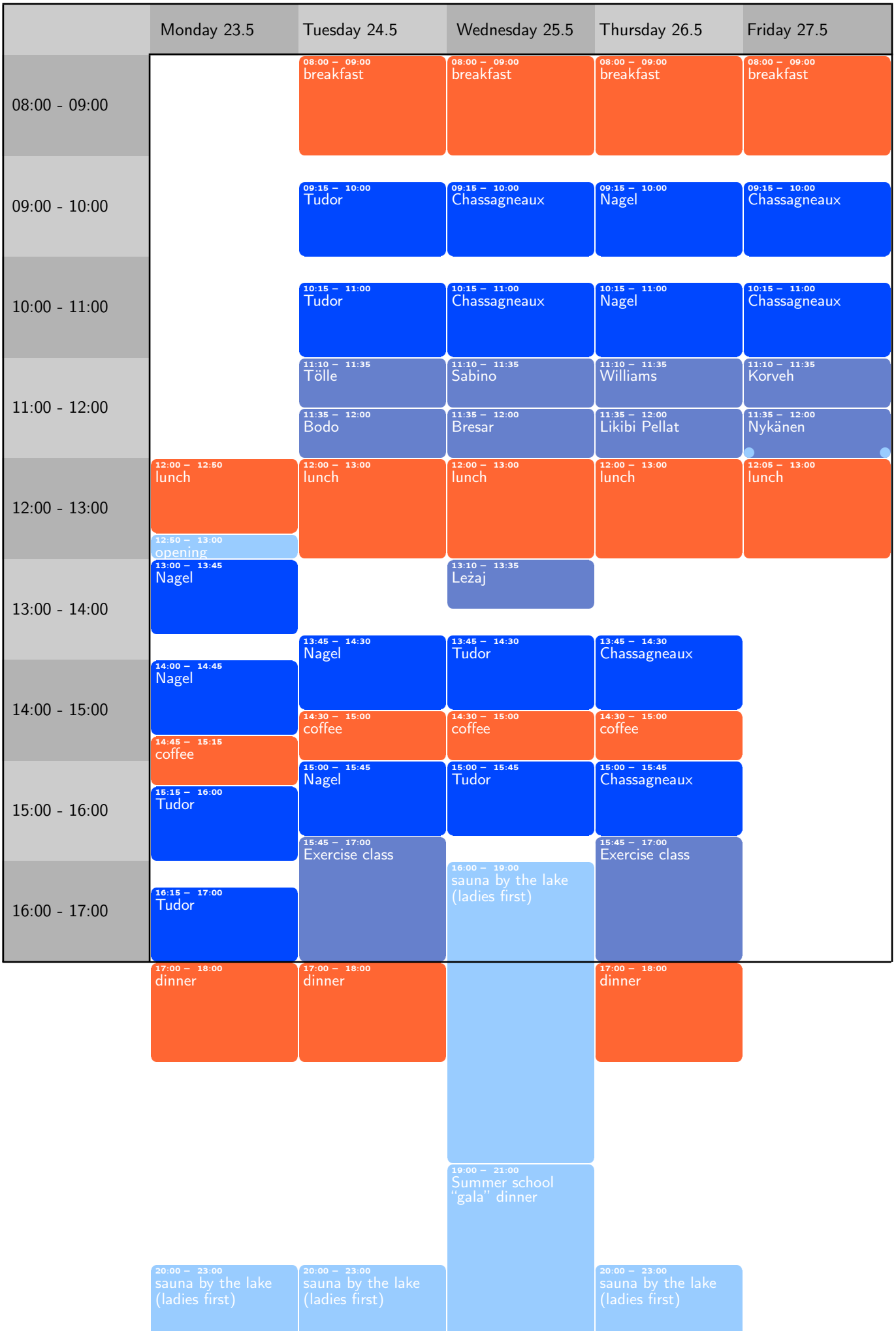
40th Finnish Summer School on Probability and Statistics, Lammi Biological Station



1. Minicourses

Non-Gaussian selfsimilar processes.

