ESF – Science Meeting – Scientific report

"Stochastic Methods in Finance and Physics"

ACMAC, Heraklion, Greece

15–19 July 2013

1. Summary

The workshop *Stochastic Methods in Finance and Physics* was organized at the Department of Applied Mathematics of the University of Crete and the Archimedes Center for Modeling, Analysis and Computation (ACMAC) and took place at the facilities of ACMAC in Voutes campus, Heraklion, from the 15th to the 19th of July 2013. The organizing committee comprised of the ACMAC member Michail Loulakis (NTUA, Greece), Peter Friz (TU Berlin & WIAS, Germany), Claudio Landim (IMPA, Rio de Janeiro, Brazil & CNRS, France) and Antonis Papapantoleon (TU Berlin, Germany). The meeting had a total of 51 participants from Europe and South America with a good mixture of experienced researchers and younger participants (undergraduate and graduate students, and post-docs).

During the five days of the workshop, there were 6 two-hour mini-courses delivered by leading researchers in their fields (Deuschel, Gaudilliere, Horst, Landim, Teichmann, Weber)[1] directed towards students and young researchers who wanted to learn and deepen their knowledge in Stochastic Analysis and some of its most recent applications. In addition, there were also a total of 20 talks contributed by junior researchers and 4 posters by PhD students. The mini-courses, talks and posters presentations were followed by lively interactions and discussions.

The topics presented in the mini-courses, talks and posters covered a very wide spectrum of Stochastic Analysis and its applications, ranging from interacting particle systems and stochastic PDEs to equilibrium theory and term structure modeling.

2. Scientific Content

The main aims of this workshop were, on the one hand, to create a forum for the presentation of cutting-edge research in stochastic analysis and its applications in the fields of mathematical finance and mathematical physics and, on the other hand, to promote young faculty members, post-docs and PhD students by giving them the opportunity to learn from the mini-courses, present their research and interact with the senior researchers.

The *mini-courses* were presented by international experts in the respective fields, and each delivered two lectures of one hour. In what follows the content of each course is briefly summarized.

Jean-Dominique Deuschel (Technical University Berlin)

Quenched invariance principle for random conductance model

We consider a continuous time random walk on the lattice $\mathbb{Z}^d$ in an environment of symmetric random conductances, $\mu_{x,y}$. The law of the environment is assumed to be ergodic with respect to space shifts with $\mathbb{P}(0 < \mu_{x,y} < \infty) = 1$. In this talk, we show how a quenched invariance principle can be established under suitable moment conditions. A key ingredient in the proof is to establish the sub-linearity of the corrector by means of Moser's iteration

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[1]Unfortunately, Thaleia Zariphopoulou had to cancel her participation for personal reasons.

scheme. We also get parabolick Harnack inequalities and quenched local limit theorems.

Alexandre Gaudillière (CNRS - Marseille - LATP)

Metastability and quasi-stationnary measures

We will compare restricted ensembles and quasi-stationary distributions to describe the metastability phenomenon. This will be done by elementary spectral techniques to study convergence to local equilibrium and by introducing "soft measures" as an interpolation between quasi-stationary measures and restricted ensemble to recover in this way the "exponential law". We will then introduce some potential theoretic tools, and in particular "(κ, λ)-capacities" to compute all the relevant times via variational principal: exit, relaxation, transition and mixing time.

Ulrich Horst (Humboldt University Berlin)

Principal-Agent Games and Equilibria under Asymmetric Information

We discuss a mathematical framework within which we study various equilibrium problems under asymmetric information. The framework had originally been developed to establish existence of equilibrium results for repeated games under incomplete information. We review the original model in the first session. Suitably extended, it is flexible enough, though, to allow for an analysis of much more general (cooperative or Principal-Agent) games and of optimal risk sharing problems with private information when both parties evaluate their risk exposures using convex risk measures.

