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**Workshop on Disturbed Random Processes (III)**

**扰动随机过程论坛 (III)**



**Conference Manual**

**会议手册**

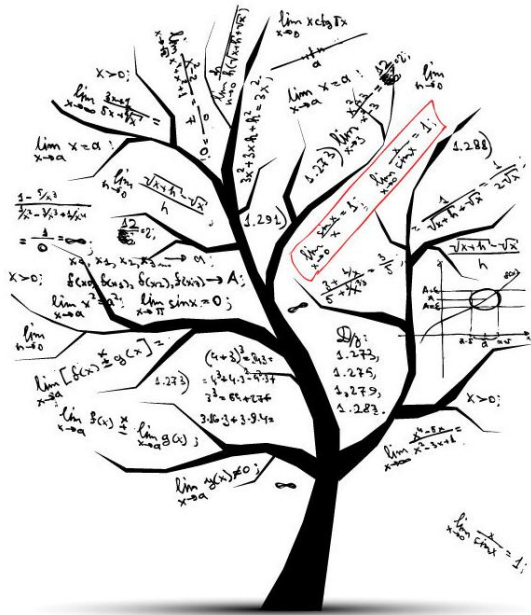
**School of Mathematics and Statistics  
Xidian University, Xi'an, Shaanxi, China**

November 21, 2023

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## ● Joint Organizing Committee 联合组委会

Xidian (XDU): Congzao DONG Shihua WANG Wendi Li

Kyiv: Alexander IKSANOV Igor SAMOILENKO Alexander MARYNYCH

## ● Contact Information 联系信息

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## ● Meeting Form, Venue and Date 会议形式地点和时间

**Form 形式:** Online Only 线上

**Online Platform 会议平台:** Voov Meeting 腾讯会议

**Meeting ID 会议 ID:** 236-633-093      Free access 无密码

**Website Access 会议网络入口:**

<https://meeting.tencent.com/dm/WwKuHXJtZTY9>

**Date 会议日期:** Tuesday on November 21 十一月二十一日周二

## ● Sponsors 主办单位和赞助

西安电子科技大学 数学与统计学院

科技部 “一带一路” 创新人才交流外国专家项目

西安 “一带一路” 统计学与随机理论及应用国际科技合作基地



## Agenda 会议日程

<b>Workshop on Disturbed Random Processes (III)</b>					
<b>No.</b>	<b>Beijing Time</b>	<b>Kyiv Time</b>	<b>Speaker</b>	<b>Title</b>	<b>Chair</b>
1	13:50-14:00	07:50-08:00	Lijun Bo	Opening speech by the Dean	Congzao DONG
2	14:00-14:40	08:00-08:40	Igor Samoilenko	Asymptotic behavior of dynamic population and epidemic models with impulse impacts	Alexander IKSANOV
3	14:50-15:30	08:50-09:30	Dariusz Buraczewski	Random walks in a sparse random environment	
4	15:40-16:10	09:40-10:10	Wendi Li	Quasi-stationary behavior for Markov-modulated Markov chains	
5	16:20-17:00	10:20-11:00	Alexander Marynych	High-dimensional limits for random walks	Wendi LI
6	17:10-17:40	11:10-11:40	Shihua Wang	A mean field game approach to equilibrium consumption under external habit formation	
<b>Break for dinner/lunch: 50 Minutes</b>					
7	18:30-19:10	12:30-13:10	Alexander Iksanov	On decoupled random walks	Alexander MARYNYCH
8	19:20-19:50	13:20-13:50	Tongqing Li	Centralized systemic risk control in the interbank system: Weak formulation and Gamma-convergence	
9	20:00-20:40	14:00-14:40	Andrey Pilipenko	On multidimensional perturbed random walks	Shihua WANG
10	20:50-21:20	14:50-15:20	Shen Peng	Mathematical programs with distributionally robust chance constraints: Statistical robustness, discretization and reformulation	

## **Titles and Abstracts 标题及摘要**

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### **Asymptotic behavior of dynamic population and epidemic models with impulse impacts**

**Igor Samoilenko**

**Abstract:**

We construct and study a continuous evolutionary model that describes a complex dynamical system with impulsive effects in a random environment. The dynamics of the system is similar to the Lotka-Volterra-type model, namely the SIR model of the spread of infection. At the same time, the model foresees both a change of functioning modes due to a switching random process, and the presence of rare but significant random influences. The task is to study and predict the parameters of the dynamic system at increasing time intervals. We interpret the new pattern of infection spread as the effect of rare burst infections that rapidly change the numbers of infected and sick people. As a result, the quantitative indicators of the population model change randomly, which we can analyze using different approximation schemes.

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### **Random walks in a sparse random environment**

**Dariusz Buraczewski**

**Abstract:**

Random walks in random environment (RWRE) were introduced in the 1970s to model a random motion of a particle in the presence of some kind of obstacle. The behavior of any RWRE is affected by both the environment and the walker's randomness. We will introduce random walks in a sparse random environment. The integer points of the real line are marked by the positions of a standard random walk with positive integer jumps. We consider a nearest neighbor random walk on the set of integers having jumps  $\pm 1$  with probability  $1/2$  at every nonmarked site, whereas a random drift is imposed at every marked site. We will present some new limit



theorems for the above defined random process in the so-called quenched settings. During the talk, we will also state some open problems related to RWSRE.

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## Quasi-stationary behavior for Markov-modulated Markov chains

Wendi Li

**Abstract:** In this talk, we present the quasi-stationary distribution for Markov-modulated Markov chains. We focus on two fundamental aspects (existence and uniqueness, convergence) in connection with quasi-stationary distribution. We first provide a sufficient criterion for the existence of the quasi-stationary distribution. An iterative algorithm to compute all quasi-stationary distributions is presented. We then carry out a study on the convergence, from a given initial distribution, to the corresponding quasi-stationary distribution. In addition, we apply the results to M/G/1-type Markov chains, and characterize the asymptotic behavior of the quasi-stationary distribution for this model. Finally, a scalar example is given to illustrate these results.