Ciprian Tudor

Lille

Abstract Self-similar processes are stochastic processes that are invariant in distribution under a suitable time scaling. These processes are often used as models for various random phenomena. The most known self-similar process is the fractional Brownian motion (fBm), which can be defined as the only Gaussian self-similar process with stationary increments. Its stochastic analysis constitutes an important research direction in probability theory nowadays. The Hermite processes are non-Gaussian extensions of the fBm. These processes, which are are also self-similar, with stationary increments and exhibit long-range dependence, have been also intensively studied in the last decades. The purpose of these lectures is to present the basic properties of the Hermite processes and to discuss some elements of the stochastic analysis with respect to them.

Probabilistic numerical methods for non-linear PDEs.

Jean-François Chassagneaux

Paris

Large deviations, moment problems and sum rules

Jan Nagel

Dortmund

Abstract In this course, we study the convergence of random probability measures which are spectral measures of random matrices. These measures can be described in different ways, in terms of moments, orthogonal polynomials or by their spectral information. In order to prove large deviation statements, it can be helpful to switch between different descriptions. It turns out that there is a very interesting and surprising connection between large deviations for random spectral measures and important identities in spectral theory called sum rules. We will study these identities from a probabilistic point of view, by proving large deviation statements in different encodings of the measures. This yields a new interpretation of sum rules and a probabilistic strategy to derive new sum rules.

2. Contributed talks

Differentiability of quadratic forward-backward SDEs with non-Lipschitz drift

Rhoss Beauneur Likibi Pellat

African Institute for Mathematical Sciences(AIMS-Ghana)/University of Ghana

Abstract In this paper, we consider quadratic forward-backward SDEs (QFBSDEs), where the drift in the diffusion in the forward equation does not satisfy the standard globally Lipschitz condition and the driver of the backward system fulfil a nonlinearity of type $f(|y|)|z|^2$, where f is any locally integrable function. We prove both the Malliavin and classical derivative of the QFBSDE and provide the representation of these processes. We study a numerical approximation of this system in the sense of [2, 1, 3] and show that the rate of convergence is the same when the drift is Lipschitz and the driver of the BSDE is quadratic in the traditional sense.

Keywords Quadratic BSDEs; BMO martingale; Malliavin calculus, stochastic flows, numerical approximation

References

[1] P. Imkeller and G. Dos Reis. Corrigendum to "Path regularity and explicit convergence rate for BSDE with truncated quadratic growth" [stochastic process.appl. 120 (2010) 348-379]. *Stochastic Process.Appl.*, 120:2286–2288, 2010.

[2] P. Imkeller and G. Dos Reis. Path regularity and explicit convergence rate for bsde with truncated quadratic growth. *Stoch. Process. Appl.*, 120:348–379, 2010.

[3] G. Dos Reis. *On some properties of solutions to quadratic growth BSDE and applications to finance and insurance.* PhD thesis, Humboldt University, 2010.

Mean field stochastic differential equations with a discontinuous diffusion coefficient

Jani Nykänen

University of Jyväskylä

Abstract We consider R^d-valued mean field stochastic differential equations of the type

$$X_t = x_0 + \int_0^t \sigma(s, X_s, \|X_s\|_{L_p})dB_s + \int_0^t b(s, X_s, \|X_s\|_{L_p})ds$$

with infinite time horizon, where $B = (B_t)_{t\in[0,\infty)}$ is a d-dimensional Brownian motion. We discuss the existence of a solution in the case that the diffusion and drift coefficient satisfy standard assumptions, but with the main exception that the diffusion coefficient σ is discontinuous in the L_p component.