Claudio Landim (IMPA / CNRS Rouen)

Metastability of Markov processes

We investigate the metastable behavior of three models: zero-range processes which exhibit condensation, random walks among random traps, and the Kawasaki dynamics for the Ising lattice gas in a large two-dimensional square with periodic boundary conditions.

Josef Teichmann (ETH Zürich)

Term structure models in discrete time

We present a self-contained and elementary theory for term structure models in discrete time, which can be applied to model the term structure of interest rates, of implied volatility smiles, or of credit spreads.

Hendrik Weber (University of Warwick)

Recent progress in the theory of non-linear stochastic PDEs

Nonlinear stochastic PDE arise as scaling limits of models in statistical physics near critical points. These natural noise term that arises in these limits is typically quite rough - often space time white noise. In these lectures I will survey some recent developments when studying these non-linear equations. Among the examples discussed will be stochastic Reaction diffusion equations and the KPZ equation.

The *talks* were contributed by young researchers, typically junior faculty members and post-docs. They also covered a wide spectrum of topics in stochastic analysis and applications in mathematical physics and mathematical finance.

The first talks were mostly concentrated on mathematical physics: *Stefan Grosskinsky* talked about the dynamics of condensation in the inclusion process and *Nikolaos Zygouras*

about continuum limits for random pinning models and Wiener chaos expansions. The talk of *Dimitrios Tsagkarogiannis* was about non-equilibrium processes for current reservoirs, while *Rebecca Neukirch* studied the problem of metastability for the zero-range process. *Paul Gassiat* used rough path analysis to understand physical Brownian motion in a magnetic field. *Paul Chleboun* talked about the separations of time scales in the low temperature East model, while *Martin Slowik* complemented the mini-course of J.-D. Deuschel by presenting a local limit theorem for the random conductance model in a degenerate ergodic environment. *Inés Armendáriz* discussed the convergence to equilibrium of the trajectories in Hammersley's process, while *Elena Sartori* presented some research on the interface of mathematical physics and finance; she talked about probabilistic models for interacting agents facing binary decisions.

The rest of the talks were focused on mathematical economics and finance. *Michail Anthropelos* presented an equilibrium model for commodity spot and forward prices, while *Selim Gökay* discussed the problem of superreplication for an agent that trades at market indifference prices. *Christoph Mainberger* talked about optimal supersolutions of convex BSDEs under constraints, while *Asgar Jamneshan* presented the newly developed concept of a conditional set theory and outlined its applications in mathematical economics. The talk of *Martin Klimmek* was about optimal martingale transport with Monge's cost function, while *Harald Oberhauser* was interested in Root's and Rost's solution of the Skorohod embedding problem. *Michael Kupper* presented some recent results on duality and superhedging in markets with model uncertainty. *Zorana Grbac* presented a theory of affine LIBOR models with multiple curves and continued with examples and calibration to market data, while *Sebastian Riedel* discussed random Fourier series as rough paths and applied those results to solve a certain class of SPDEs. *Christos Kountzakis* presented a setting for coherent risk measures in the presence of heavy tailed distributions, while *Christian Bayer* discussed asymptotic methods for the pricing of basket options in correlated local volatility models.

There were also four *poster presentations* delivered by PhD students. *Tatiana Gonzalez Grandon* used Mandelbrot's random cutouts in order to characterize the set of zeros of GWI and CBI processes, while *Xanthi-Isidora Kartala* presented her work on rational expectations, consol rate models, and stochastic viscosity solutions. The poster of *Illia Simonov* was about the numerical approximation of the solution to parabolic SPDEs forced by a Levy noise, while *Marios Stamatakis* presented his work on a hydrodynamic limit for the zero range process in the presence of condensation.

The slides of the mini-courses, talks and poster presentations are available for download at the conference webpage:

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`http://www.acmac.uoc.gr/SMFP2013/`

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3. **Assessment of the Results and Impact of the Workshop**

The field of stochastic analysis is a flourishing field of mathematics, partly due to its applications in physics, biology, economics and finance, which have raised interesting and challenging questions, leading to new research directions. The workshop on *Stochastic Methods in Finance and Physics* has brought together some of the leading researchers in stochastic analysis with significant expertise in the applications to physics and finance. They had the opportunity to learn about new developments in their respective fields and exchange ideas about problems and solution techniques.

