdős-Rényi model. We propose a general framework which can be used to study the scaling limit of many different critical random graph models. Using our method, we establish the same scaling limit in the critical regime for three families of models: the inhomogeneous random graphs, the bounded-size-rule processes, and the critical edge percolation on the configuration model. This is joint work with S. Bhamidi, N. Broutin and S. Sen.

Statistical Quality Control in Longitudinal Proteomics Clinical Experiments

Yiren Wang, University of Cincinnati

This study aims at evaluating the performance stability of the clinical proteomics experiments. Proteomics technology provides detailed profile of proteins in a biological sample. It exhibits great potential to help researchers differentiate biological differences between phenotypes (for example, cancer patients vs. healthy individuals). The spread of these technologies, however, is accompanied by persistent concerns about the quality of proteomics methods. We employ a group of statistical quality control methods to analyze the multivariate quality metrics obtained on a proteomics instrument during 2008-2009. The principal methods include Shewhart control chart, cumulative sum plot (CUSUM), and exponentially weighted moving average (EWMA) control chart. The detected out of control patterns guide us for further investigation on the instrumental or operational changes in the experiment and their impacts.

Tail Asymptotics of Extremes for Bivariate Gaussian Random Field

Yuzhen Zhou, Michigan State University

Excursion probability of univariate random field has been applied to lots of statistical problems. Motivated by the increasing need for multivariate spatial modeling, we study the excursion probability of a class of non-smooth bivariate Gaussian random field. Applying the double sum method, we establish an explicit form for the tail probability of double extremes for the bivariate field.