Normal Tempered Stable Processes and the Pricing of Energy Derivatives

Piergiacomo Sabino

University of Helsinki

Abstract In this study we consider the pricing of energy derivatives when the evolution of spot prices is modeled with a normal tempered stable driven Ornstein-Uhlenbeck process. Such processes are the generalization of normal inverse Gaussian processes that are widely used in energy finance applications. We first specify their statistical properties calculating their characteristic function in closed form. This result is instrumental for the derivation of non-arbitrage conditions such that the spot dynamics is consistent with the forward curve without relying on numerical approximations or on numerical integration. Moreover, we conceive an efficient algorithm for the exact generation of the trajectories which gives the possibility to implement Monte Carlo simulations without approximations or bias. We illustrate the applicability of the theoretical findings and the simulation algorithms in the context of the pricing of different contracts, namely, strips of daily call options, Asian options with European style and swing options. Finally, we present an extension to future markets.

Keywords: Lévy-driven Ornstein-Uhlenbeck Processes; Normal Tempered Stable processes; Simulations; Energy Markets; Derivative Pricing

Transition densities of subordinators

Łukasz Leżaj

University of Jyväskylä

Reflected diffusions with asymptotically normal reflection

Miha Bresar

University of Warwick

Abstract Stability of reflecting random walks and diffusions in unbounded domains have been studied for many years. Recently we have considered a multidimensional driftless diffusion in generalised parabolic domain. We begin by classifying phase transitions between transience and recurrence, depending on model parameters and quantify recurrence via passage-time moments. In the positive recurrent case, we further classify asymptotic properties of invariant distribution and the rate of convergence in total variation distance. This is joint work with Aleks Mijatovic and Andrew Wade.

Variability of paths and differential equations with BV-coefficients

Jonas Tölle

Aalto University

Abstract In stochastic analysis, it is well-established to interpret stochastic differential equations (SDEs) in integrated form, a viewpoint conceptually strongly related to the distributional formulation of partial differential equations. However, there are many situations, where even the concept of the integral is subtle. Several powerful theories have emerged to treat these situations, such as rough path theory or the theory of regularity structures. On the other hand, these methods are usually applied to situations where the coefficient maps are smooth, and most of the existing methods break down

completely if one allows discontinuities (provided that the forcing term is not too regular). In particular, this is the case if we admit general functions of bounded variation (BV-functions) as a possible choice of our nonlinear coefficients. In this talk, we combine tools from fractional calculus and harmonic analysis, together with certain fine properties of BV-functions, allowing us to give a meaningful definition for (multidimensional) generalized Lebesgue-Stieltjes integrals for sufficiently regular Hölder functions. The key idea is that the unknown function should not spend too much time on the "bad" regions of the BV-coefficient maps. Our novel multiplicative composition estimate leads to a systematic way to quantify this in terms of potential theory of Riesz energies and the occupation measure of the unknown function. We discuss several consequences, and provide existence and uniqueness results for certain differential systems involving BV-coefficients, which can be applied to pathwise SDEs with focus on the fractional Brownian motion. Furthermore, we may relax our hypotheses by formulating them in terms of fractional Sobolev norms such that our results can be extended to certain discontinuous paths, such as typical realizations of certain Lévy processes. The talk is based on joint works together with: Michael Hinz (Bielefeld University) & Lauri Viitasaari (Uppsala University): `https://arxiv.org/abs/2003.11698`, `https://arxiv.org/abs/2105.06249`.

Stochastic integration with respect to canonical α-stable cylindrical Lévy processes

Gergely Bodo

King's College London

Abstract In this work, we introduce a theory of stochastic integration with respect to symmetric α-stable cylindrical Lévy processes. Since α-stable cylindrical Lévy processes do not enjoy a semi-martingale decomposition, our approach is based on a decoupling inequality for the tangent sequence of the Radonified increments. This approach enables us to characterise the largest space of predictable Hilbert-Schmidt operator-valued processes which are integrable with respect to an α-stable cylindrical Lévy process as the collection of all predictable processes with paths in the Bochner space L^α. We demonstrate the power and robustness of the developed theory by establishing a dominated convergence result allowing the interchange of the stochastic integral and limit.

