Friedrich-Alexander-Universität
Naturwissenschaftliche Fakultät

GRK 2339 IntComSin
Lectures on
Kunita Flows and SPDE's
Speaker: Max Sauerbrey (MPI Leipzig)

List of Abstracts

Monday, March 2, 2026
Tuesday, March 3, 2026

Department of Mathematics
Cauerstr. 11, 91058 Erlangen

Lecture 1: *Basics of Stochastic Integration*

We introduce Brownian motion and state the Kolmogorov--Chentsov continuity condition. From the latter we observe the fundamental obstruction in S(P)DE theory: products arise, which are not classically defined. Introducing martingales and the Burkholder--Davis--Gundy inequality, we present Ito's classical approach to alleviate this issue using statistical cancellations. This leads to Ito integration allowing us to rephrase SDEs as suitable integral equations.

Lecture 2: *Stochastic Differential Equations and Flows of Diffeomorphisms*

We proceed to prove a classical well-posedness theorem for SDEs: the existence and uniqueness of solutions for Lipschitz coefficients. Unlike in the deterministic setting, when constructing a flow map, subtleties regarding null sets arise. Using Kunita's idea of leveraging the Kolmogorov--Chentsov theorem, see his lecture notes, we show that under suitable assumptions on the coefficients stochastic flows of diffeomorphisms may anyways be constructed.

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Lecture 3: *Ito--Wentzell Formulae and Applications to SPDEs*

We investigate the action of a function on an Ito process, resulting in the chain rule for stochastic processes called Ito's formula. If f is a random field, this leads to the Ito--Wentzell formula. Then we review standard well-posedness theory for linear parabolic SPDEs, which turns out too weak to apply the usual Ito--Wentzell formula. As a solution we suggest the version derived in a recent work with Antonio Agresti and Mark Veraar (arxiv:2511.12692).

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