Eighth Bielefeld-SNU joint Workshop in Mathematics Abstracts

Construction of skew-orthogonal polynomials from orthogonal polynomials for quaternionic non-hermitian random matrices

Markus Ebke

Skew-orthogonal polynomials can be used to determine the eigenvalue correlation functions of quaternionic non-hermitian random matrices. But finding the right set of polynomials for a given matrix ensemble is difficult. In my talk I will present a construction starting from the orthogonal polynomials of the complex non-hermitian ensemble, which is much better understood. I will show that if these orthogonal polynomials fulfill a three-step recurrence relation, then finding the sought after skew-orthogonal polynomials is easy.

Law of iterated logarithms for symmetric Dirichlet form

Jaehun Lee

In this talk, we discuss the law of iterated logarithm for symmetric Hunt processes in metric measure space equipped with volume doubling and reverse volume doubling conditions. For the Hunt process $X = (X_t)_{t\geq 0}$, we focus on the law of iterated logarithms for the distance $d(X_0, X_s)$ and local time $\ell(x, t)$. Especially, we concentrate on the sharp sufficient conditions when time goes to 0 or ∞.

This is joint work with Soobin Cho and Panki Kim.

Taming the MHD equations

Andre Schenke

In this talk, a new model for the flow of an electrically conducting fluid through a porous medium is presented: the *tamed magnetohydrodynamics (TMHD) equations*. After a brief discussion of regularisation schemes and motivation for fluid dynamical equations, we prove existence, uniqueness and regularity in the deterministic case. When the taming parameter tends to infinity, the solution to the TMHD equations converges in a suitable sense to a weak solution of the MHD equations. In the stochastic case, we prove existence and uniqueness of a solution for periodic boundary conditions, as well as existence of a Feller semigroup and an invariant measure. Finally, we discuss questions of uniqueness and ergodicity for this invariant measure.

Stochastic analysis of ensemble-based Kalman-type filters

Wilhelm Stannat

Ensemble-based Kalman-type filters form a large class of stochastic algorithms for the Bayesian state estimation of Markovian signals observed with noise. They have been invented in the context of numerical weather prediction and since then successfully applied to various estimation problems for time-structured data in the engineering and natural sciences. The theoretical understanding of many of their features, however, are still in their infancy.

In our talk we will present asymptotic results for Ensemble-based Kalman-type filters in the continuous time limit, thereby providing a rigorous mathematical derivation of the Ensemble Kalman-Bucy filter including approximation errors. A striking implication is the universality of the time-continuous limit across a large class of Ensemble-based Kalman-type filters.

We further investigate the behavior of the resulting Ensemble Kalman-Bucy filter applied to continuous-time filtering problems. We also derive mean field limiting equations in the infinite ensemble size limit to assess asymptotic consistency, as well as uniform-in-time accuracy and stability results for finite ensemble sizes.

References

[1] Long-time stability and accuracy of the ensemble Kalman-Bucy filter for fully observed processes and small measurement noise (with J. de Wiljes, S. Reich), SIAM J. Appl. Dyn. Syst., Vol. 17, 1152-1181, 2018.

[2] On the continuous time limit of the Ensemble Kalman Filter (with T. Lange), Preprint arXiv:1901.05204, submitted.

[3] On the continuous time limit of Ensemble Square Root Filters (with T. Lange), Preprint arXiv:1910.12493, submitted.

Well-posedness for a class of degenerate Itô-SDEs with fully discontinuous coefficients

Heasung Lee

We show uniqueness in law for a general class of stochastic differential equations in $\mathbb{R}^d$, $d \geq 2$, with possibly degenerate and/or fully discontinuous locally bounded coefficients among all weak solutions that spend zero time at the points of degeneracy of the dispersion matrix. The points of degeneracy have d-dimensional Lebesgue-Borel measure zero. Weak existence is obtained for more general, not necessarily locally bounded drift coefficient. Generalized Dirichlet form theory and regularity results for PDEs are the main tools to derive our results. This is joint work with Gerald Trutnau (Seoul National University).

Hölder Estimates for Parabolic Nonlocal Operators

Marvin Weidner

In this talk we study parabolic equations determined by nonlocal operators in a general framework of bounded and measurable coefficients. Our emphasis is on the weak Harnack inequality and Hölder regularity estimates for solutions of such equations. We allow the underlying jump measures to be singular with a singularity that depends on the coordinate direction. This approach also allows to study several classes of non-singular jump measures that have not been dealt with so far. This is joint work with Moritz Kassmann (Bielefeld University) and Jamil Chaker (University of Chicago).

Heat kernel bounds for non-local operators with singular kernels

Kyung-Youn Kim

We prove sharp two-sided bounds of the fundamental solution for an integro-differential operator of order $\alpha \in (0, 2)$ that generates a d-dimensional Markov processes. This process can be written as d independent copies of one-dimensional jump processes, i.e., the jumping measure is singular with respect to the d-dimensional Lebesgue measure. This is a joint work with Moritz Kassmann and Takashi Kumagai.