Risk-indifference pricing under contagion

Edward Korveh

African Institute for Mathematical Sciences (AIMS) Ghana & University of Ghana

Abstract In this talk, we present the pricing of a contingent claim when considering contagion effects in the market. The problem is formulated as a stochastic differential game between the market and an investor in the market, and is solved via stochastic maximum principle.

NB: This is a joint work with Olivier Menoukeu Pamen (IFAM, University of Liverpool, UK, and German Research Chair in Stochastic and Finance, AIMS Ghana).

Differential geometry on MCMC Hamiltonian

Bernardo Williams

University of Helsinki

Abstract Monte Carlo (HMC) together with the No U-turn sampler (NUTs) is go to algorithm for sampling from a posterior target distribution. It works efficiently and without hand tuning whenever the parameter space does not suffer from high curvature. Using differential Geometry it is possible to incorporate a Riemannian metric which is position dependent, this means that the metric adapts to areas of high curvature, furthermore, NUTs is generalised over manifolds eliminating the need for hand-tuning the parameters.

3. Participation and Accommodation fees

The participation fee (30 €) is to be paid on location in cash.

The accommodation fee depends on the number of nights the participant is staying and the type of room. The participants who have been awarded on their request a FDNSS-travel grant from the summer school organization do not need to pay the accommodation fee.

You are also very welcome to bring your family, don't need to pay for children under 4 years, and 4-10 old children years pay half of the lodging price.

The participants who are visiting the summer school for the day and do not need accommodation, can pay on place their lunch or dinner directly to the biological station cantine.

The accommodation fee for each night is

- 80.25 € in single room with WC and shower
- 71,25 € in single room
- 67 € in double room with WC and shower
- 62 € in double room

which includes also breakfast, lunch, coffee and dinner (and the summer school "gala"-dinner on wednesday)

If you are undergraduate student please use instead the discounted prices for undergraduates. ´

The accommodation fee (depending on the number of nights and type of room) can be paid by the participants or their supporting institutions by bank transfer to the University of Helsinki, with the following information:

Bank account IBAN: FI58 5000 0120 3778 32
SWIFT (BIC): OKOYFIHH
Recipient: Helsingin Yliopisto
Payment: First-name Family-name 40th Probability Summer School
Reference Number: H516/75160014
Amount: ? €× number of nights

Please don't forget the reference number!

4. Useful Information

4.1. **Recommendations on dealing with the Covid epidemic.** We will follow the guidelines of our host institution, the University of Helsinki: Coronavirus situation at the University of Helsinki

Please do not come to the summer school when ill or when experiencing symptoms of the coronavirus disease. In that case it is ok to cancel your partecipation and you will be completely refunded by the summer school organization of your accommodation fee.

Be sure to practise extremely careful hand and coughing hygiene.

VENUE:

Lammi Biological Station
Pääjärventie 320
16900 Lammi, Finland
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The nearest towns are Hämeenlinna (about 45 km) and Lahti (about 40 km), from which there are frequent bus connections to Lammi, see matkahuolto, onnibus. When you reach the bus stop in Lammi, please feel free to call Dario (the organizer) at the phone numbers +358503754069 , +358294151407, so that hopefully we can pick you up by car from the nearest bus-stop (Kirkkokallio).

Wi-Fi connection at Helsinki University facilities two Wi-Fi networks are available, eduroam and HelsinkiUni Guest with password *uniguest*

Free time activities The biological research station is surrounded by forest and it is next to a lake. Many activities are possible for relaxing during the free time, cycling, rowing , swimming in the lake (bring your swim suit!), fishing, sauna, walking / jogging in the forest, table-tennis, and there is also a volleyball court and a frisbee-golf course.

Let's hope that we will have nice summer weather, you can check the weather forecast here.

Welcome to Lammi !

5. Participants

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