Universität Bielefeld | Fakultät für Physik

Condensed Matter Theory

Seminar

Michael Röckner

Universität Bielefeld

Nonlinear Fokker-Planck equations and distribution dependent SDE

Joint work with Viorel Barbu (Romanian Academy of Sciences, Iasi)
It is a classical problem to present a solution of a PDE as the density of the time marginal distributions of a stochastic process. If the PDE is a linear Fokker-Planck equation, then by classical stochastic analysis this is known to be true under very general conditions. For nonlinear Fokker-Planck equations the situation is much more difficult and only known to be true under very restrictive assumptions on the regularity of the (nonlinear) dependence of the coefficients in the Fokker-Planck equations on the solutions. In this talk a new general concept is presented, how to find the desired stochastic process (similarly as in the linear case) through solving a corresponding stochastic differential equation (SDE), whose coefficients, however, depend on the marginal distributions of its solution (DDSDE). The point is that this new general concept does not require strong regularity assumptions on the coefficients (as e.g. fulfilled for McKean-Vlasov type equations) and thus does not rule out a lot of other nonlinear Forker-Planck equations of interest in Physics. As an example it will be shown that it can be applied to the case, where the nonlinear Fokker-Planck equation is a generalized porous media equation on d-dimensional Euclidean space (with d arbitrary), perturbed by a transport term. So its solution is the density of the time marginal distributions of a (tractable) stochastic process solving a corresponding DDSDE. Apart from its conceptual interest this result could lead to new numerical approximations of solutions to nonlinear Fokker-Planck equations through numerically solving the corresponding DDSDE.
In the first part of the talk we shall recall the general connection between stochastic differential equations and (both linear and nonlinear) Fokker-Planck equations.
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