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## High-dimensional limits for random walks

Alexander Marynych

**Abstract:**

We prove limit theorems for random walks with  $n$  steps in the  $d$ -dimensional Euclidean space as both  $n$  and  $d$  tend to infinity. If a generic step of such a random walk has uncorrelated components and its squared norm has finite expectation we show that a properly rescaled random walk trajectory viewed as a random metric space converges in probability in the Gromov-Hausdorff sense to a deterministic metric space called Wiener spiral as  $d, n \rightarrow \infty$ . In case when the squared norm of the generic step has infinite expectation its tail is regularly varying with index  $-\alpha$   $\alpha \in (0,1)$  and the angular components of two different steps are asymptotically orthogonal as  $d \rightarrow \infty$  we prove that the random walk path converges in distribution in the Gromov-Hausdorff sense to a genuinely random metric space identified with the range of a certain  $l_2$ -valued random process that we call  $\alpha$ -stable crinkled subordinator. The latter can be



thought of as a version of the usual  $\alpha$ -stable subordinator with each out of countably many jumps being in a direction orthogonal to the directions of all other jumps.

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## A Mean Field Game Approach to Equilibrium Consumption under External Habit Formation

Shihua Wang

### Abstract

This paper studies the equilibrium consumption under external habit formation in a large population of agents. We first formulate problems under two types of conventional habit formation preferences, namely linear and multiplicative external habit formation, in a mean field game framework. In a log-normal market model with the asset specialization, we characterize one mean field equilibrium in analytical form in each problem, allowing us to understand some quantitative properties of the equilibrium strategy and conclude some financial implications caused by consumption habits from a mean field perspective. In each problem with  $n$  agents, we can construct an approximate Nash equilibrium for the  $n$ -player game using the obtained mean field equilibrium when  $n$  is sufficiently large. The explicit convergence order in each problem can also be obtained.

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## On decoupled random walks

Alexander Iksanov

### Abstract:

We call a decoupled random walk a sequence  $\hat{S}_1, \hat{S}_2, \dots$  of independent random variables such that, for each  $n \in \mathbb{N}$ ,  $\hat{S}_n$  has the same distribution as the position at time  $n$  of a standard random walk with nonnegative jumps. Similarly, we call a decoupled renewal process the counting process  $(\hat{N}_t)_{t \geq 0}$  defined by  $\hat{N}_t = \sum_{n \geq 1} 1_{\hat{S}_n \leq t}$ . I shall present a functional limit theorem for  $(\hat{N}_t)_{t \geq 0}$ , properly scaled, normalized and centered, as  $t \rightarrow \infty$  under the assumption that the variance of  $\hat{S}_1$  is positive and finite. Also, I shall discuss the asymptotic of  $\log P\{\min_{n \geq 1} \hat{S}_n \geq t\}$  as  $t \rightarrow \infty$  under various assumptions imposed on the distribution of  $\hat{S}_1$ . Our interest to the so defined decoupled random walks was caused



by their appearance in the particular case when  $\hat{s}_1$  has an exponential distribution of unit mean in the context of infinite Ginibre point processes.

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## Centralized systemic risk control in the interbank system: Weak formulation and Gamma-convergence

Tongqing Li

### Abstract:

In this talk, we introduce a systemic risk control problem by the central bank, which dynamically plans monetary supply to stabilize the interbank system with borrowing and lending activities. Facing both heterogeneity among banks and the common noise, the central bank aims to find an optimal strategy to minimize the average distance between log-monetary reserves of all banks and the benchmark of some target steady levels. A weak formulation is adopted, and an optimal randomized control can be obtained in the system with finite banks by applying Ekeland's variational principle. As the number of banks grows large, we prove the convergence of optimal strategies using the Gamma-convergence argument, which yields an optimal weak control in the mean field model. It is shown that this mean field optimal control is associated to the solution of a stochastic Fokker–Planck–Kolmogorov (FPK) equation, for which the uniqueness of the solution is established under some mild conditions.

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## On multidimensional perturbed random walks

Andrey Pilipenko

### Abstract:

Let  $(X_n)$  be a Markov chain on a multidimensional lattice. Suppose that jumps  $(X_n)$  outside a fixed set  $A$  belong to the domain of attraction of a stable law and are arbitrary in  $A$ . We will call  $(X_n)$  a random walk perturbed in the set  $A$ . We study functional limit theorems for scaling limits of  $(X_n)$ . It is proven that if the jumps from  $A$  are not too heavy-tailed, in particular, if they have a finite positive moment, then the distribution of the corresponding scale limit is a stable process. This means that perturbations have no effect in a long range. We also provide a counterexample if perturbation has very heavy tails.





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## **Mathematical programs with distributionally robust chance constraints: Statistical robustness, discretization and reformulation**

**Shen Peng**

**Abstract:**

In this talk, we consider mathematical programs with distributionally robust chance constraints (MPDRCC), where the ambiguity set is given by the general moment information. From the contaminated data-driven viewpoint, we first study the qualitative statistical robustness of MPDRCC. Then, motivated by the computational tractability, we investigate the discrete approximation of MPDRCC. The corresponding convergence results of the optimal value and the optimal solution set of the discrete approximation problem are established. After that, a reformulation of the discrete approximation problem is presented under standard assumptions, which is applied to solve MPDRCC approximately according to the above convergence results. Finally, two applications are reported, and some numerical results show that the statistical robustness assertion and the discrete approximation scheme are practical and effective.