The mini-courses gave the opportunity to students and young researchers to learn about recent developments in stochastic analysis and its applications, and discuss with the more experienced researchers in the relaxed atmosphere that is offered by the ACMAC center.

They also had the opportunity to present their own research results in front of an expert audience, and receive helpful feedback. Indeed, the discussion spaces that are offered at ACMAC were frequently occupied by participants during the five days of the workshop. Moreover, there was high number of undergraduate and graduate students from Greek universities that attended the workshop. Since stochastic analysis is rather less represented in Greece compared to other fields (e.g. Analysis or PDEs), it was a prime opportunity for students to learn about this exciting branch of mathematics.

Concluding, the feedback we received from the participants was uniformly very positive, both about the scientific contents of the workshop and about the location and facilities offered by ACMAC. Several have even expressed their desire to return for a similar event in two or three years.

4. List of Pariticipants

 (1) Anthropelos Michail, University of Piraeus
 (2) Armendariz Ines, University of Buenos Aires (UBA)
 (3) Bayer Christian, Weierstrass Institute
 (4) Chatzitoliou Sofia, University of Crete
 (5) Chleboun Paul, Warwick Maths Institute
 (6) Deuschel Jean-Dominique, TU Berlin
 (7) Dimakis Konstantinos, University of Crete
 (8) Englezos Nikolaos, University of Piraeus
 (9) Gassiat Paul, TU Berlin
(10) Gaudilliere Alexandre, CNRS - Marseille - LATP
(11) Gokay Selim, Technische Universitat Berlin
(12) Gonzalez Grandon Tatiana, Berlin Math School
(13) Grbac Zorana, Technical University Berlin
(14) Grosskinsky Stefan, University of Warwick
(15) Horst Ulrich, Humboldt University Berlin
(16) Jamneshan Asgar, Humboldt University Berlin
(17) Kartala Xanthi-Isidora, Athens University of Economics and Business
(18) Klimmek Martin, Oxford University
(19) Kountzakis Christos, University of the Aegean
(20) Kupper Michael, University of Konstanz
(21) Landim Claudio, IMPA
(22) Loulakis Michail, National Technical University of Athens and ACMAC
(23) Mainberger Christoph, Humboldt Universitaet zu Berlin
(24) Neukirch Rebecca, University of Bonn
(25) Oberhauser Harald, TU Berlin
(26) Papadaki Panayiota, University of Crete
(27) Papadopoulos Apostolos, University of Crete
(28) Papagiannouli Aikaterini, National Technical University of Athens
(29) Papapantoleon Antonis, TU Berlin
(30) Pulvirenti Elena, ACMAC
(31) Rempoutsika Lemonia-Marina, University of Crete
(32) Riedel Sebastian, TU Berlin
(33) Saplaouras Alexandros, Technical University of Berlin
(34) Sartori Elena, Ca' Foscari University of Venice
(35) Sfakianakis Theodoros, University of Piraeus
(36) Simonov Illia, University of Leoben
(37) Skaftourou Aikaterini, University of Crete
(38) Slowik Martin, TU Berlin
(39) Sourdis Christos, University of Crete
(40) Stamatakis Marios, University of Crete
(41) Tatsi Marianna, University of Piraeus
(42) Teichmann Josef, ETH Zurich
(43) Toursounidi Paraskevi, University of Crete
(44) Toursounidi Christina, University of Crete
(45) Tsagkarogiannis Dimitrios, University of Crete
(46) Tsenoglou Ioannis, University of Edinburgh
(47) Tsourtis Tasos, University of Crete
(48) Vu Lan Nguyen, Ecole Normale Superieur Paris
(49) Weber Hendrik, University of Warwick

(50) Xatzitoliou Sofia, University of Crete
(51) Zygouras Nikolaos, Warwick University

5. **Program of the Workshop**

Monday

9:00–9:15	**Opening Address**
9:15–10:15	**Jean-Dominique Deuschel**
	Quenched invariance principle for random conductance model I
10:15–11:15	**Alexandre Gaudillière**
	Metastability and quasi-stationnary measures I
11:15–11:45	Coffee Break
11:45–12:45	**Stefan Grosskinsky**
	Dynamics of condensation in the inclusion process
12:45–13:45	**Nikolaos Zygouras**
	Continuum limits for random pinning models and Wiener chaos expansions
13:45–15:15	Lunch and Coffee Break
15:15–16:15	**Dimitrios Tsagkarogiannis**
	Nonequilibrium Processes for Current Reservoirs
16:15–16:45	**Rebecca Neukirch**
	Metastability in the zero-range process
16:45–17:15	**Paul Gassiat**
	Physical Brownian motion in magnetic field as rough path

Tuesday

9:00–10:00	**Hendrik Weber**
	Recent progress in the theory of non-linear stochastic PDEs I
10:00–11:00	**Jean-Dominique Deuschel**
	Quenched invariance principle for random conductance model II
11:00–11:30	Coffee Break
11:30–12:30	**Claudio Landim**
	Metastability of Markov processes I
12:30–13:30	**Alexandre Gaudillière**
	Metastability and quasi-stationnary measures II
13:30–15:00	Lunch and Coffee Break
15:00–15:30	**Paul Chleboun**
	Time scale separation in the low temperature East model
15:30–16:00	**Martin Slowik**
	Local limit theorem for the random conductance model in a degenerate ergodic environment
16:00–17:00	**Poster Session**

Wednesday

9:00–10:00	**Claudio Landim** Metastability of Markov processes II
10:00–11:00	**Hendrik Weber** Recent progress in the theory of non-linear stochastic PDEs II
11:00–11:30	Coffee Break
11:30–12:30	**Inés Armendáriz** Convergence to equilibrium of the trajectories in Hammersley's process
12:30–13:30	**Elena Sartori** Probabilistic models for interacting agents facing binary decisions
13:30–15:00	Lunch and Coffee Break
15:00– 20:30–	**Free Evening and Excursion** **Conference Dinner**

Thursday

9:00–10:00	**Ulrich Horst** Principal-Agent Games and Equilibria under Asymmetric Information I
10:00–11:00	**Ulrich Horst** Principal-Agent Games and Equilibria under Asymmetric Information II
11:00–11:30	Coffee Break
11:30–12:00	**Michail Anthropelos** An equilibrium model for commodity spot and forward prices
12:00–12:30	**Selim Gökay** Superreplication when trading at market indifference prices
12:30–13:00	**Christoph Mainberger** Optimal supersolutions of convex BSDEs under constraints
13:00–13:30	**Asgar Jamneshan** Conditional set theory
13:30–15:00	Lunch and Coffee Break
15:00–15:30	**Martin Klimmek** Optimal martingale transport with Monge's cost function
15:30–16:00	**Harald Oberhauser** Root's and Rost's solution of the Skorohod embedding problem
16:00–17:00	**Michael Kupper** On the duality of the superhedging price under model uncertainty

Friday

9:00–10:00	**Josef Teichmann**
	Term structure models in discrete time I
10:00–11:00	**Josef Teichmann**
	Term structure models in discrete time II
11:00–11:30	Coffee Break
11:30–12:30	**Zorana Grbac**
	Affine LIBOR models with multiple curves: theory, examples and calibration
12:30–13:00	**Sebastian Riedel**
	Random Fourier series as rough paths and applications to a class of SPDEs
13:00–13:30	**Christos Kountzakis**
	Canonical modelling for coherent risk measures in dominated variation of tails
13:30–15:00	Lunch and Coffee Break
15:00–16:00	**Christian Bayer**
	Asymptotics beats Monte Carlo: The case of correlated local vol baskets